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Identifying Operations Research Systems Analysts' Technical Competencies: A Delphi Approach

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IDENTIFYING OPERATIONS RESEARCH SYSTEMS ANALYSTS'

TECHNICAL COMPETENCIES: A DELPHI APPROACH

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ABSTRACT

IDENTIFYING OPERATIONS RESEARCH SYSTEMS ANALYSTS' TECHNICAL COMPETENCIES: A DELPHI APPROACH

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After the attacks of September 11, 2011, the demands for more agile, adaptive, critical-thinking, and multi-talented U.S. Army Operations Research Systems Analysts (FA49s) have only increased. Tomorrow's joint operating environment demands U.S. Army FA49s to be ingenious, proactive, and multi-talented; proficient in their core competencies as military leaders as well as being proficient in their technical competencies as problem solvers in the operations research field.

The purpose of this study was to identify the technical competencies and knowledge, skills, and abilities (KSAs) required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical competencies and KSAs, this study employed a qualitative research design with a quantitative component using a conventional, web-assisted Delphi methodology.

The Delphi study engaged 10 experts through a first round of data gathering through a web-based questionnaire. First round data was synthesized and sent to the experts, seeking consensus, during a subsequent second round. Expert consensus was achieved on the second round, precluding the need for subsequent rounds to reach consensus. The study resulted in the experts' identification and consensus on 5 technical competencies, 21 areas of knowledge, 41 skills, and 22 abilities that are required for

future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

This research made four significant contributions to the engineering management discipline. First, it has added to the existing body of knowledge in engineering management theory and methodology by presenting and substantiating that a Delphi process is capable of identifying future and/or forecasting requirements. Second, it contributed to the literature by providing a basis for the expansion of the domain of competencies and KSAs for operations research. Third, this research contributed to the identification of competencies and KSAs that are germane to the practical development of military FA49 educational curricula and may be germane to the practical development of engineering management curricula. Fourth, this research has suggested directions for future research to enhance understanding of the competencies, knowledge, skills, and abilities for the operations research field.

This dissertation is dedicated to my loving wife and best friend, Suki.

Without her love, support, and belief in me, I would never have finished this endeavor.

My homework is done.

Plus 1, baby!

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INTRODUCTION

According to Lieutenant General David F. Melcher (2004), "Every organization must adapt or perish. ORSAs are no exception" (p. 2). When the General said this, he was then acting as the Deputy Chief of Staff, G8 (Resource Management), for the Army and the proponent for Functional Area 49 (FA49, Operations Research/Systems Analysis (ORSA)) and what he was ultimately referring to was the growing of U.S. Army FA49 leaders. General Melcher asked, "What exactly does leadership entail for an ORSA and what skills are required" (2004, p. 6). He posited that leadership within FA49 was twofold: 1) leading other analysts and 2) leading a multidisciplinary team (2004). He indicated that for the most part a U.S. Army FA49 was fairly well prepared to lead other analysts but was not as well prepared to lead a multidisciplinary team (2004). The crux of the matter for both leadership endeavors is the possession of competencies a United States (U. S.) Army FA49 needs as both an Officer (core competencies) and an analyst (technical competencies) in order to be successful.

Coming forward to 2012, while the senior leadership within the U.S. Army FA49 Proponent's Office may have changed, the question on the competencies and skills required of a U.S. Army FA49 still remains. According to the current U.S. Army FA49 Proponent Office's Strategic Plan, "it is critical to identify what the OR[SA] of the future must look like … in order to grow the right skill set now" (FA49 Proponent Office, 2011).

Chapter 1 begins with an overview of the potential environment of the future within which a U.S. Army FA49 will operate. With that environment described, an overview follows to provide a perspective of a U.S. Army FA49 officer. A statement of the problem is offered to identify a deficiency in past literature. The intent of the research study is established in the ensuing purpose statement. Research questions are then provided to narrow the focus of the research study. In the section on the nature of the study, a short overview of the research approach is provided. Assertions as to the significance of the study with regards to the field of engineering management are then advanced. Limitations on generalizability are then discussed. A delimitation, what the study is not intended to do, and definitions of key terms, designed to assist the reader, follow.

1.1 Joint Operating Environment

To the U. S. military, the operational environment is defined as "a composite of the conditions, circumstances, and influences that affect the employment of military forces and bear on the decisions of the unit commander" (United States Joint Chiefs of Staff, 2012, p. 270). The operational environment is further classified into current and future environments. As the onus of this study will focus on future U.S. Army FA49 competencies, only the future operational environment will be discussed.

In 2010, the United States Joint Forces Command (USJFCOM) published a revised study for the future operational environment, *The Joint Operating Environment, JOE 2010*, hereafter simply referred to as the JOE. While the JOE does not constitute U.S. government policy, it did serve as a starting point for deliberations about the future security environment (United States Joint Forces Command, 2010). While speculative in nature, the intent of the JOE was to inform the Department of Defense (DOD) about the future operating environment U.S. military forces could potentially face in the next twenty-five years (United States Joint Forces Command, 2010). Succinctly, the JOE reviews the trends influencing the world's security for the next quarter century, analyzes the operational contexts that will frame the future security environment, and forecasts possible implications for the U.S. armed forces. The JOE concludes with a section highlighting future opportunities. The following is an overview of the trends and the contextual environment identified in the JOE.

The JOE identified ten trend areas that will set the stage for the operational contexts that will frame the future security environment. The trends were chosen for one of three reasons: first, "how a trend might enhance or erode the power of a specific state" (United States Joint Forces Command, 2010, p. 12), second, "how a trend might enhance or erode the power of the overall state system of relations relative to non-state actors" (United States Joint Forces Command, 2010, p. 12), or third, "how trends contribute to the emergence or suppression of global networks or ideologies that transcend the international system as we currently perceive it" (United States Joint Forces Command, 2010, p. 12). Linear or non-linear trajectories for these trends, either individually or in combination, pose resource and strategic implications for U.S. national security in the future (United States Joint Forces Command, 2010). It is the understanding of these trends and their resultant contexts that will enable U.S. armed forces to be prepared for the future. Subsequently, it is imperative FA49s are acutely aware of these trends and contexts to properly perform their roles and responsibilities as problem solvers and identifiers of risk. The ten trends are enumerated in Table 1 along with entailing specifics extracted from the JOE (United States Joint Forces Command, 2010). Next is a synopsis of the contexts for conflict and war identified in the JOE.

Trend Area	Entails
Demographics	Predictable consequences for populations of regions and states Implications for future strategic postures and attitudes 8 billion by 2030 95% of population increase will occur in developing countries Number of elderly in developed countries will increase 2x Youth bulge creating unemployed young men in developing countries
Globalization	Peaceful and cooperative world only if globalization continues Global remittance flows
Economics	Global trade and finance imbalances U.S. federal spending and revenue Squeezing of U.S. discretionary spending
Energy	By 2030, demand estimated to be 50% greater Fossil fuels comprise 80% of energy Coal usage will double in developing countries Lack of reserves not the issue, instead platforms and refining capacity shortage Implications for future conflict Pooling of U.S. and allied resources may become imperative
Food	Driving factors include growing population and prosperity expanding dietary preferences Grain use and projected demand Fish stocks
Water	World's clean water supply increasingly at risk by 2030 Growing populations will make water shortages more acute 40% of world's population will face water stress
Climate Change and Natural Disasters	Global warming and its effects Rising of global sea levels will affect 20% of world's population Natural disasters colliding with urban sprawl
Pandemics	Appearance of a pathogen, natural or manmade, capable of devastating mankind Not likely but responses must be considered Profound implications for U.S. forces

Table 1 - JOE Trend Areas

Trend Area	Entails
Cyber	If current pace continues, greater change will occur by 2030 than occurred in the whole of the 20th century Key is how these advances will be put to use Advances in technology will not be limited to the U.S. and her allies Major source of strategic challenges Disregard for national borders Cyber threats will demand innovative approaches to counter them
Space	No longer limited to superpowers Degradation of space systems

Table 1 – JOE Trend Areas Continued

The JOE implies that the contextual events U.S. armed forces will most likely face will arise from a convergence of the trajectories of the aforementioned trends. As Colin Gray (cited in United States Joint Forces Command, 2010) wrote in his monograph for the Strategic Studies Institute, "Contexts of conflict and war are the environment created by the confluence of major trends. Contexts illuminate why wars occur and how they might be waged" (p. 38). The contextual world in the next twenty-five years will be complex and ambiguous. Cooperation and competition among conventional powers, weak and falling states, threats of unconventional power, radical ideologies, proliferation of weapons of mass destruction, technology, urbanization, and a battle of narratives will dominate the world arena (United States Joint Forces Command, 2010). All of the above will present various confrontations and risks for the employment of U.S. armed forces. These confrontations and risks will require engagement; new and innovative ways to conduct warfare; alliances, partnerships, and coalitions; diplomacy, cultural sensitivity, political acumen, and military competencies (United States Joint Forces Command, 2010). As military officers, U.S. Army FA49s must possess the core competencies associated with being leaders as well as the technical competencies associated with being analysts to enable them to adequately respond to these confrontations and risks as the premier problem solvers and risk identifiers within the U.S. Army.

Despite the complexities and ambiguities associated with the trends and contextual framework of the future security environment, the JOE highlighted four areas the U.S. armed forces could better prepare its leaders and forces for the demands of the future. The first area is professional military education (United States Joint Forces Command, 2010) referred to within the JOE as the "critical key to the future" (United States Joint Forces Command, 2010, p. 69). Teaching, training, and priming the next generation of senior military leaders have already begun. The leaders of tomorrow's U.S. armed forces must master the technical and operational aspects of war, possess the fundamentals of good leadership, understand myriad frameworks associated with the future security environment, and be equipped with the competencies drawn from education from multiple disciplines (United States Joint Forces Command, 2010). The second area is defense economics and acquisition policies (United States Joint Forces Command, 2010) for "without a thorough and coherent reform of the acquisition processes, there is the considerable prospect an opponent could incorporate technological advances more affordably, quickly, and effectively with serious implications for future joint forces" (United States Joint Forces Command, 2010, p. 71). The third area addressed is the personnel system (United States Joint Forces Command, 2010):

> If we expect to develop and sustain a military that operates at a higher level of strategic and operational understanding, the time has come to address the recruiting, education, training, incentive, and promotion systems so that they are consistent with the intellectual requirements for the future Joint Force. (p. 71)

The fourth and final area is simulation (United States Joint Forces Command, 2010). Since the Second World War, the U.S. military's ground forces have sustained the overwhelming majority of the casualties (United States Joint Forces Command, 2010). Heavy investment needs to be undertaken to develop simulations for infantry forces similar to what has already been developed for pilots, naval warfare, and armored forces (United States Joint Forces Command, 2010) as lessons learned from current Overseas Contingency Operations indicate that this trend is continuing (United States Joint Forces Command, 2010). With the environment of the future in which a U.S. Army FA49 will operate described, an overview follows as to what exactly is a U.S. Army FA49.

1.2 U.S. Army FA49 – ORSA

U.S. Army officers are managed by three functional categories and associated functional groups delineated by either branch or functional area name. Each branch and functional area receives a numerical designation. For example, those officers within the Armor Branch are numerically categorized as 19s and those officers within the ORSA FA are numerically categorized as 49s. The same follows suit for all the branches and functional areas within the U.S. Officer Corps. Table 2 below (Adapted from the United States Department of the Army (2010)) lists the three functional categories and their associated functional groups to include their respective branches and functional areas to which a U.S. Army Officer may be assigned. FA49 falls within the Operations Support functional category and within the Forces Development functional group. A branch contains a grouping of officers comprising an arm or service of the U.S. Army (United States Department of the Army, 2010). A functional area contains a grouping of officers by technical specialty or skill usually requiring unique education, training, and experience (United States Department of the Army, 2010).

Functional Category	Functional Group	Branches & Functional Areas
Maneuver, Fires, and Effects (MFE)	Maneuver	Armor (19), Infantry (11), and Aviation (15)
	Fires	Field Artillery (13) and Air Defense Artillery (14)
	Maneuver Support	Engineer (12), Chemical (74), and Military Police (31)
	Special Operations Forces	Special Forces (18), Psychological Operations (37), and Civil Affairs (38)
	Effects	Public Affairs (46) and Information Operations (30)
Operations Support	Network & Space Operations	Signal Corps (25), Information Systems Management (53), Telecommunication Systems Engineer (24), and Space Operations (40)
	Intelligence, Surveillance, and Reconnaissance & Area Expertise	Military Intelligence (35), Strategic Intelligence (34), and Foreign Area Officer (48)
	Plans Development	Strategic Plans and Policy (59) and Nuclear and Counterproliferation (52)
	Forces Development	Force Management (50), Operations Research/Systems Analysis (49), and Simulation Operations (57)
	Education and Training	Permanent Academy Professor (47)
Force Sustainment	Integrated Logistics Corps	Transportation Corps (88), Ordnance (91), Quartermaster (92), and Logistics Branch (90)
	Soldier Support	Human Resources (42H) and Financial Management (36)
	Acquisition Corps	Acquisition Corps (51)
	Health Services	Army Medical Department Corps (Medical, Dental, Veterinary, Nurse, Medical Specialist, and Medical Services
	Special Branches	Chaplain and Judge Advocate General

Table 2 - U.S. Army Officer Functional Categories and Functional Groups.

U.S. Army FA49s are uniquely competent and operationally experienced officers who are trained to think with a disciplined mind (FA49 Proponent Office, 2011). They are officers who should be proficient at solving problems, identifying risk, and communicating results and recommendations. Not all U. S. Army officers are qualified to be a FA49. U.S. Army FA49s should have a background in the fields of math, science, economics, finance, or engineering; however, these fields are not all inclusive (United States Department of the Army, 2010). U.S. Army FA 49s integrate military knowledge with science and management, incorporating both established and emerging technologies and tools to add value in a constantly changing global environment (Center For Army Analysis, 2008). U.S. Army FA49s produce analyses and other analytic products to reinforce essential decisions by the leadership at all echelons within the DOD. These officers recommend prospective answers to complex militarily strategic, operational, and tactical problems in support of Overseas Contingency Operations and other war fighting operations as well as business issues (FA49 Proponent Office, 2011). U.S. Army FA49s are integral to processes supporting the critical doctrine, organization, training, material systems, leader development, personnel and facility (DOTMLPF) development missions to organize, man, train, equip, sustain and resource transformation from the current to the Future Combat Force (United States Department of the Army, 2010). In doing so, the U.S. Army FA49 "introduces quantitative and qualitative analysis to the military's decision making processes by developing and applying probability models, statistical inference, simulations, optimizations and economic models" (United States Department of the Army, 2010, p. 286). U.S. Army FA49s typically serve in one of several general assignments within the DOD as: 1) a combat analyst, 2) a staff analyst, 3) an analyst in an organization whose principal mission is to provide analysis that supports military forces; or 4) an instructor teaching ORSA and/or mathematics courses (United States Department of the Army, 2010).

In summary, a U.S. Army FA49 is a problem solver and identifier of risk who by employing their technical competencies and requisite knowledge, skills, and abilities integrates military knowledge with science and management producing analyses and analytic products to enable decision makers and stakeholders within the DOD.

1.3 Statement of the Problem

In conjunction with USJFCOM's JOE, the U.S. Army analytically looked at the future, and believes the United States will continue to be engaged in a period of persistent conflict—a period of extended confrontation among states, non-state, and individual actors (United States Department of the Army, 2008). The joint operating environment in which this interminable conflict will be waged will be intricate and multidimensional. Since Overseas Contingency Operations for the United States began with the attacks of September 11, 2011, the demands for more agile, adaptive, critical-thinking, and multi-talented FA49s have only increased. Tomorrow's joint operating environment demands ORSAs who will be ingenious, proactive, and multi-talented; proficient in their core competencies as military leaders leading during times of intricacy and multidimensionality as well as being proficient in their technical analytical competencies as problem solvers.

As alluded to before, one of the most difficult challenges for the U.S. Army FA49 community will be to develop the abstraction for what the future U.S. Army FA49 needs to look like to meet ever-evolving U.S. Army requirements so that the future U.S. Army FA49 is competent as both a leader and an analyst. Of these two facets of a U.S. Army FA49, exploring the extent of future U.S. Army FA49 technical competencies and knowledge, skills, and abilities (KSAs) was the focus of this study. The leadership competencies and their associated components and actions required of all U.S. Army Officers are outlined in the U.S. Army's Field Manual 6-22, *Army Leadership – Competent, Confident, and Agile*; however, the technical competencies and KSAs for a U.S. Army FA49, following extensive review of the literature, have not been found to exist in the literature.

1.4 Purpose of the Study

The purpose of this study was to identify the technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical competencies and KSAs, this study employed a qualitative research design with a quantitative component using a conventional, web-assisted Delphi methodology.

In order to fully comprehend the purpose of this study, the researcher refers the reader to the definitions identified in Section 1.9. These definitions as well as the discussion on the joint operating environment is Section 1.1 and the detailed explanation of the Delphi methodology in Chapter 3 should provide the reader with sufficient clarity to allow him/her to adequately decompose and gain full understanding of the purpose of this study.

Accomplishing the research purpose required focus regarding what the research intended to achieve. The primary and secondary research questions provided in the following section provided this focus.

1.5 Research Questions

This research study was focused on answering the following primary and secondary research questions:

> ***Primary Research Question (PRQ)*** – *What are the technical competencies required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*
>
> ***Secondary Research Question 1 (SRQ1)*** – *What knowledge facilitates mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*
>
> ***Secondary Research Question 2 (SRQ2)*** – *What skills facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*
>
> ***Secondary Research Question 3 (SRQ3)*** – *What abilities facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*

The PRQ is focused on identifying the technical competencies required for future U.S. Army FA49s to perform their duties with the joint operating environment of the next twenty-five years; however, as technical competencies are comprised of knowledge, skills, and abilities, the SRQs were needed to focus on them individually so that a comprehensive listing (competencies and KSAs) could be compiled.

By answering the PRQ and the SRQs and thus succeeding in achieving the purpose of this study, this research contributed to the scholarly body of knowledge for engineering management. The significant original contributions made by this effort are discussed in the next section.

1.6 Significance of the Study

As will be further elaborated in the next chapter, the scholarly literature has shown that a major gap in the past research on operations researcher systems analyst technical competencies and KSAs exists.

To assist in partially filling this gap, this research makes four significant contributions to the engineering management field. First, while the Delphi methodology may not be unknown to the engineering management community, its use and application to identify competencies and/or KSAs is limited to a relatively small number of studies, none of which focused on ORSA competencies or KSAs. This study has added to the existing body of knowledge in engineering management theory and methodology by presenting and substantiating that the Delphi process is capable of identifying pertinent issues and future and/or forecasting requirements with regard to the identification of ORSA competencies and KSAs. Second, it contributed to engineering management literature by providing a basis for the expansion of the domain of competencies and KSAs. Through the use of the Delphi technique, this research helped close a gap in the understanding of required competencies and KSAs for operations researchers. Third, being the first rigorous research study based on ORSA technical competencies and KSAs for the U.S. Army FA49 field, this research has provided areas for future research that suggest the conduct of additional studies that can be used to potentially extend the findings to the wider operations research community as a whole (i.e. beyond the military ORSA domain). Finally, this research contributed to the identification of competencies and KSAs that are germane to the development of engineering management (operations research focus) and military educational curricula. As such, development of these curricula may bring clarity and enhancements to human resource life-cycle developmental models that may assist with both human resource career management and career advancement issues.

1.7 Limitations of the Study

Careful consideration must be given to the limitations associated with the Delphi methodology (Linstone & Turoff, 2002). Of the limitations presented by Linstone and Turoff, four had pertinence for this study:

1. Imposing monitor views and preconceptions of a problem upon the respondent group by over specifying the structure of the Delphi and not allowing for the contribution of other perspectives related to the problem.

2. Poor techniques of summarizing and presenting the group response and ensuring common interpretations of the evaluation scales utilized on the exercise.

3. Ignoring and not exploring disagreements, so that discouraged dissenters drop out and an artificial consensus is generated.

4. Underestimating the demanding nature of a Delphi and the fact that the respondents should be recognized as consultants and properly compensated for their time if the Delphi is not an integral part of their job function. (Linstone & Turoff, 2002, p. 6)

In addressing the first limitation, the researcher by clearly predefining the levels of consensus during the iterative rounds avoided researcher bias (Wilhelm, 2001). A Delphi coordinator should have no vested interest in the outcome and should be in a facilitation role (Okoli & Pawlowski, 2004); the direction of emergence and consensus should not affect the personal interests of the researcher.

With respect to the second limitation, between the exploration and evaluation phases, outlined in detail in Chapter 3 of the research study, the researcher conducted a round of peer debriefings to "enhance the account" (Creswell, 2009, p. 192) of the first round's qualitative data analysis as well as enhance the study's overall credibility. The purpose of the peer debriefings was to have those individuals being debriefed to ask questions and review the researcher's qualitative data analysis outputs from the first round data analysis for intellectual and methodological rigor. To ensure a common interpretation of the evaluation scales used, the researcher avoided a numerical method and instead opted to provide scales based upon words. Additionally, the researcher provided his contact information to the panel members and assured them he was available to answer their questions concerning the questionnaires or any other matter that needed clarification.

Regarding the third limitation, one purpose of Delphi is to achieve consensus. Delphi allows judgment to change throughout the rounds, or emerge, and the research should also look at why judgment changed in panelists (Rowe & Wright, 1999). Researchers can use a journal to capture their decision trail of all key theoretical, methodological and analytical decisions made in the research from beginning to end. This enables the substantiation of the trustworthiness of the research (Skulmoski, Hartman, & Krahn, 2007). To that end, the researcher kept copious notes thus providing for assurances for the trustworthiness of the research. Also with regards to the third limitation, opinionated panelists may have been the ones who agreed to participate while less opinionated experts may have not elected to participate; thus biasing the results. This bias was partially overcome by guaranteeing anonymity (Franklin & Hart, 2007). Finally, the panel members themselves served as a check (member check) when the researcher sent out the results from the previous round with the current round in order to identify key issues that may have been missed or misrepresented (Franklin & Hart, 2007; Goodwin, 2002).

In addressing the fourth limitation, the researcher was unable to provide compensation; however, the researcher did incentivize the expert panel members by offering them the results of the study upon completion. To aid in managing the expert panel members' time the researcher kept the questionnaires as abbreviated as possible and kept the submission process as easy as possible (Hsu & Sandford, 2007; Skulmoski et al., 2007).

A final limitation affecting this study would be the generalizability of the outcome. A major desired outcome would have been for the technical competencies and KSAs identified to be generalizable to the maximum extent possible; however, given the purposive nature associated with selecting a Delphi study's panel of experts, the generalizability of the results is strictly limited. This study only addressed the technical competencies and KSAs of active duty U.S. Army FA49 officers within the DOD. Hence, the outcomes derived from the study will not be capable of being extrapolated to other services within the DOD or towards civilians who possess a FA49-like moniker within the U.S. Army or DOD.

1.8 Delimitation of the Study

This section discusses a delimitation of the research. A delimitation is the way in which the effort was constrained or narrowed to limit the overall scope of this specific research.

The research did not look at identifying technical competencies and KSAs for all operations researchers, but rather focused on identifying the technical competencies and KSAs required of future U.S. Army FA49s. As such, participants only included U.S. Army Colonel (COL) and Lieutenant Colonel Promotable (LTC(P)) ranked FA49 experts. These U.S. Army FA49 experts were selected because they were deemed to possess the requisite knowledge necessary to provide relevant answers to the PRQ and the SRQs. Furthermore, the success, validity, and quality of a Delphi study is inextricably linked to the panel of experts involved.

1.9 Definition of Key Terms

For the purposes of this study and to assist the reader, the following terms are defined:

Expert – An individual with extensive education or training, possessing acute and relevant knowledge, longevity, and has risen to the top in their domain or field of specialization. This definition is a synthesis derived from definitions by Ayyub (2001), Booker & McNamara (2003), Shanteau (1992), Shanteau, Weiss, Thomas, & Pounds (2002), Adler & Ziglio (1996), and Jackson (1999).

U.S. Army FA49 Expert – An individual usually with twenty-one or more years of experience in the U.S. Army and who possesses a minimum of a master's degree. These individuals hold or have held the highest and key positions in the U.S. Army FA49 community. These officers hold the rank of COL or LTC(P). According to the U.S. Army, "Attaining the grade of colonel is realized by a select few and truly constitutes the elite of the officer corps" and "those promoted to colonel are truly the world-class specialists in their respective fields" (United States Department of the Army, 2010, p. 19).

Competency – Demonstrated and measurable capability comprised of knowledge, skills, or abilities that is causally related to superior performance in a given job or situation. This definition is a synthesis derived from definitions by Lahti (1999); Mirabile (1985); Spencer & Spencer (1993); and Ulrich, Brockbank, Yeung, & Lake (1995).

Core or General Competency – A competency that applies to everyone in an organization across a variety of occupations. This definition is a synthesis derived from definitions by Hoge, Tondora, & Marrelli (2005) and the U.S. Office of Personnel Management (2011). An example is leadership.

Technical Competency – A competency tailored to particular knowledge, skills, or abilities that apply to everyone performing a specific type of service or job in an organization. This definition is a synthesis derived from definitions by Hoge, Tondora, & Marrelli (2005) and the U.S. Office of Personnel Management (2011). An example may be executes financial analysis.

Knowledge – A learned or acquired concrete or abstract awareness, understanding, or information that directly relates to the performance of a job. This definition is a synthesis derived from definitions by Hoge, et al. (2005), Lahti (1999), and Lucia and Lepsinger (1999). An example may be knowledge of the DOD's Planning, Programming, Budgeting, and Execution System (PPBES).

Skill – A concrete or abstract potential or capacity to successfully perform physical or mental tasks using tools, equipment, or machinery. This definition is a synthesis derived from definitions by Hoge, et al. (2005), Lahti (1999), and Lucia and Lepsinger (1999). An example may be spreadsheet modeling.

Ability – An enduring cognitive or physical potential or capacity to successfully perform physical or mental tasks possessing a wide range of plausible results not necessarily involving tools, equipment, or machinery. This definition is a synthesis derived from definitions by Hoge, et al. (2005) and Lahti (1999). Examples may include analytical thinking or conducting a cost benefit analysis.

Delphi Methodology - A "method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone & Turoff, 2002, p. 3).

The preceding definitions were provided to assist the reader in comprehending the relevant terms that were integral to the pursuit of this research endeavor. This chapter now concludes with the summary provided in the following section.

1.10 Summary

Tomorrow's joint operating environment will demand U.S. Army FA49s who will be ingenious, proactive, and multi-talented; proficient in their core competencies as military leaders leading during times of intricacy and multidimensionality as well as being proficient in their technical analytical competencies as problem solvers. In order to adapt and be prepared for the joint operating environment of the next quarter century, U.S. Army FA49s will have to possess both core leadership and technical competencies in order to successfully perform their duties as officers and analysts. Figure 1 below summarizes the framework guiding this study.

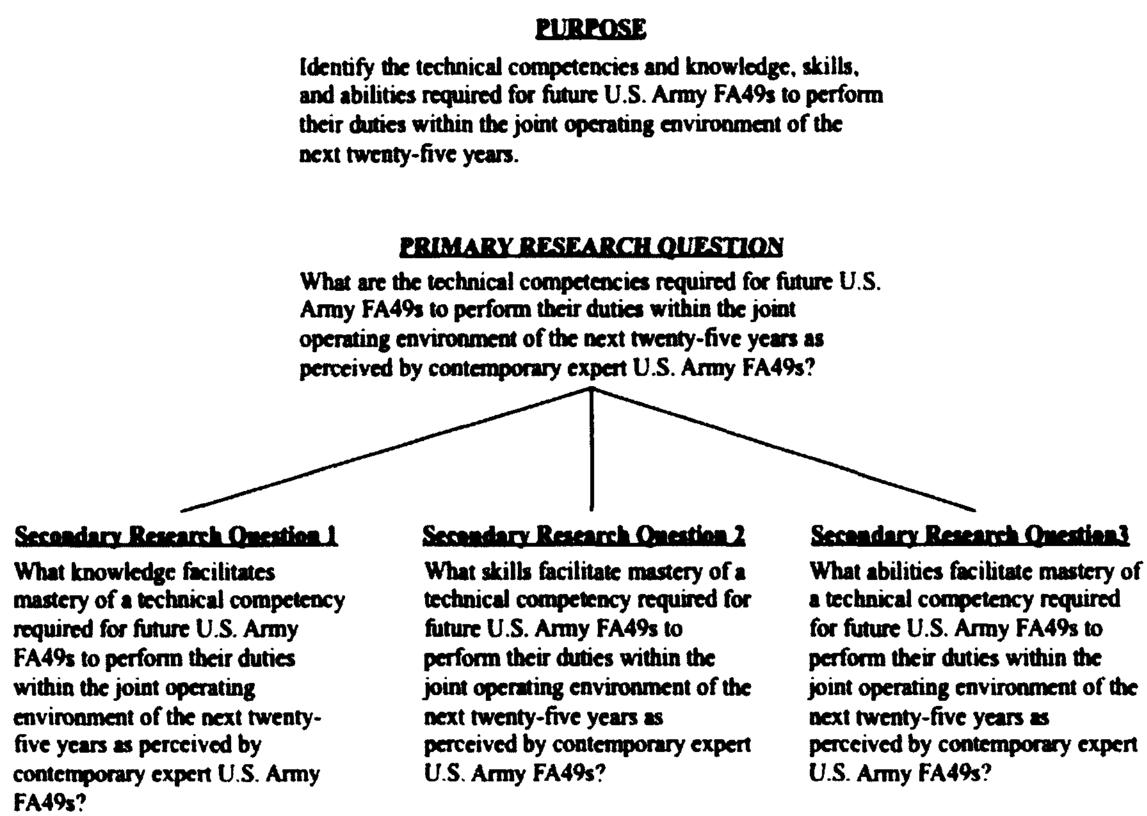

Figure 1 - Guiding Framework

This chapter included overviews of the potential environment of the future within which a U.S. Army FA49 may operate and what is a U.S. Army FA49. A statement of the problem, purpose and research questions, significance of the study, limitations, delimitations, and definitions of key terms followed these overviews. Chapter 2 will appraise the literature. Chapter 3 will describe the methods and procedures applied for assembling and analyzing the data for this study. Chapter 4 will present the results and findings. Finally, Chapter 5 will provide conclusions, contributions, and areas for potential future research stemming from this study.

CHAPTER 2

REVIEW OF THE LITERATURE

Chapter 2 presents the literature to establish the setting for the research; to frame it appropriately within the literature. The researcher's rationale and approach underlying the review are discussed to include breadth of the review. To set the environment, the researcher provides high-level contextual information for competencies and operations research. Directly relevant literature is then summarized and synthesized. Closing out the chapter, the final section identifies the gaps in the research and the need for additional research related to the research purpose, PRQ, and SRQs.

2.1 Approach Underlying the Review

The emphasis of the literature review was to reduce the amount of information presented in the scholarly journals to only the material applicable and directly relevant for the research. The breadth of the review ensured the researcher was exposed to the relevant and necessary material. Given the nature of the research purpose and the PRQ and the SRQs, the researcher included in his search literature from the engineering management, operations research, and management science disciplines. The literature search within these disciplines focused on discovering previous work on the identification of an operations researcher's (civilian and military) competencies, knowledge, skills, and/or abilities.

The researcher followed the following guidelines for the rationale for including or excluding journal articles and published manuscripts:

1. The researcher rigorously reviewed the scholarly journals in Table 3 searching for articles on an operations researcher's (civilian and military) competencies, knowledge, skills, and/or abilities.

2. Literature reviewed had to have a respondent population as the basis for their findings and conclusions. Surveys of literature were not included.

3. The literature found from the searches conducted in (1) and filtered by (2) was evaluated against the PRQ and SRQs to determine overall relevance for inclusion.

4. The researcher used his academic knowledge and knowledge and training in operations research as a U.S. Army FA49 to ensure the material chosen for final inclusion in the literature review was of scholarly quality and contained satisfactory rigor.

5. When no new viewpoints or information was being encountered, the researcher made the determination the literature search was complete (Leedy & Ormrod, 2010).

The search for literature included appropriate scholarly journals in the fields associated with the purpose, PRQ, and SRQs. A clear distinction was made between scholarly literature founded on rigorous research and that which was published with no rigorous basis, with the latter excluded. As previously stated, the sources included came from multiple disciplines and include the journals annotated in Table 3. A scholarly review and a report of the findings and themes were conducted. A synthesis and critique of the literature is provided in Section 2.3; however, prior to discussing the literature, the researcher, in an attempt to set the environment, provides high-level contextual information for both competencies and operations research for those unfamiliar with these domains that are germane to the overall research purpose.

Journal Title	ISSN	Retrieval Source
Dissertations & Theses: Full Text	NA	Dissertations & Theses: Full Text (ProQuest)
Engineering Management International	0167-5419	ScienceDirect Engineering & Technology Backfile
Engineering Management Journal	1042-9247	ABI/INFORM Global (ProQuest)
Engineering management journal (London, England)	0960-7919	IEEE Xplore
IEEE engineering management review	0360-8581	IEEE Xplore
IEEE transactions on engineering management	0018-9391	IEEE Xplore
Management science and engineering	1913-0341	ABI/INFORM Global (ProQuest)
Journal of Operations Management	0272-6963	ScienceDirect
European Journal of Operational Research	0377-2217	ScienceDirect
European Management Journal	0263-2373	ScienceDirect
International Journal of Operations & Production Management	0144-3577	ABI/INFORM Global (ProQuest)
Journal of General Management	0306-3070	Business source Premier (EBSCO)
Harvard Business Review	0017-8012	Business source Premier (EBSCO)
Management Science	0025-1909	Business source Premier (EBSCO)
Journal of the Operational Research Society	0160-5682	JSTOR
American Journal of Operations Research	2160-8830	Directory of Open Access Journals
Annals of Operations Research	0254-5330	Business Source Complete (EBSCO)
Central European Journal of Operations Research	1435-246X	Business Source Complete (EBSCO)
Journal of the Operations Research Society of America	0096-3984	JSTOR
Operations Management Research	1936-9735	ABI/INFORM Global (ProQuest)
Operations Research	0030-364X	JSTOR & INFORMS PubOnline
Academy of Management Journal	0001-4273	Business Source Complete (EBSCO)
Interfaces	0092-2102	JSTOR
Decision support systems	0167-9236	ScienceDirect Journals
Industrial engineering	0019-8234	ABI/INFORM Global (ProQuest)

Table 3 - Scholarly Journals Reviewed

2.2 High-level Context

Before proceeding with the review of the scholarly literature retrieved from the journals and databases, a high-level contextual setting of the environment is deemed appropriate. High-level contexts for competencies and operations research are discussed below.

2.2.1 Competency

In the following subsections, the researcher presents a brief history of competency and the competency movement, a justification for the use of terminology, and a short synopsis of competency in the U.S. Army.

Brief History of Competency and the Competency Movement

The general notion of competencies can be traced back to the Chinese empire over 3,000 years ago (Hoge et al., 2005). In the Middle Ages, specific skills needed for effective job performance were learned by apprentices working with a master craftsman (McLagan, 1997). Over the centuries, the knowledge and skills to be taught in their curricula by educators have been defined (McLagan, 1997). In the late 19th and early 20th centuries, Sir Francis Galton, an English biologist, and James Cattell, an American psychologist, pioneered the development of objective techniques to measure human intellectual capabilities (Shippmann et al., 2000). Ernest Fleishman and John Flanagan analyzed behavior of overseers and identified performance factors in the 1940s and 1950s (Shippmann et al., 2000). By the 1960s, psychologists were attempting to pinpoint individual variables that would convincingly predict job performance (Shippmann et al., 2000). One such individual was Harvard's David McClelland (Hoge et al., 2005).

McClelland's work led to him publishing an article in 1973 entitled "Testing for Competence Rather Than for 'Intelligence'" in which he proposed replacing intelligence and aptitude tests with competency testing or criterion sampling (Hoge et al., 2005; Shippmann et al., 2000). McClelland is credited with originating the term competency (Dubois, Rothwell, Stern, & Kemp, 2004). As defined by McClelland, competencies were the knowledge, skills, traits, attitudes, values, self-concepts, or motives directly related to job performance and shown to differentiate between average and superior performers (Shippmann et al., 2000; Spencer, McClelland, & Spencer, 1994). McClelland's work was a new approach to identify requirements for successful work and launched the competency modeling movement in the United States (Spencer et al., 1994).

Additional influential contributors to the competency movement were McLagan, Boyatzis, Spencer and Spencer, and Prahalad and Hamel. McLagan (1980) established competency models as the center for planning, integrating, organizing, and improving aspects of human resource management. According to Rothwell and Lindholm (1999), within the U.S. training and development community McLagan became "perhaps the most widely-known practical theorist" (p. 94). Boyatzis worked with McLagan on training and development competency-based projects (Rothwell & Lindholm, 1999). Boyatzis (1982) published the first fully researched and empirically based book on competency model development (Rothwell & Lindholm, 1999) titled *The Competent Manager: A Model for Effective Performance*. In his book, Boyatzis reexamined data from past competency studies on managers and identified competencies that distinguished superior managers from those less superior. Spencer and Spencer (1993) published *Competence at Work: Models for Superior Performance,* which Rothwell and Lindholm (1999) suggest may be "the most research-oriented and comprehensive of all the competency books in providing the theoretical backgrounds for competency modeling" (p. 95). In their book, Spencer and Spencer provided guidance on developing a competency dictionary and model, summarized 20 years of past research using the job competence assessment methodology, described human resource management applications of job competence assessment research, and suggested future directions.

While McLagan, Boyatzis, and Spencer and Spencer focused their research on individual performance and capability, Prahalad and Hamel (1990) moved the frontier of competency modeling into the organization and focused on organizational performance and capability. Prahalad and Hamel (1990) introduced the concept of core competence for an organization. The term core or organizational competency is used in reference to the collective learning and performance capabilities of the entire organization (Prahalad & Hamel, 1990). "Core competencies are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies.... Core competence is communication, involvement, and a deep commitment to working across organizational boundaries" (Prahalad & Hamel, 1990, p. 82).

Terminology

Based on interviews with experts, Zemke (1982) described competencies as "Humpty Dumpty words meaning only what the definer wants them to mean" (p. 28) and according to Hoge et al. (2005) one fundamental challenge in the application of competency approaches is establishing consensus regarding an operational definition. The literature is replete with numerous and various definitions that outline the core elements of competency (Blancero, Boroski, & Dyer, 1996; Boyatzis, 1982; Klein, 1996; Lahti, 1999; Mansfield, 1996; McClelland, 1973; McLagan, 1997; Mirabile, 1985; Spencer & Spencer, 1993; Ulrich et al., 1995; United States General Accounting Office, 2004); however, there is no clear consensus on definitions. Conspicuously absent is a DOD definition; were one present, the researcher would have elected to use it. Since the DOD did not have a prescribed definition for competency, the researcher had to synthesis a working definition for the term and its constituent elements from the literature. These synthesized definitions were presented in Chapter 1.

A View of Competency in the U.S. Army

In the U.S. Army, the term 'competency' applies to both the organization and individuals (Schirmer, Thie, Harrell, & Tseng, 2006). As an organization, the U.S. Army has two core competencies, combined arms maneuver and wide-area security (Caslen & Leonard, 2011). With individuals, the U.S. Army "tends to associate competencies with people only in reference to leadership competencies" (Schirmer et al., 2006, p. 7); as such, an entire U.S. Army Field Manual, FM 6-22, is dedicated to the concept of leadership and its competencies. As addressed in Chapter 1, a U.S. Army FA49 is both a leader and an analyst. In addition to the leadership competencies that each U.S. Army FA49 needs to possess, Dalziel notes "another approach to competencies … is especially useful when looking at specific functions. This approach involves finding the right set of technical attributes [technical competencies and KSAs] that people need to know in order to perform this function" (2004, p. 60). These technical competencies and KSAs are specific work-related (Jeou-Shyan, Hsuan, Chih-Hsing, Lin, & Chang-Yen, 2011) competencies and KSAs "that apply to everyone providing a particular type of service [function] in the organization" (Hoge et al., 2005, p. 16). As described in Chapter 1, a U.S. Army FA49 performs a specific function (operations research systems analysis) within the U.S. Army, and as such, identification of these technical competencies and KSAs is warranted. In performing this study, the researcher pursued to identify those technical competencies and KSAs required by a U.S. Army FA49.

In this section, the researcher provided high-level context on competencies to include a brief history of competencies as well as the competency movement. The general notion of competencies was shown to be traceable back thousands of years but it wasn't until the works of McClelland, McLagan, Boyatzis, Spencer and Spencer, and Prahalad and Hamel that the competency movement started. The researcher also provided justification on the necessity for synthesizing a definition for competency and its constituent elements. Finally, the researcher discussed the term 'competency' and how it is applied within the U.S. Army, organizationally and individually. The next section will address a high-level context for operations research.

2.2.2 Operations Research

In the following subsections, the researcher presents the advent of operations research and a discussion on the concept of operations research to include its definition, basis for decisions, and potential implementation outcomes. For in depth chronicles of civilian and U.S. Army operations research, the researcher suggests Gass' & Assad's (2005) *An Annotated Timeline of Operations Research: An Informal History* and Shrader's & the U.S. Department of the Army's (2006, 2008, 2009) three volume set on the *History of Operations Researcher in the United States Army.*

Birth Of

The lineage of operations research can be apocryphally traced as far back as biblical times when Joseph aided the Pharaoh and the Egyptians to survive through seven fat years followed by seven lean years (Gass & Assad, 2005). Archimedes (287-212 BC), considered by some to be the patron saint of military operations researchers, may have been the first operations analyst as the scientific advisor to King Hieron. His collecting of data, analyzing the data, and using the results to counter the Roman siege of Syracuse may be considered a very early form of operations research (Shrader & United States Department of the Army, 2006).

The true advent of operations research occurred just prior to WWII (Gass & Assad, 2005; Shrader & United States Department of the Army, 2006). In 1936 the British Air Ministry established the Bawdsey Manor Research Station to analyze how radar could be used to defeat enemy aircraft (Gass & Assad, 2005; Shrader & United States Department of the Army, 2006). The first use of the term "operational research" occurred in 1938 (Gass & Assad, 2005). Operations research's emergence during WWII served as an important method in "assisting civilian and military leaders in making scientifically sound improvements in the design and performance of weapons and equipment" (Shrader & United States Department of the Army, 2006, p. iii). Operations research techniques were extended to addressing tactics and strategy during the war, and to matters of political and economic policy after the war (Shrader & United States Department of the Army, 2006). It was the urgency of finding a solution for the survival of England that led to the transfer of operations research to post-war commerce and industry (Shrader & United States Department of the Army, 2006).

In the post WWII era we find operations research:

- enriched by new disciples from the academic and business communities;

- broadened by new mathematical, statistical, and econometric idea;

- influenced by other fields of human and industrial activities;

- techniques developed and extended by researchers and research centers;

- made doable and increasingly powerful through the advent of the digital computer;

- formalized and modified by new academic programs;

- going world-wide by the formation of country-based and international professional organizations;

- supported by research journals established by both professional organizations and scientific publisher;

- sustained by a world-wide community of concerned practitioners and academics who volunteer to serve professional organizations, work in editorial capacities for journals, and organize meetings that help to announce new technical advances and applications (Gass & Assad, 2005, p. x)

What It Is

Operations research, also known as "'operational research,' 'operations analysis,' 'management science,' 'industrial engineering,' 'decision science,' and, in its more expansive manifestation, 'systems analysis'" (Shrader & United States Department of the Army, 2006, p. vi), just like the term 'competency,' has many definitions, each correct and practical. One common civilian and the U.S. military's definition for operations research are:

> *operations research (noun) – the application of scientific and especially mathematical methods to the study and analysis of problems involving complex systems - called also operational research (Merriam-Webster, 2012)*
>
> *operations research — the analytical study of military problems undertaken to provide responsible commanders and staff agencies with a scientific basis for decision on action to improve military operations. Also called operational research; operations analysis* (United States Joint Chiefs of Staff, 2012, p. 244).

Succinctly, operations research is a discipline where the application of advanced analytical methods helps decisions makers make better decisions (The Institute For Operations Research And The Management Sciences (INFORMS), 2004). A popular conception of operations research is one of an activity fixated on complex mathematics (Ormerod, 2010; Shrader & United States Department of the Army, 2006), statistical techniques (Ormerod, 2010; The Institute For Operations Research And The Management Sciences (INFORMS), 2004), simulation (The Institute For Operations Research And The Management Sciences (INFORMS), 2004), and optimization (The Institute For Operations Research And The Management Sciences (INFORMS), 2004). While mathematical methods are helpful, sometimes essential, it is possible for an operations researcher to construct beneficial studies without them (Shrader & United States Department of the Army, 2006); today's practitioners also employ softer approaches (e.g. qualitative analysis) (Ormerod, 2010).

Operations research may not be a purely natural or social science (Gass & Assad, 2005), but it is a science (Ackoff, 1956; Gass & Assad, 2005); a "science of decision making, the science of choice" (Gass & Assad, 2005, p. ix).

By using these approaches, operations researchers empower stakeholders to make more efficacious decisions based on:

- more complete data
- consideration of all available options
- careful predictions of outcomes and estimates or risk
- the latest decision tools and techniques (The Institute For Operations Research And The Management Sciences (INFORMS), 2004, p. 4)

Implementation and usage of operations research may lead to fixing of broken or inefficient processes, limiting or reduction of risk, more efficient tracking and usage of data, a competitive advantage, building of intelligence into key systems, informing high-level strategy, improving of day-to-say operation, better asset utilization, cost savings, and increased revenues (The Institute For Operations Research And The Management Sciences (INFORMS), 2004).

In summary, the researcher provided high-level contextual information on operations research to include its origins, definitions, basis for decisions, and potential implementation outcomes. Operations research was introduced as a science that when applied appropriately could assist decision makers execute effective judgments.

With the high-level contexts provided for both competencies and operations research, the focus shifts in the next section to the synthesis of the directly relevant literature retrieved from the scholarly journals and databases (Table 3) identified in Section 2.1

2.3 Synthesis and Critique

In conducting this literature review, no contemporary, ongoing research could be found exploring U.S. Army FA49 competencies or KSAs. Therefore, presented in this section is a summary of the directly relevant literature found after performing and completing the literature search in accordance with the procedures outlined in Section 2.1 for scholarly works on the identification of an operations researcher's (civilian and military) competencies, knowledge, skills, and/or abilities along with a synthesis of the material, which includes a scholarly critique. This literature, spanning more than 5 decades, establishes the foundation for this research study. Through synthesis, the researcher identified the general themes running throughout the literature thus pulling together the different perspectives and research results into a cohesive whole (Leedy & Ormrod, 2010). With the critique, holes or gaps in the existing body of knowledge were exposed; holes which additional research related to the research purpose, PRQ, and SRQs will fill.

The purpose of this study was to identify the technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical competencies and KSAs, this study employed a qualitative research design with a quantitative component using a conventional, web-assisted Delphi methodology. In conducting the literature review, the researcher stringently analyzed each article with regard to four differentiating topical areas, which can be directly ascertained from the purpose statement for this study. Those four topical areas were:

1) Domain – military or civilian (business or academia). The researcher was intent on identifying technical competencies and KSAs for a U.S. Army FA49. To this end, the researcher wanted to identify in which domain(s) had previous work been conducted with regard to the identification of competencies and KSAs.

2) Elements Under Consideration – competency, knowledge, skill, ability, technique, method, or tools. As the researcher was intent on identifying technical competencies and KSAs, this topical area was focused on what had been previously identified within the literature.

3) Method of Investigation – Delphi, survey, questionnaire. The research design, fully explained in Chapter 3, for this researcher's study employed the Delphi methodology. The researcher wanted to identify what methods had been previously employed to gather data for analysis and interpretation.

4) Timeframe – elements under consideration being based on past, present, or future determinations. The timeframe associated with the researcher's study is future focused. The researcher wanted to identify on what timeframe had previous studies' results been focused.

By analyzing the literature and identifying the components of each topical area, the researcher was able to distinguish the general themes running throughout. This synthesis allowed for a critique in which the researcher determined the gaps in the scholarly body of knowledge.

2.3.1 Synthesis

Two early operations research surveys of the 1950s and 1960s focused on industrial operations research activities (Hovey & Wagner, 1958; Schumacher & Smith, 1965). Hovey and Wagner's survey sought answers to queries about adoption of operations research methods, areas of current application, success of these current applications, and what educational training was recommended for the operations research profession. Their indicated purposes included an indication of recognition and study of operations research problem areas and an analysis of employment data to forecast personnel needs and qualifications (1958). Surveys were sent to 158 companies in the United States and Canada whose activities focused on industrial and commercial research. The surveys were not sent to private consulting firms or government organizations. Their respondent rate was 57%. There were twelve operations research application areas and techniques identified by the respondents: forecasting, production scheduling, inventory control, quality control, transportation, advertising and sales research, maintenance and repair, accounting procedures, plant location, equipment replacement, packaging, and capital budgeting (1958). One respondent further noted that qualifications of operation research personnel should include the abilities to write, to present adequate oral presentations, to ascertain and evaluate details, and to be able to work as part of a team (1958).

Schumacher and Smith's (1965) survey was a follow-up survey on Hovey and Wagner's research conducted seven years earlier. They posited that the profession of operations research had grown and were interested in identifying the then current trends in organization and size of operations research groups and characteristics of operations research staff. Additionally, there were interested if there had been any changes in areas of application and technique. Surveys were sent to 168 companies selected by cross-referencing Fortune 500 industrial corporations with firms identified in the 1964 *College Placement Annual* in which they achieved a respondent rate of 39%. The twelve operations research application areas identified by the respondents included the same as identified in Hovey and Wagner's survey. This may be coincidental for it is unknown if the respondents were asked to provide examples of operations research applications their corporations were employing or whether they were asked to identify whether or not they were engaging in the twelve application areas identified in Hovey and Wagner's previous survey.

Turban (1972) identified operations research techniques associated with current projects in his national survey conducted in 1969 of operations research activities at the United States corporate level. The major topics covered within the survey were organizational structure of the operations research departments and their positions in the corporation, the internal structures of these operations research departments, their budgets and savings, and past, present, and future activities. In the survey's section on activities, operations research techniques were investigated. Surveys were sent to the largest 475 United States non-military corporate headquarters. The 475 corporate headquarters were chosen from the Fortune 500 list: the 300 largest industrial corporations, 50 industrial corporations ranked between 300 and 500, and the 25 largest corporations from the banking, utilities, merchandising, life insurance, and transportation sectors. The respondent rate was 23%. The respondents offered up the following techniques (listed in precedence order first to last) as the most prevalent in corporate use in performing current projects: statistical analysis (included probability theory, regressions analysis, exponential smoothing, statistical sampling, and hypothesis testing), simulation, linear programming, inventory theory, PERT/CPM, dynamic programming, nonlinear programming, queuing, heuristic programming, and miscellaneous. Turban asserted that it appeared that the simplest techniques were most frequently used (1972).

Weston (1973) reported on his 1970 study that attempted to gain comprehension of the current status of operations research specifically applied to corporate planning. To accomplish his study, Weston sought survey feedback from firms listed in the Fortune 500 and second 500. From the author's articulation, it appears he received a respondent rate of 16%. Specific quantitative tools and techniques in use by corporate planning personnel were identified. Those tools and techniques were, in ascending order: simulation, linear programming, network analysis, inventory theory, non-linear programming, dynamic programming, integer programming, and inventory theory. Weston concluded that firms with formalized planning functions were likely to implement quantitative tools and techniques with planning processes (1973).

Gaither (1975) conducted a mail survey that examined the adoption of operations research techniques by manufacturing organizations. He sought answers to five research questions: the overall extent of usage of operations research techniques, organizational units and how many operations research personnel administer these operations research techniques, types of manufacturing problems analyzed with operations research techniques, overall results achieved by operations research personnel, and problems encountered using operations research techniques. In performing his study, a pilot-tested mail survey was sent to a proportional stratified random sample of 500 manufacturing firms selected from a total population of 1,398 manufacturing firms with 250 or more employees from the states of Arkansas, Colorado, Kansas, Missouri, New Mexico, Oklahoma, and Texas. The respondent rate was 55%. Less than half of the respondents used operations research techniques at their firm. The respondents were asked to respond to their usage of 14 techniques: PERT, CPM, Linear Programming, Exponential Smoothing and Regression Analysis, Computer Simulation, Queuing Theory, Nonlinear Programming, Integer Programming, 01 Programming, Stochastic Programming, Dynamic Programming, Direct Search Methods, Heuristic Programming, and Game Theory. Greater than one-half of the firms who used operations research techniques reported using PERT, CPM, Linear Programming, Exponential Smoothing and Regression Analysis, and Computer Simulation. Respondents were not asked to identify additional techniques; they were only to vote on the provided 14 techniques. Only summary information was provided. The author drew no conclusions.

Green, Newsome, & Jones (1977) conducted a survey to identify the application of quantitative techniques to production/operations management in large corporations. Their intent was to gather data on nineteen quantitative techniques with emphasis on determining four specifics: extent of use of each technique, estimating the value of each technique, predicting future utilization of each technique, identifying barriers to utilization. The respondent population included vice-president production managers in the Fortune 500 companies. The respondent rate was 15%. The techniques receiving the highest cumulative usage rates were time series analysis, network analysis, inventory models, statistical sampling, linear programming, simulation, and regression and correlation. The respondents identified six techniques they expected to receive increased future usage: simulation, queuing theory, nonlinear programming, time series analysis, network analysis, and Bayesian statistics. Green, et.al surmised that the results of their survey reflected a pessimistic perspective of the use of quantitative techniques to production/operations management (1977).

Ledbetter and Cox (1977) presented the details of their 1975 study aimed at the use of operations research in production management. The researchers sought to ascertain the level of growth in the use of operations research techniques in industrial management, the relative utilization of several operation s research techniques, and the use of specific operations research techniques in eleven areas of production management. The 500 largest U.S. industrial firms were chosen as the respondent population. These firms were again chosen based upon the researchers' assumption that these firms would represent the state-of-the-art utilization of operations research techniques. The respondent rate achieved was 35%. Those participating in the study provided frequency of use information on seven specific pre-identified techniques commonly taught as part of the operations research curricula at universities. Those techniques were regression analysis, linear programming, simulation, network models, queuing theory, dynamic programming, and game theory. Regression analysis, linear programming, and simulation were the most heavily used while queuing theory, dynamic programming, and game theory showed very low usage rates. Network models showed a moderate usage rate. The authors concluded that the data clearly indicated simulation, linear programming, and regression were the most popular techniques while game theory, dynamic programming, and queuing theory were the least popular. The authors conjectured that operations research practitioners were expanding their applications and were transferring knowledge gained in one area, particularly with network modeling and simulation, to other areas. They also offered that their findings should suggest other fertile areas of operations research applications and that their findings should provide a baseline for comparison purposes.

Thomas and DaCosta's (1979) sample survey of United States corporate operations research aimed at generating information on the utilization of operations research and management science in the contemporary large corporation yielded results on the use of specific techniques, areas of application, areas of initiation, problems in implementation, organization acceptance, and decentralization of operations research and management science. The respondent population included 420 large private United States corporations. Their design frame was comparable to Hovey and Wagner's, Schumacher and Smith's, and Turban's. The respondent rate was 36%. Greater than 50% of the respondents reported their use of the techniques associated with statistical analysis, simulation, linear programming, PERT/CPM, and inventory theory. Other lesser identified techniques were queuing theory, nonlinear programming, heuristic programming, Bayesian decision analysis, dynamic programming, risk analysis, integer and mixed programming, Delphi, and financial methods. The authors surmise Bayesian decision theory and heuristic programming possessed potential for growth based on the fact they had not shown up as part of Turban's (1972) study.

Forgionne's (1983) random sample survey in 1982 of 500 corporate executives from among the 1,500 largest American operated corporations listed in the *EIS Directory* looked at corporate management science activities. He solicited information from the respondents in four main areas: user characteristics, current techniques being utilized, areas and degree of application, and perceived effectiveness, benefits, and implementation problems. The respondent rate was 25%. The respondents identified eight techniques. In ascending order those techniques were: statistical analysis, computer simulation, PERT/CPM, linear programming, queuing theory, nonlinear programming, dynamic programming, and game theory. Forgionne concluded that his results regarding techniques currently in use were similar to those found by Turban (1972) and Thomas and DaCosta (1979) (1983).

Thomas & Mitchell (1983) wrote about operations research in the U.S. Marine Corps. Their survey in 1981 was aimed at determining the usage frequency and the importance of thirty-five current operations research techniques. The authors' research population included the 77 U.S. Marine officers with an occupation specialty rating as an operations analyst. The respondent rate was 93.5%. The techniques identified as the most widely used and the most important were parametric data analysis, probability theory, cost effectiveness, and networks. The techniques identified as the least widely used and the least important were mathematical programming methods such as nonlinear, dynamic, heuristic, integer, and mixed programming. The authors concluded that there was a very high correlation between utilization and perceived importance of the 35 operations research techniques offered for rating on the questionnaire (1983).

Ford, Bradbard, Ledbetter & Cox (1987) reported on their 1985 study aimed at the use of operations research in production management. The researchers sought to ascertain the level of growth in the use of operations research techniques in industrial management, the relative utilization of several operation s research techniques, and the use of specific operations research techniques in eleven areas of production management. This study essentially repeated the Ledbetter and Cox (1977) study of 1975 and extended its results through 1985. As with the earlier study, the 500 largest U.S. industrial firms were chosen. These firms were again chosen based upon the researchers' assumption that these firms would represent the state-of-the-art utilization of operations research techniques. The respondent rate achieved was 14.4%. Those participating in the study provided frequency of use information on the same seven specific pre-identified techniques used in 1975. Again, those techniques were regression analysis, linear programming, simulation, network models, queuing theory, dynamic programming, and game theory. Just as in 1975, regression analysis, linear programming, and simulation were heavily used while queuing theory, dynamic programming, and game theory showed very low usage rates. Network models maintained a moderate usage level. The researchers concluded two factors had promoted higher usage of operations research techniques since the previous survey: (1) a continued emphasis on quantitative analysis in business and engineering schools at undergraduate and graduate levels and (2) increased availability of microcomputers and specialized software.

Carter (1987, 1988) conducted an extensive survey of all members of the Operational Research Society. The purpose of the survey was to investigate the structure of the Operational Research Society's membership, educational background, frequency of use of modeling areas, types of computers in use, and involvement with decision support systems and expert systems. Surveys were sent to 3,381 members with a respondent rate of 42%. Within the survey, the following 14 current techniques in use by the society's members were identified: decision analysis, forecasting, inventory control, simulation, mathematical programming, statistical techniques, surveys, queuing theory, quality control, network analysis, heuristics, financial modeling, corporate modeling, and other modeling areas (1987, 1988). In addition to these 14 techniques, 7 skills were identified: model building, research data collection, formal presentation, other written communications, other oral communications, project staff management, and other (1987, 1988). No significant conclusions were drawn, only a summarization was provided.

Harpell, Lane, & Mansour's (1989) longitudinal study of operations research in practice over fifteen years identified quantitative techniques Operations Research Society of America members consistently identified as most important. This longitudinal study extended, in part, the previous studies of Hovey and Wagner (1958) and Schumacher and Smith (1965). Beginning in 1973 and at five-year intervals, 500 surveys, 250 each to practitioners and educators, were randomly sent out. The respondent rate over the fifteen-year period varied from 34.4 to 42.4%. Of the fifty-six techniques listed on the survey, three – statistics, linear programming, and simulation – consistently stand out as being the most important to academicians and practitioners. The authors concluded the results of their survey appeared to be consistent with Turban's (1972) findings.

Abdel-Malek, Wolf, Johnson, & Spencer's (1999) Institute for Operations Research and the Management Sciences (INFORMS) survey of its membership on the practice of operations research was conducted to obtain opinions about the current state of operations research and try and deduce implications for the future. The survey focused on demographics, relevant operations research methods, literature, software, implementation factors, and suggestions for future practice. Surveys were sent to 2,384 practicing INFORMS members situated as consultants or members in industry, research, government, and service organizations. The respondent rate was 12%. The authors' survey listed both quantitative and qualitative operations research methods and asked the respondents to rate these methods according to payoff. The highest payoff methods identified were the qualitative methods with quantitative methods a close second. The qualitative methods included quality function deployment, Delphi, and focus groups. The quantitative methods included applied probability and statistics, scheduling, network analysis, simulation, and heuristics.

Four general themes arose from the analysis of the literature. The first theme was that the civilian domain has been examined extensively. The second theme was that the overwhelming majority of the elements under investigation were techniques or tools. The third theme was the overwhelming nature of the method of investigation being surveys. The fourth and final theme identified based upon examining the timeframe associated with the results of previous studies was that then current techniques had been investigated. Table 4 summarizes this synthesis of the literature and places the researcher's study in context. An examination of Table 4 also offers insights into the gaps in the current body of knowledge. Those gaps are identified in the following critique.

	Domain		Elements Under Investigation						Method of Investigation		Timeframe	
Author	Civilian	Military	Competency	Knowledge	Skill	Ability	Technique	Other	Survey	Delphi	Then Current	Future
Hovey & Wagner (1958)	X					X	X		X		X	
Schumacher & Smith (1965)	X						X		X		X	
Turban (1972)	X						X		X		X	
Weston (1973)	X						X	X	X		X	
Gaither (1975)	X						X		X		X	
Green et al. (1977)	X						X		X		X	
Ledbetter & Cox (1977)	X						X		X		X	
Thomas & DaCosta (1979)	X						X		X		X	
Forgionne (1983)	X						X		X		X	
Thomas & Mitchell (1983)		X					X		X		X	
Ford et al. (1987)	X						X		X		X	
Carter (1987, 1988)	X				X		X		X		X	
Harpell et al. (1989)	X						X		X		X	
Abdel-Malek et al. (1999)	X							X	X		X	
Winklbauer (2012)		X	X	X	X	X				X		X

Table 4 - Literature Relationship to Research Purpose, PRQ, and SRQs

2.3.2 Critique

This section of the chapter discusses various aspects presented in the synthesis section and identifies gaps in the existing body of knowledge, as well as the specific gaps that will be filled by this researcher's study.

The First Gap, Domain – A significant gap existed in the literature with respect to what domain(s) had been investigated. The complete absence of an examination of the military domain of operations research with no published knowledge on military operations research competencies and KSAs or techniques is astonishing, especially given the fact civilian operations research evolved from military operations research. The lone exception is Thomas & Mitchell's (1983) characterization of operations research in the U.S. Marine Corps; however, it must noted that it may be possible to infer that Carter's (1987, 1988) survey of members of the Operational Research Society, Harpell's et al. (1989) survey of Operations Research Society of America members, Abdel-Malek's et al. (1999) survey of INFORMS members could have included military personnel since those organizations do not specifically cater to the civilian population.

The Second Gap, Elements Under Consideration – A major gap in the literature existed in the identification of what was being investigated. This is significant given the prevalent nature of competency modeling within the civilian sector. Of the studies reviewed, none identified competencies or knowledge. None save for one, Hovey and Wagner (1958), identified abilities, and a single respondent indirectly provided this identification of abilities. All but four singularly identified operations research techniques; Hovey and Wagner (1958) identified application and technique areas and abilities, Weston (1973) identified tools as well as techniques, Carter (1987, 1988) identified skills in addition to techniques, and Abdel-Malek et al. (1999) identified methods.

The Third Gap, Method of Investigation – A significant gap in the literature existed in the method of investigation used to collect the previous studies' data. All previous studies used surveys as their method of data collection. Multiple methods (e.g. Delphi, IGM, NGT) for collecting data from groups of individuals have existed for decades. It is surprising other methods have not been used especially given the state of today's technology.

The Fourth Gap, Timeframe – Finally, an examination of the timeframe exposed a major gap in the literature; no future-focused research has been conducted. The elements under investigation within the previous studies were always associated with what was explicitly then the here-and-now.

While the literature contains multiple studies that have identified then-current operations research techniques, abilities, skills, methods, or tools within the civilian sector through the use of surveys, the researcher was unable to find a single Delphi study that focused, comprehensively or otherwise, on future technical competency and KSA identification within the U.S. Army domain let alone within the operations research or engineering management communities as a whole.

This critique unequivocally identifies multiple gaps that individually and collectively point to the need to further develop the knowledge within the operations research and engineering management communities. Identification of future technical competencies and KSAs within the U.S. Army domain using Delphi, which is the focus of this research study, provided an unmistakable supplement to the existing body of scholarly knowledge.

2.4 Summary

This chapter established the foundation for this research study through a review of the directly relevant extant literature. Within this chapter, the researcher presented the rationale and approach underlying the literature review. The researcher also set the environment by providing high-level contextual information for competencies and operations research. Following the setting of the environment, the researcher synthesized and critiqued the scholarly literature retrieved during the exhaustive literature search. Through synthesis, the researcher identified four general themes running throughout the literature thus pulling together the different perspectives and research results into a cohesive whole. With the critique, four holes or gaps in the existing body of knowledge were exposed; holes which additional research related to this study's research purpose, PRQ, and SRQs filled. In the next chapter, the researcher will discuss the research design developed by the researcher and how the research design was implemented.

CHAPTER 3

RESEARCH DESIGN

Chapter 3 describes the methods and procedures applied for assembling and analyzing the data for this study. This chapter will include a discourse of the research technique; a characterization of the expert panel to include composition and size; an examination of the data collection methodology and instruments; discussions of the data analyses, informed consent, confidentiality and anonymity, validity and reliability; and, finally, a chapter summary.

The purpose of this study was to identify the technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical competencies and KSAs, this study employed a qualitative research design with a quantitative component using a conventional, web-assisted Delphi methodology.

Delphi is a technique frequently used for eliciting consensus from within a group of experts that has application in reliability and has advantages over other methods of using panel decision making (Helmer-Hirschberg & Quinton, 1976). There are primarily three group decision making processes used for creative or judgmental problem solving: Nominal Group Technique (NGT), Interacting Group Method (IGM) and Delphi (Delbecq, Van de Ven, & Gustafson, 1975).

NGT is very similar in structure to Delphi; however, it uses a face-to-face forum. A group decision is made based upon a statistical criterion for aggregating the individual judgments (Rowe & Wright, 1999). NGT was not chosen because of its face-to-face forum requirement.

IGM is nothing more than a brainstorming exercise in which the individuals openly discuss their ideas with each other, provide feedback, and analyze each other's work. The process ends when the group arrives at a level of agreement (Clayton, 1997). As with NGT, IGM was not chosen because of the necessity to have all the individuals collectively gathered in one place.

Delphi is very similar in structure to NGT, but Delphi possesses two characteristics not found in either of the other two processes. First, exploration of the topic by members is conducted in isolation and under conditions of anonymity. Second, communication between members in Delphi is overseen remotely by a director and occurs via questionnaires and feedback reports. Both NGT and IGM group decision-making exercises require large groups of people to be brought together (Clayton, 1997).

As to having to decide among the three processes, NGT, IGM, or Delphi, the researcher chose Delphi as the contributors to this study were geographically dispersed across the continental United States and only Delphi allowed for geographical dispersion.

According to Linstone and Turoff, "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (2002, p. 3). Delphi is beneficial when other methods are not adequate or appropriate for data collection. Delphi is particularly useful when:

1. The problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis.

2. The individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience and expertise.

3. More individuals are needed than can effectively interact in a face-to-face exchange.

4. Time and cost make frequent group meetings infeasible.

5. The efficiency of face-to-face meetings can be increased by a supplemental group communication process.

6. Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured.

7. The heterogeneity of the participants must be preserved to assure validity of the results, i.e., avoidance of domination by quantity or by strength of personality ("bandwagon effect"). (Linstone & Turoff, 2002, p. 4)

Additional advantages include: iterations with controlled feedback, statistical group response, and the use of experts (Goodman, 1987); Delphi provides the researcher consensus expert opinion free of bias (Williams & Webb, 1994); consensus will emerge with one representative opinion from the experts (Dalkey & Helmer, 1963; Linstone & Turoff, 2002); a consensus of experts will provide more accurate data than a single expert (Dalkey, 1969; Dalkey, Brown, & Cochran, 1969; Dalkey & Helmer, 1963; Delbecq et al., 1975; Helmer-Hirschberg, 1963; Helmer-Hirschberg & Quinton, 1976; Linstone & Turoff, 2002); and finally, the feedback between rounds can widen knowledge and stimulate new ideas and in itself be highly motivating (Pill, 1971).

Delphi was an appropriate method for this research endeavor for multiple reasons. First, this study employed the original ideas of a group of expert participants within the U.S. Army FA49 community to identify those technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Second, the expert panel members to this study were geographically dispersed across the continental United States thus making a group meeting infeasible due to time and cost constraints. Finally, the participants were considered the senior leaders within the U.S. Army FA49 community and were thus considered experts within the field.

The appropriateness of selecting Delphi as the methodology for this study was presented in the preceding paragraphs. What follows in the next section is a detailed examination of Delphi.

3.1 Research Technique

Delphi is an iterative decision support tool that enables anonymous, systematic honing of authoritative opinion with the aim of arriving at mutual synergy of judgments between expert panel members (Brown, Cochran, & Dalkey, 1969; Dalkey, 1969; Dalkey et al., 1969; Dalkey & Helmer, 1963; Delbecq et al., 1975; Helmer-Hirschberg & Quinton, 1976; Linstone & Turoff, 2002; Martino, 1972). Delphi was developed in the 1950s by the Rand Corporation as a means to obtain group consensus in forecasting the outcome of Russian nuclear bombings on munitions capabilities within the continental United States (Dalkey & Helmer, 1963). The technique derived its name from the ancient Greek myth of the Oracle of Delphi. The Oracle of Delphi was thought to have the power to foresee the future. Because of these semantic overtures, Delphi has been very closely associated with forecasting and prediction (Rowe & Wright, 1999).

Delphi consists of two sequential phases: exploration and evaluation (Ziglio, 1996). During exploration, the subject matter to be studied is identified and a purposively chosen panel of subject matter experts is recruited to be contributors in the study (Delbecq & Van De Ven, 1974; Skulmoski et al., 2007). Open-ended questions are presented to the expert panel members, enabling them to explore the problem in an anonymous manner. The exploration phase is referred to as Round 1. The evaluation phase, Rounds 2 and higher, is used to gather the contributor's opinions on the ideas identified by exploration from Round 1 (Murry & Hammons, 1995). In Round 2, information from Round 1 is reported back to the expert panel members and they are asked to reply with their concurrence or non-concurrence on the ideas. Likert scales are usually used in Rounds 2 and higher (Linstone & Turoff, 2002). The data from Round 2 are analyzed and summarized and then sent back to the expert panel members as Round 3. Round 3 data are analyzed to determine for consensus. If the expert panel has not reached consensus, additional rounds may be initiated. Delphis continue until consensus is reached.

To ensure credibility in Delphi studies, a researcher must identify and justify their consensus levels (Fink, Kosecoff, Chassin, & Brook, 1984). Sackman (1975) noted that the consensus approach might lead to a watered down version of opinions and according to Linstone and Turoff (2002) there seems to be no firm rules for establishing when consensus is reached. As such, the lead of each Delphi study establishes the criterion for determining consensus in the study (Clayton, 1997). The criterion for determining consensus has been achieved has been defined in a variety of ways. For instance, Powell (2003) suggested some studies were looking for 100% consensus while Scheibe, Skutsch, and Schofer (2002) stated that a randomly assigned range was the most common criterion. Another interpretation by Wilhelm (2001) suggested if normal distribution of responses can be assumed, then those responses falling outside +/-1 standard deviation from the mean could be considered outliers. As a final interpretation, English and Kernan (1976) chose the benchmark that if the coefficient of variance was less than or equal to 0.5, then a strong consensus was considered to have been achieved. Once consensus is achieved, evaluation is concluded and the final report is written.

While appearing to be a straightforward approach to conducting research, careful consideration must be given to the limitations associated with the Delphi methodology (Linstone & Turoff, 2002). Of the limitations presented by Linstone and Turoff, four had pertinence for this study:

1. Imposing monitor view's and preconceptions of a problem upon the respondent group by over specifying the structure of the Delphi and not allowing for the contribution of other perspectives related to the problem.

2. Poor techniques of summarizing and presenting the group response and ensuring common interpretations of the evaluation scales utilized on the exercise.

3. Ignoring and not exploring disagreements, so that discouraged dissenters drop out and an artificial consensus is generated.

4. Underestimating the demanding nature of a Delphi and the fact that the respondents should be recognized as consultants and properly compensated for

their time if the Delphi is not an integral part of their job function. (Linstone & Turoff, 2002, p. 6)

In addressing the first limitation, the researcher by clearly predefining the levels of consensus during the iterative rounds avoided researcher bias (Wilhelm, 2001). A Delphi coordinator should have no vested interest in the outcome and should be in a facilitation role (Okoli & Pawlowski, 2004); the direction of emergence and consensus should not affect the personal interests of the researcher.

With respect to the second limitation, between the exploration and evaluation phases, outlined in detail in Chapter 3 of the research study, the researcher conducted a round of peer debriefings to "enhance the account" (Creswell, 2009, p. 192)of the first round's qualitative data analysis as well as enhance the study's overall credibility. The purpose of the peer debriefings was to have those individuals being debriefed to ask questions and review the researcher's qualitative data analysis outputs from the first round data analysis for intellectual and methodological rigor. To ensure a common interpretation of the evaluation scales used, the researcher avoided a numerical method and instead opted to provide scales based upon words. Additionally, the researcher provided his contact information to the panel members and assured them he was available to answer their questions concerning the questionnaires or any other matter that needed clarification.

Regarding the third limitation, one purpose of Delphi is to achieve consensus. Delphi allows judgment to change throughout the rounds, or emerge, and the research should also look at why judgment changed in panelists (Rowe & Wright, 1999). Researchers can use a journal to capture their decision trail of all key theoretical, methodological and analytical decisions made in the research from beginning to end. This enables the substantiation of the trustworthiness of the research (Skulmoski et al., 2007). To that end, the researcher kept copious notes thus providing for assurances for the trustworthiness of the research. Also with regards to the third limitation, opinionated panelists may have been the ones who agreed to participate while less opinionated experts may have not elected to participate; thus biasing the results. This bias was partially overcome by guaranteeing anonymity (Franklin & Hart, 2007). Finally, the panel members themselves served as a check (member check) when the researcher sent out the results from the previous round with the current round in order to identify key issues that may have been missed or misrepresented (Franklin & Hart, 2007).

In addressing the fourth limitation, the researcher was unable to provide compensation; however, the researcher did incentivize the expert panel members by offering them the results of the study upon completion. To aid in managing the expert panel members' time the researcher kept the questionnaires as abbreviated as possible and kept the submission process as easy as possible (Hsu & Sandford, 2007; Skulmoski et al., 2007).

In summary, Delphi is a two-phased decision support tool that allows a group of experts to reach consensus on matters under deliberation. For credibility to be ensured in Delhi studies, consensus levels must be predefined and predetermined. While straightforward in its approach, Delphi possesses difficulties that must be considered by a researcher. This researcher addressed four such difficulties, taken from the literature, and the ameliorating steps implemented were provided.

3.2 Expert Panel

Careful selection of the panel of experts is crucial to a successful Delphi (Stitt-Gohdes & Crews, 2004) as the validity and quality of the results generated are directly related to the selection of the panel of experts (Hsu & Sandford, 2007). For, "If the panelists [experts] participating in the study can be shown to be representative of the group or area of knowledge under study then content validity can be assumed" (Goodman, 1987, p. 731).

Specifications for selecting individuals for membership existed in the literature. Silva (2007) suggested three: knowledge, practical engagement, and their inclination to contribute to the subject matter under exploration and evaluation; Hsu & Sandford (2007) suggested two: highly trained and competent within the specialized area of knowledge; Adler and Ziglio (1996) suggested the following four: knowledge and experience with the issues under investigation, capacity and willingness to participate, sufficient time to participate in the Delphi, and effective communication skills; and Delbecq, Van de Ven, and Gustafson specifically stated three groups of people were well credentialed to be subjects of a Delphi study:

> 1. The top management decision makers who will utilize the outcomes of the Delphi study.
>
> 2. The professional staff members together with their support team.
>
> 3. The respondents to the Delphi questionnaire whose judgments are being sought. (Delbecq et al., 1975, p. 85)

As such, the identification of experts is a major point of debate in the use of Delphi and the researcher had to closely examine and seriously consider the qualifications of panel members and the definition and use of the term expert (Williams & Webb, 1994). One of the key issues related to the use of experts in Delphi research is disagreement with respect to who is an expert (Goodman, 1987; Sackman, 1975). "Simply because individuals have knowledge of a particular topic does not necessarily mean that they are experts" (Keeney, Hasson, & McKenna, 2001, p. 196) and thus researchers must explicitly stipulate the criteria in their methodology as to how an expert is defined. The definitions of an expert and a U.S. Army FA49 expert were provided in Chapter 1. As an aide-mémoire, those definitions were:

> *Expert – An individual with extensive education or training, possessing acute and relevant knowledge, longevity, and has risen to the top in their domain or field of specialization.*
>
> *U.S. Army FA49 Expert – An individual usually with twenty-one or more years of experience in the U.S. Army and who possesses a minimum of a master's degree. These individuals hold or have held the highest and key positions in the U.S. Army FA49 community. These officers hold the rank of COL or LTC(P). According to the U.S. Army, "Attaining the grade of colonel is realized by a select few and truly constitutes the elite of the officer corps" and "those promoted to colonel are truly the world-class specialists in their respective fields"* (United States Department of the Army, 2010, p. 19).

There are multiple viewpoints in the literature on the exact size of the expert panel for a Delphi study. Powell (2003) noted that there is little empirical evidence of the effect of the number of participants on the reliability or validity of the process. Linstone and Turoff (2002) and Ziglio (1996) both noted that the size of an expert panel would undoubtedly be variable. Okoli and Pawlowski (2004) posited group size does not depend on statistical power and suggested the optimum size to be 10-18 individuals. For focused studies, Stitt-Gohdes and Crews (2004) suggested 10-15 participants should be adequate. For homogeneous populations (all expert panel members come from the same discipline (Clayton, 1997)), Hsu & Sanford (2007), Skulmoski, Hartman, & Kran (2007), and Wilhelm (2001) suggested a panel of 10 to 15 experts; and for heterogeneous populations (all expert panel members possess expertise with the topic in question but come from varying professional stratifications (Clayton, 1997)) , Delbecq, Van de Ven & Gustafson (1975) suggested a panel of 5 to 10 experts.

The total population of U.S. Army FA49s possessing the rank of COL or LTC(P), of which the researcher is personally a member, equals 67. As this group of individuals constituted a homogeneous population, the researcher created a 10-member, purposively chosen expert panel from among this group. Such a panel formation is consistent and within the guidance prescribed by the literature.

3.3 Data Collection & Instruments

This study was approached in phases. There were two broad phases to the approach: exploration and evaluation. These phases included: developing an open-ended questionnaire, conducting an initial review of the questionnaire, selecting the panel, submitting the open-ended questionnaire to the expert panel members, analyzing the results, and creating the next questionnaire(s). The process of questioning the panel, analyzing the results, and modifying the questionnaire would continue until consensus was achieved. Ideally and typically, Delphi studies conclude with an expert panel reaching consensus within three rounds of questioning. Figure 2 illustrates these phases.

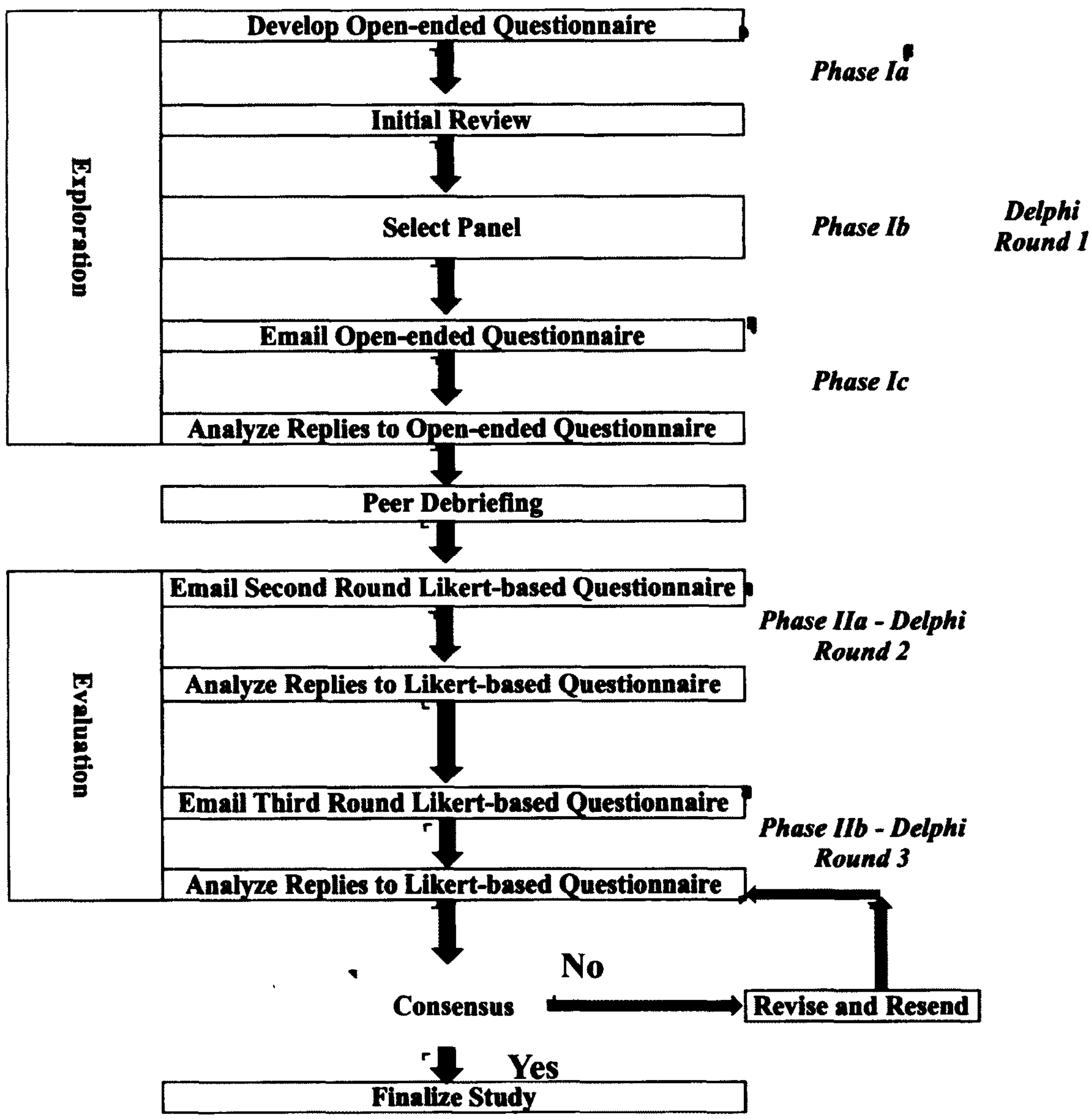

Figure 2 - Research Phases

During Phase Ia, the researcher developed the open-ended questionnaire (Appendix D) based on research and his own expertise as a FA49 Colonel. Upon developing the questionnaire, the researcher solicited remarks (Initial Review) from two U.S. Army FA49 personnel who were not a part of the expert panel and two civilian contractors who performed ORSA subject matter expert functions as part of their contractual requirements. This solicitation process sought feedback to enhance face validity and clarity and clarify and produce an open-ended questionnaire that achieved the desired effect. Each of the four personnel was contacted individually via email. Within the email, these four reviewers were furnished with a gateway web-link to an Old Dominion University sponsored Inquisite Survey™ (Inquisite, 2012) site that housed the open-ended questionnaire to be reviewed. The four reviewers were asked within the email to examine the open-ended questionnaire for understanding of what was expected as input for each of the sections (i.e. checking on the questionnaire's face validity) and to provide comments on the directions provided, ease of use, and functionality. General comments were also solicited. The feedback received from these individuals regarding face validity was extremely positive with all four personnel saying that the developed questionnaire did indeed appear prepared to capture information concerning U.S. Army FA49 competencies, KSAs, and demographics. All four reviewers commented on the open-ended questionnaire's directions, ease of use, and functionality. Collectively, they said the provided directions were easy to understand and unambiguous. Three of the four offered comments on the lack of color as the reviewed questionnaire was black and white. The researcher corrected this flaw by introducing a standardized color scheme provided within the software. All four said the navigation was simplistic and two of the four said that the progress meter was a good thing because they disliked questionnaires that didn't show one's progress.

Phase Ib, Selecting the Expert Panel, entailed seeking out expert panel members and obtaining their permission for participation. The researcher's intent in creating this panel was to seek out U.S. Army FA49 experts who would be willing to participate. A request for participation message (Appendix A) describing the purpose of the study and an informed consent letter (Appendix B) outlining their rights as human subjects was sent via email to prospective expert panel members asking for them to participate. As the population constituted a homogeneous population, the researcher created a 10-member expert panel from amongst this group.

Phase Ic began the first round of the Delphi process. The intent of this phase was to collectively identify technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. This phase began the process of providing answers to the PRQ and SRQs 1-3. This phase commenced with a Round One Participation Message (Appendix C) individually being sent via email to each expert panel member. The Round One Participation Message thanked the expert panel members for bestowing their services; provided them with a copy of U.S. Joint Forces Command's JOE 2010, The Joint Operating Environment for their use if they were not familiar with it or if they just wanted to refresh themselves with its contents; and furnished them with a gateway web-link to an Old Dominion University sponsored Inquisite Survey™ (Inquisite, 2012) site. The JOE 2010 provided the expert panel members with a common background and a focused target on which to direct their efforts (Rotundi & Gustafson, 1996), i.e. a starting frame of reference. Upon entering the Inquisite Survey™ (Inquisite, 2012) site, the expert panel members began the procedure of completing the Round One Questionnaire (Appendix D). Upon arriving at the site for the Round One Questionnaire, the expert panel members were provided with instructions on how to navigate and complete the questionnaire. The purpose of the Round One Questionnaire was to provide the expert panel members with the opportunity to individually develop a list of technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. The questionnaire was divided into five sections: Section 1 – Technical Analytical Competencies, Section 2 – Knowledge, Section 3 – Skills, Section 4 - Abilities, and Section 5 – Demographics. The expert panel members had seven (7) days to complete the questionnaire. The researcher sent a follow-up email (Appendix E) as a reminder to anyone who had not responded by the suspense. The first round of Delphi ended upon the researcher receiving the replies to the open-ended questionnaire and conducting the analysis. This also signified an end to the overall exploratory phase. The replies to the open-ended questionnaire were analyzed using qualitative analysis (Section 3.4.1).

In between the exploration and evaluation phases, the researcher conducted a round of peer debriefings to "enhance the account" (Creswell, 2009, p. 192) of the first round's qualitative analysis as well as enhance the study's overall credibility. The purpose of the peer debriefings was to have those individuals being debriefed to ask questions and review the researcher's data analysis outputs from the first round data analysis for intellectual and methodological rigor. The researcher conducted one peer debriefing round after his completing qualitative analysis of the first round's data. The researcher chose two Old Dominion University Ph.D. candidates, one in the Engineering Management and Systems Engineering Ph.D. program and the other in the Higher Education Ph.D. program. Both of these individuals were chosen for two reasons: 1) their candidate status and 2) their familiarity with Grounded Theory. Their familiarity with Grounded Theory forced the researcher to have to positively demonstrate the effectiveness of his intellectual reasoning and methodology for arriving at his categorical conclusions. Because of appointment conflicts, these peers were debriefed separately. The debriefing steps are outlined in Appendix F. The conclusion reached was that the researcher's categorical conclusions were consistent with his intellectual and methodological approaches. Upon completing the peer debriefings, the questionnaire for the next Delphi round was created.

Phase IIa signified the beginning of the second Delphi round and commenced with a Round Two Participation Message (Appendix G) to the expert panel members individually thanking them for their participation in the first round and urging them to provide their continued support. The purpose of this round's questionnaire was to begin discerning the level of agreement or disagreement among the expert panel members. The researcher provided the expert panel members with a demographic summary of the expert body and a summary of the first round's responses. The participation message also included a gateway web-link to an Old Dominion University sponsored Inquisite Survey™ (Inquisite, 2012) site housing the second questionnaire (Appendix H) that contained the initial set of identified technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. The researcher asked the expert panel members to annotate their opinion of the importance of each listed technical competency and KSA on a four-point Likert scale: Strongly Agree = 4, Agree = 3, Disagree = 2, and Strongly Disagree = 1. The researcher chose this even numbered Likert scale with no neutral option to prevent expert panel members from gravitating toward an undecided response (Linstone & Turoff, 2002). The expert panel members had three (3) days to complete the questionnaire. The researcher sent a follow-up email (Appendix I) as a reminder to anyone who had not responded by the suspense. Once the responses were received, they were analyzed by calculating the mode, median, and interquartile range as well as the mean, standard deviation, and coefficient of variance for each Likert item. This analysis would have been used as the basis for the development of the next Delphi round's questionnaire. As stated before, Delphi studies typically conclude with an expert panel reaching consensus within three rounds of questioning. In the case of this research study, consensus (addressed in Section 3.4.2, Quantitative Data Analysis) was reached after the second round; hence, Phase IIb was not necessary. Figure 3 illustrates the revised phases of this study as executed.

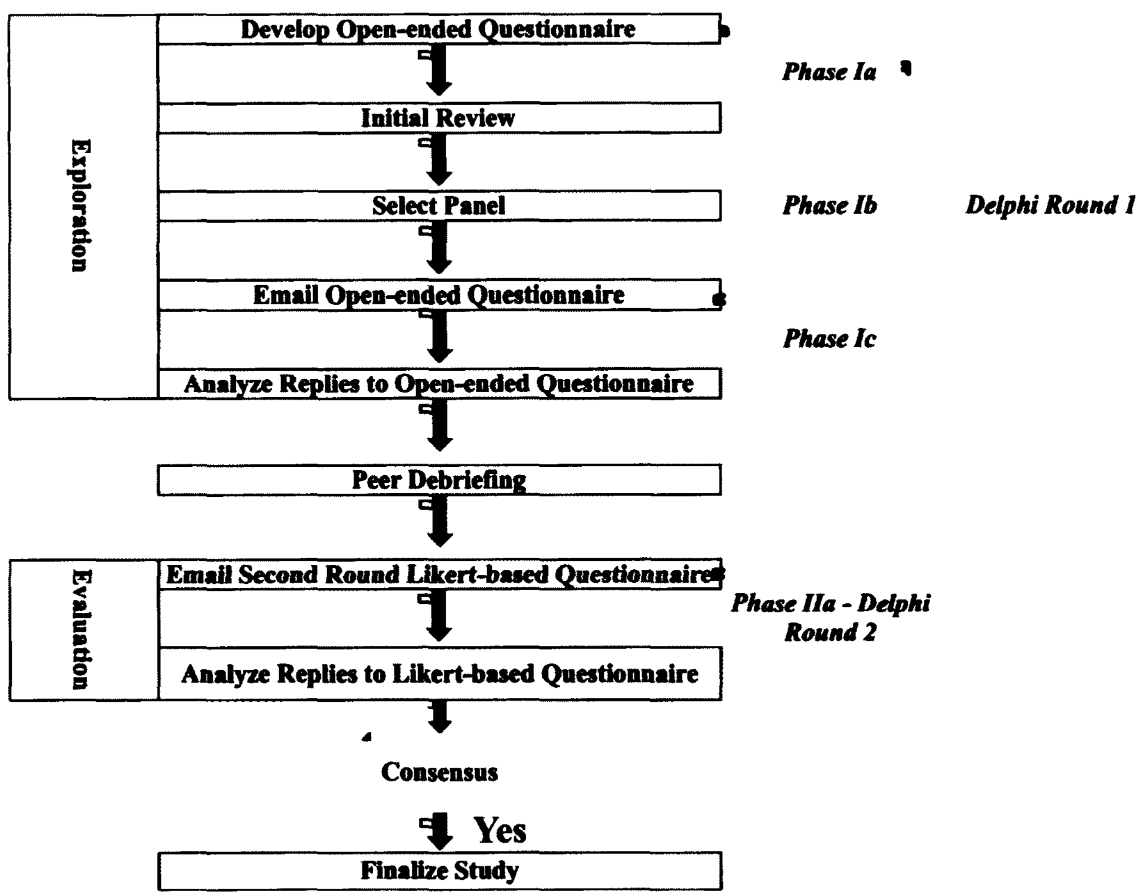

Figure 3 - Research Phases, Revised

3.4 Data Analysis

Data produced by the study required both qualitative and quantitative analysis. During Round One of the Delphi, the expert panel members were asked open-ended and demographic questions. The data generated by the responses to the open-ended questions required qualitative data analysis and the answers to the demographic questions required quantitative analysis. During Round Two, the expert panel members were asked to respond to Likert scaled questions based upon responses from Round One. The responses to these questions required quantitative data analysis.

The subsections that follow will elaborate upon the qualitative and quantitative data analysis. In Subsection 3.4.1, elaboration on the qualitative data analysis technique used is provided that includes referenced sources for Grounded Theory and the coding schema employed during each stage of the qualitative analysis. In Subsection 3.4.2, a discussion on descriptive statistics and their use is offered.

3.4.1 Qualitative Data Analysis

During Round One of the Delphi study, the expert panel members were asked open-ended and demographic questions. The responses to these open-ended questions from the expert panel members required qualitative data analysis. To accomplish this task, the researcher used qualitative coding techniques identified by Charmaz (2006) in *Constructing Grounded Theory – A Practical Guide Through Qualitative Analysis,* Miles and Huberman (1994) in *An Expanded Sourcebook – Qualitative Data Analysis*, and Saldaña (2011) in *The Coding Manual for Qualitative Researchers.*

For the open-ended questions, the researcher performed coding in two stages using elements typically associated with grounded theory methodology. Grounded theory methods contain structured, yet flexible directions for assembling and analyzing qualitative data for the purpose of building a theory *grounded* in the data (Charmaz, 2006). While the researcher did not create a theory for this study, the researcher still wanted to ensure the qualitative data was assembled and analyzed using a structured approach; hence, the choice and use of elements of grounded theory methodology.

During the first stage of coding for the open-ended questions, the researcher employed the elemental methods of initial and *in vivo* coding (Charmaz, 2006; Saldaña, 2011). The use of these elemental methods provided the foundational approaches to the overall coding for the responses to the open-ended questions (Saldaña, 2011). The use of initial coding, also known as open coding (Saldaña, 2011), allowed the researcher to break down the qualitative responses to the open-ended questions into distinct parts, closely examine them line-by-line, and initially compare these lines for similitudes (Charmaz, 2006; Miles & Huberman, 1994; Saldaña, 2011). As the researcher was examining the responses of a unique population, the chance for colloquial or jargon responses or expressions existed. The use of *in vivo* coding allowed the researcher to refer to a specific word or phrase found within the corpus of the qualitative data used by the expert panel members themselves (Charmaz, 2006; Saldaña, 2011). The similitudes became the emerging categories that were taken forward to the second stage.

During the second stage of coding for the open-ended questions, the researcher employed focused coding in an attempt to integrate the emergent categories (Charmaz, 2006; Saldaña, 2011). Focused coding allowed the researcher to categorize the data coded during the first stage based on thematic or conceptual similitudes, progressing from a low level of abstraction to a higher-level of abstraction (Charmaz, 2006; Saldaña, 2011). Focused coding allowed the researcher to insightfully and completely categorize the data (Charmaz, 2006). When no new information appeared to be emerging from the coding, the categories were considered saturated and the qualitative analysis stopped (Charmaz, 2006; Saldaña, 2011).

Using the above coding schemas for the two stages of qualitative data analysis, while labor intensive, allowed the researcher first to identify the emerging categories and then to identify the higher-level abstraction categories for competencies and KSAs that would be carried forward as elements for inclusion. Using these coding schemas associated with Grounded Theory provided rigorousness to the overall research effort.

3.4.2 Quantitative Data Analysis

Descriptive statistics were employed to analyze the demographic data from Round 1. These descriptive statistics of the demographic data were provided back to the expert panel members during Round Two as a means to foster comradeship among the expert panel members, which is important for enhancing discourse with Delphis (Rotundi & Gustafson, 1996).

During Round Two, the expert panel members responded to Likert scaled questions based upon responses from Round One. The data generated by the responses to these Likert scaled questions required quantitative data analysis. Delphi studies require measures of both central tendency and variability (Wilhelm, 2001) to be measured. The mean, mode, median, standard deviation, coefficient of variation, and interquartile range of each of the responses to the Likert scaled questions were determined. The researcher used Microsoft's Excel to perform the quantitative data analysis.

To confirm if a necessity existed for supplemental Delphi rounds, the researcher used the coefficient of variation to determine if a strong consensus had been reached. English and Kernan (1976) recommended calculating the coefficient of variance as a method to determine the measure of dispersion in answers. According to these researchers, a strong consensus is achieved when the coefficient of variance is less than or equal to 0.5. For this study, the researcher adhered to this interpretation for a strong consensus. If a strong consensus was reached, the Delphi process stopped and no further rounds would be necessary.

Only those technical competencies and KSAs with median ratings equaling Agree or Strongly Agree were included in the final compilation. The value ranges for the levels of agreement were: Strongly Agree – 3.26 – 4.00, Agree – 2.50 – 3.25, Disagree – 1.75 – 2.49, and Strongly Disagree – 1.00 – 1.74.

While not as labor intensive as the qualitative data analysis, the quantitative data analysis was critical as the outputs from this analysis when paired with the predetermined levels of consensus and category inclusion drive the necessity, or not, for subsequent Delphi rounds along with producing the overall outcomes for the study.

3.5 Informed Consent

Prior to participating in the study, each prospective expert panel member received a copy of an informed consent letter (Appendix B) outlining his or her rights as a human subject. This informed consent letter adhered to guidelines prescribed by Old Dominion University's Institutional Review Board.

3.6 Confidentiality & Anonymity

Confidentiality and anonymity were critical to expert panel member candidness and data validity (Cooper & Schindler, 2006). All information provided by an expert panel member was anonymous to everyone but the researcher. All information provided by the expert panel members was treated with complete confidentiality. No personally identifiable information (PII) was ever disseminated. No one but the researcher ever saw or knew the name or identity of an expert panel member. All data was encoded to protect the identity of the expert panel members. A number was used to code each survey and electronic response. Documentation was numbered by order of receipt. Each expert panel member was identified to the expert panel and in the researcher's written reports, presentations, and publications through an ID number.

All digital documentation was password protected and encrypted (128 bit) and stored against both physical and non-physical theft. The researcher secured a backup copy of the data in a locked file cabinet at his residence. Only the researcher had access to the complete file associated with the study. All hard copies produced of the original data instruments will be destroyed upon completion of the research study. All digital records will be destroyed at a date no earlier than five years after the successful defense of the researcher's dissertation. The destruction of the digital records will be accomplished by incineration or executing an option that meets U.S. DOD 5220-22 M standards for securely erasing magnetic media. To avoid inadvertent disclosure of an expert panel member's email address, only individually addressed email responses between the researcher and individual expert panel members were used.

An expert panel member may face a risk of inadvertent disclosure of PII. The researcher attempted to mitigate this risk by following the procedures outlined in the above paragraphs. While an ID number may link an expert panel member to their responses, to the researcher's knowledge there was nothing in an expert panel member's responses that could reasonably place an expert panel member at risk of criminal or civil liability or be damaging to their financial standing, employability, or reputation.

3.7 Validity & Reliability

As poignantly stated by Onwuegbuzie and Johnson, "Research needs to be defensible to the research and practice communities for whom research is produced and used" (2006, p. 48). The research needs to be rigorous. To that end, nothing was more important than the issues surrounding reliability and validity in the design of this research study. The researcher acknowledged the potential exists for criticisms of knowledge (output of the intended study) elicited through Delphi studies with regards to validity and reliability. Acknowledging that criticisms existed was the first step in helping to reduce researcher bias. Without this acknowledgement, the researcher would not and dare say could not have appropriately attempted to complete this proposed research study. Failure to account for potential criticisms would have led to a sloppy research study that would have had no merit. To counter issues of bias, the researcher remained focused, attentive to detail, and objective in the study and kept copious notes on actions taken. By keeping a record of decisions made and why they were made also aided in providing transparency.

In the subsections that follow, actions taken by the researcher to address and enhance the instrument validity and the qualitative validity and reliability of the study are presented. By adhering to these actions, the researcher obtained the highest level of instrument validity and research qualitative validity and reliability possible.

3.7.1 Instrument Validity

The two areas addressed by the researcher to enhance the instrument validity within the study were limited to face and content validity. In addressing face validity, the researcher, upon developing the open-ended questionnaire in Phase Ia, solicited remarks from two U.S. Army FA49 personnel who were not a part of the expert panel and two civilian contractors who performed ORSA subject matter expert functions as part of their contractual requirements. This solicitation process sought feedback to enhance face validity and clarity and clarify and produce an open-ended questionnaire that achieved the desired effect. The feedback received from these individuals regarding face validity was extremely positive with all four personnel saying that the developed questionnaire did indeed appear prepared to capture information concerning U.S. Army FA49 competencies, KSAs, and demographics. For additional feedback, the reader is referred to the discussion on Phase Ia in Section 3.3.

With regards to content validity, careful selection of the panel of experts was crucial to this study as the validity and quality of the results generated were directly related to the selection of the panel of experts. Content validity was assumed for the study as the panelists that were chosen were representative of the group and the topic under consideration (Goodman, 1987).

3.7.2 Qualitative Validity

To check for the accuracy of the findings (Creswell, 2009) and enhance the overall qualitative validity of the study, the researcher employed the following actions:

1) To ensure and enhance the credibility in this Delphi study, the researcher identified and justified the level of consensus prior to embarking upon the research as identified by Fink et al (1984).

2) In between the exploration and evaluation phases, the researcher conducted a round of peer debriefings to "enhance the account" (Creswell, 2009, p. 192) of the first round's qualitative analysis as well as enhance the study's overall credibility. Peer debriefing allowed for the peers who reviewed the categorical findings to ask questions about the findings so that the account would resonate with people other than the researcher (Creswell, 2009).

3) Member checking, an inherent quality of Delphi studies, was implemented. One uses member checking "to determine the accuracy of the qualitative findings through taking the final report or specific descriptions or themes back to participants and determining whether these participants feel that they are accurate" (Creswell, 2009, p. 191). The information gathered from Round 1 was analyzed and provided back to the panel members for use in the subsequent round. Panel members were afforded the opportunity to provide their comments on agreement or disagreement with the information provided. This is the time when the panel members had the opportunity to comment and make suggestions and identify key issues the researcher might have missed.

3.7.3 Qualitative Reliability

To ensure the consistency of the approach taken (Creswell, 2009) and to enhance the overall qualitative reliability of the study to maximize the potential of the repeatability were the study to be performed by another individual, the researcher explicitly detailed the research design employed in this study, thus providing for methodological reliability. The use of peer debriefings also added to the overall reliability of the research effort by authenticating the processes involved in the analysis of the Round 1 data.

3.8 Summary

Chapter 3 described the methods and procedures applied for assembling and analyzing the data for this study. This chapter began with a discussion of the appropriateness of selecting Delphi instead of other group decision making processes. The chapter then transitioned into a detailed discourse on Delphi with consideration given to its background, phases, and credibility based upon identification and justification of consensus levels. This detailed discourse ended with an examination of four difficulties associated with implementing Delphi and steps taken by the researcher to ameliorate these difficulties. Next was offered a characterization of the expert panel to include its composition and size. The emphasis then shifted to examining the data collection methodology and instrumentation, which included a meticulous outlining of the research phases. With the data collection effort outlined, the focus changed to the qualitative and quantitative data analysis strategies used. Prescriptive measures for informed consent, warranted by Old Dominion's Institutional Review Board, were then provided.

Assurances for how confidentiality and anonymity of the expert panel members would be maintained followed. The chapter concluded with an assessment of the research design's validity and reliability and those actions taken to establish rigor.

CHAPTER 4

RESULTS

The purpose of this study was to identify the technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical competencies and KSAs, this study employed a qualitative research design with a quantitative component using a conventional, web-assisted Delphi methodology. This Delphi methodology was conducted to gather data and to build consensus among the expert panel members in identifying those technical competencies and KSAs. Specifically, the research was concentrated on answering the PRQ and SRQs 1-3. Two Delphi rounds were employed to solicit the judgments of a purposively chosen panel of U.S. Army FA49 experts.

This chapter presents the results and interprets the findings of the data collection effort. The results and interpretations begin with the first Delphi round discussed to include the formation of the expert panel and the first Delphi round's timeline. This is followed by an examination of the demographics of the expert panel members and a detailed evaluation of the results obtained during the exploratory phase of this study. The second Delphi round is then discussed to include Round 2's timeline. The results for Round 2 are then presented and evaluated. The chapter then begins to draw to a close with consideration given to consensus and inclusion of the evaluation phase's results. Discussions of consequences of the data are reserved for Chapter 5.

4.1 First Delphi Round

The purpose of Round 1 was to have the expert panel members individually identify technical analytical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. This phase began the process of seeking answers to the PRQ and SRQs 1-3. This phase commenced with a Round 1 Participation Message (Appendix C) being sent via email to each expert panel member. The Round One Participation Message provided the expert panel members with a gateway web-link to an Old Dominion University sponsored Inquisite Survey™ (Creswell, 2009) site housing the first questionnaire (Appendix D); a copy of U.S. Joint Forces Command's JOE 2010, The Joint Operating Environment; and their unique ID numbers for tracking purposes. The questionnaire was divided into five sections: Section 1 – Technical Competencies, Section 2 – Knowledge, Section 3 – Skills, Section 4 - Abilities, and Section 5 – Demographics. The expert panel members had seven (7) days to complete the questionnaire. The first round of Delphi ended upon the researcher receiving the replies to the open-ended questionnaire and conducting the analyses. This also signified an end to the overall exploratory phase. The replies to the open-ended questionnaire were analyzed, distilled, and synthesized using coding practices associated with grounded theory as detailed in Chapter 3.

4.1.1 Forming the Expert Panel & Round 1 Timeline

Initially, the researcher contacted 10 prospective U.S. Army FA49 expert panel members, which represented the number identified in Chapter 3 as the minimum number necessary for an expert panel for a Delphi study drawn from a homogenous population.

As of December 2011, the total population of U.S. Army FA49 COLs and LTC(P)s equaled sixty-seven (67) officers to include the researcher himself. The researcher contacted the 10 prospective expert panel members on 12 December 2011 by sending them the Request for Participation Message (Appendix A) and the Informed Consent Letter (Appendix B) vie email to their individual Army Knowledge Online (AKO) email accounts. By 16 December 2011, the researcher had received replies from 8 of the prospective expert panel members indicating their willingness and consent to participate in the study. The researcher sent these 8 experts the Round One Participation Message (Appendix C) between 13 and 16 December 2011. Of note, one prospective panel member identified a caveat saying that he was to deploy to Afghanistan mid-January 2012 and asked if the process was going to be totally electronic or a combination of electronic and physical (i.e. paper-based questionnaires via postal mail). This officer did not want to participate if the process would require correspondence via postal mail because he was worried that the time delays imposed would significantly slow down the data collection effort. Upon receiving the researcher's reply that the entire process would be conducted electronically, this prospective panel member agreed to participate in the study.

The researcher never received a reply from the remaining 2 prospective expert panel members, and therefore, still seeking the minimum required 10 expert panel members for the Delphi study; the researcher contacted an additional 2 prospective expert panel members. By 20 December 2011, the researcher had received replies from these additional two prospective members indicating their willingness and consent to participate in the study. By 22 December 2011, these 2 additional expert panel members were provided with the Round One Participation Message (Appendix C).

The expert panel members were given 7 days to complete the first round questionnaire. Five (5) expert panel members completed the questionnaire within their 7 allotted days. The remaining 5 expert panel members were sent a follow-up message (Appendix E) via email to their individual AKO email accounts on the first day after their responses were due. Two (2) of the remaining 5 completed their questionnaire the day their follow-up message was sent. The final 3 expert panel members all requested extensions of between 2-4 days. The extensions were granted. By 23 December 2011, 8 of the 10 expert panel members had provided responses to the first round questionnaire. On 23 December 2011, the researcher was contacted by 1 of the remaining 2 delinquent expert panel members by telephone. He informed the researcher that he was traveling during the holidays and would not be able to meet his granted extension. He advised the researcher he would submit his responses during the first week of January 2012 and asked the researcher if he was amenable to this proposition. The researcher acquiesced. The researcher received this expert panel member's responses on 4 January 2012.

The expert panel member who indicated his pending deployment to Afghanistan in mid-January never completed his survey. This expert panel member had requested an extension but did not meet it. After repeated attempts at contacting this individual failed, the researcher contacted one more additional prospective expert panel member. On 4 January 2012, the researcher sent this prospective expert panel member the Request for Participation Message (Appendix A) and the Informed Consent Letter (Appendix B) via email to this prospective expert panel member's individual AKO email account. On 6

January 2012, the researcher received a reply from this prospective expert panel member indicating his/her willingness and consent to participate in the study. That same day, the researcher sent this newest expert panel member the Round One Participation Message (Appendix C). On 9 January 2012, the researcher received responses from this tenth and final expert panel member.

Data collection for Round 1 took 29 days to complete. On average, an expert panel member took 6.7 days to complete the Round 1 questionnaire. The minimum amount of time needed was 1 day and the maximum amount of time was 22 days. Table 5 summarizes the data collection timeline for Round 1.

#	Unique ID	App A & B Sent	App C Sent	Began Rd 1	Completed Rd 1	App E to be Sent	App E Sent	Extension Granted
1	0147	12/12/11	12/16/11	12/16/11	12/21/11	12/22/11	NA	
2	1486	12/12/11	12/13/11	12/13/11	12/16/11	12/20/11	NA	
3	8699	1/4/12	1/6/12	1/6/12	1/9/12	1/13/12	NA	
4	3009	12/12/11	12/13/11	12/13/11	12/23/11	12/20/11	Y	Y - 48 hours
5	4992	12/12/11	12/14/11	12/14/11	1/4/12	12/21/11	Y	Y - 96 hours
6	5832	12/12/11	12/14/11	12/14/11	12/21/11	12/21/11	Y	
7	7699	12/12/11	12/13/11	12/13/11	12/20/11	12/20/11	Y	
8	9622	12/12/11	12/13/11	12/13/11	12/15/11	12/20/11	NA	
9	1154	12/14/11	12/15/11	12/15/11	12/15/11	12/22/11	NA	
10	8333	12/20/11	12/22/11	12/22/11	12/23/11	12/29/11	NA	
11	2764	12/12/11	12/13/11	12/13/11	Did not complete	12/20/11	Y	

Table 5 - Round 1 Data Collection Timeline

4.1.2 Expert Panel Demographics

During Round 1, the expert panel members were asked to provide demographic information. As the U.S. Army FA49 COL and LTC(P) population is relatively small, the researcher did not ask the panel members to provide current duty positions as this could have led to inadvertent identification of a panel member.

The expert panel was comprised of 8 COLs and 2 LTC(P)s. The average time in service (TIS), which is the indicator of how long an individual has served in the military, of these individuals was 23.7 years. TIS ranged from 21.7 years to 28.7 years. TIS was calculated by subtracting an individuals basic active service date (BASD) from the current date. The expert panel members have served an average of 11.8 years as a U.S. Army FA49. Years served as a U.S. Army FA49 ranged from 10.6 years to 15.7 years. Years served as a U.S. Army FA49 was calculated by subtracting an expert panel members FA49 designation date from the current date. During their years of service to the nation, 80% of the expert panel members have deployed in support of military operations as a U.S. Army FA49 either in Iraq, Afghanistan, or other areas of conflict. The majority of the expert panel members were white, not Hispanic, males between 41-45 years of age. Seven of the ten expert panel members received their undergraduate education and source of military commissioning from the United States Military Academy (USMA), West Point, NY. The remaining three expert panel members received their undergraduate education from other colleges or universities with their source of military commissioning being the Reserve Officers' Training Corps (ROTC) program. All of the expert panel members possessed postgraduate degrees with an overwhelming majority of the expert panel members (7 out of 10) possessing Doctor of Philosophy (Ph.D.) degrees. All but one of the expert panel members have attended a Senior Service College (SSC), which is the highest military education offered to military members. Forty percent (40%) have been published in a journal or periodical for their work as a U.S. Army FA49. A simple majority (6 out of 10) of the expert panel members have served as instructors while functioning as a U.S. Army FA49. Table 6 summarizes the expert panel members' demographic feedback.

COL	LTC(P)	Avg TIS	Avg Years as FA49	Deployed	
8	2	23.7 years	11.8 years	Yes	80%
				No	20%

Ethnicity		Gender		Age	
White	90%	Male	80%	41-45	70%
Field left blank	10%	Female	20%	46-50	20%
				> 51	10%

Source of Commission		Postgraduate Education		SSC Attendance	
West Point	70%	Masters	30%	Yes	90%
ROTC	30%	Ph.D.	70%	No	10%

Published		Instructor	
Yes	40%	Yes	60%
No	60%	No	40%

Table 6 - Expert Panel Demographics

As portrayed above, the expert panel members brought remarkable breadth and depth of U.S. Army FA49 knowledge to this Delphi study. The detailed results of this research effort are presented in the next section.

4.1.3 Results

For the open-ended questions, the researcher performed coding in two stages using elements associated with grounded theory methodology. During the first stage of coding for the open-ended questions, the researcher employed the elemental methods of initial/open coding and in vivo coding. The use of initial/open and in vivo coding allowed the researcher to break down the qualitative responses to the open-ended questions into distinct parts and compare them for similitudes. The similitudes became the emerging categories that were taken forward to the second stage. During the second stage of coding for the open-ended questions, the researcher employed focused coding in an attempt to integrate the emergent categories. Focused coding allowed the researcher to insightfully and completely categorize the data. Given the terse nature to the overwhelming majority of the replies, in most cases first stage coding was all that was necessary to identify categories from the preponderance of the expert panel responses. When no new information appeared to emerge from the coding, the categories were considered saturated and the qualitative analysis stopped. Peer debriefings were conducted for each of the two stages to enhance the credibility of the of the researcher's qualitative analysis.

The expert panel members provided 326 responses to the open-ended questions: 84 competencies, 91 items of knowledge, 78 skills, and 73 abilities. Table 7 summarizes the total number of responses provided by the expert panel. A synopsis follows regarding the two coding stages for competencies and KSAs.

Unique ID	Competencies Submitted	Knowledge Submitted	Skills Submitted	Abilities Submitted
5832	10	10	10	10
9622	9	8	8	6
1154	10	9	7	11
1486	5	8	3	3
7699	12	10	10	10
147	8	8	9	5
3009	10	10	6	5
8333	3	10	10	10
4997	10	8	10	7
8699	7	10	5	6
Total	84	91	78	73
Average	8.4	9.1	7.8	7.3

Table 7 - Round 1, Number of Submissions by Respondent

Competencies

The expert panel members were asked to provide responses to the following question concerning competencies:

Please list those technical analytical competencies you believe would be required for future U.S. Army Fa49s to perform their duties within the joint operation environment of the next twenty-five years.

The expert panel members provided a total of 84 responses to the open-ended question concerning competencies. A cumulative listing of the expert panel members' responses can be found in Appendix J. During the first stage of coding, 11 categories emerged, Appendix K, that were further refined during the second stage of coding (shown in Appendix L) into the five categories shown in Table 8. These 5 categories were carried forward for inclusion in the Round 2 questionnaire as elements to be voted upon by the expert panel. None of the expert panel members provided additional comments.

COMPETENCY
Lead Analysis
Plan Analysis
Execute Analysis
Evaluate Analysis
Communicate Analysis

Table 8 - Competency Categories

Knowledge

For the knowledge section of the questionnaire, the expert panel members were asked to provide responses to the following question:

Please list what technical knowledge you believe would facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

The expert panel members provided a total of 91 responses to the open-ended question concerning knowledge. A cumulative listing of the expert panel members' responses can be found in Appendix M. During the first stage of coding, 18 categories emerged, Appendix N, that were further refined during the second stage of coding (shown in Appendix O) into the 21 categories shown in Table 9. Normally during focused coding, one would expect the number of categories to decrease as one progresses from a lower level of abstraction to a higher level of abstraction; however, it was determined that too high a level of abstraction had actually been accomplished for two of the categories (Organizations and Running) during the first stage of coding and that these resultant categories needed to be reevaluated and the abstraction level lowered. The final 21 categories were carried forward for inclusion in the Round 2 questionnaire as elements to be voted upon by the expert panel. None of the expert panel members provided additional comments.

KNOWLEDGE
Acquisition Management
Army Operations
Army Organization
Army Processes (e.g. PPBE)
DoD Organization
Economics
Historical Applications of OR
How the Army Runs
How the DoD Runs
How the Federal Government Runs
Interagency Operations
Joint Operations
Joint Processes (e.g. JCIDS (DOTMLPF-P))
Leadership
Mathematics
Methods/Tools
Military Planning Processes (MDMP, JOPP)
Multinational Operations
Operational Environment
Resource Management (includes HRM)
Role of ORSA

Table 9 - Knowledge Categories

Skills

When the expert panel members transitioned to the skills section of the questionnaire, they were asked to provide responses to the following question:

Please list what technical skills you believe would facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

The expert panel members provided a total of 78 responses to the open-ended question concerning skills. A cumulative listing of the expert panel members' responses can be found in Appendix P. During the first stage of coding, 28 categories emerged, Appendix Q, that were further refined during the second stage of coding (shown in Appendix R) into the 41 categories shown in Table 10. As with the analysis of items of knowledge, a higher level of abstraction had occurred during the first coding stage. The modeling, simulation, mathematics, and data analysis categories were at too high a level of abstraction and needed to have their abstraction level lowered. The resulting 41 categories were carried forward for inclusion in the Round 2 questionnaire as elements to be voted upon by the expert panel. None of the expert panel members provided additional comments.

Abilities

Just like the previous sections of the questionnaire, the expert panel members were asked to provide responses to a question concerning abilities:

Please list what technical skills you believe would facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

The expert panel members provided a total of 73 responses to the open-ended question concerning abilities. A cumulative listing of the expert panel members' responses can be found in Appendix S. During the first stage of coding, 19 categories emerged, Appendix T, that were further refined during the second stage of coding (shown in Appendix U) into first 18 and then 17 categories. During the review, it was determined that one of the final 17 categories (mathematical reasoning) may have been taken to too far a level of abstraction and subsequently this category and its 5 progenitors would need to be included in the final category listing. The final 22 categories are shown in Table 11. These 22 categories were carried forward for inclusion in the Round 2 questionnaire as elements to be voted upon by the expert panel. None of the expert panel members provided additional comments.

SKILL
Active listening
Ad hoc (quick turn) modeling
Agent based modeling
Analyzing data with and/or without software
Combat Modeling
Common software packages (SPSS, GAMS, MATLAB, Minitab, MS Office)
Computer modeling
Computer Programming (VBA, Java)
Conduct Research
Cost benefit analysis
Data analysis and interpretation
Data modeling
Database programming, development, analysis, mining
Decision analysis (to include multi-objective)
Design of Experiments
Discrete event simulation
Effective Communication (writing, speaking, presentation)
Forecasting
Goal Programming
Leadership
Linear Algebra
Math Programming
Mathematics (Probability, Statistics)
Metric development
Military planning processes (MDMP, JOPP)
Modeling (general)
Negotiation
Optimization
Prioritization
Problem solving
Process improvement analysis
Qualitative analysis
Quantitative analysis
Risk analysis
Simulation (general)
Spreadsheet modeling
Statistical analysis with and/or without Software
Survey analysis
Survey development
Trend analysis
Value modeling

Table 10 - Skill Categories

ABILITY
Analytical Thinking
Application of OR Techniques to Military Problems or Situations
Creative Thinking
Critical Thinking
Communicate (Written and Oral Expression)
Comprehension (Written and Oral)
Deductive Reasoning
Evaluating a Study
Inductive Reasoning
Information Ordering
Integrating Information and Data
Leadership
Making Projections Based on Data
Managing a Study
Mathematical Reasoning
Motivate/Inspire
Problem Sensitivity
Problem Solving
Synthesizing Information and Data
Teamwork (Form, Manage, Lead)
Value Focused Thinking
Visualization

Table 11 - Ability Categories

4.2 Second Delphi Round

The purpose of this round was to begin discerning the level of agreement or disagreement among the expert panel members. Round 2 commenced with a Round Two Participation Message (Appendix G) to the expert panel members. The participation message included a gateway web-link to an Old Dominion University sponsored Inquisite Survey™ (Inquisite, 2012) site housing the second questionnaire (Appendix H) that contained the set of identified technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. The expert panel members were asked to annotate their opinion of the importance of each listed technical analytical competency and KSA on a four-point Likert scale: Strongly Agree = 4, Agree = 3, Disagree = 2, and Strongly Disagree = 1. The expert panel members were also provided with the opportunity to include comments; however, none did so. The expert panel members had three (3) days to complete the questionnaire. Once the responses were received, they were analyzed by calculating the mode, median, and interquartile range as well as the mean, standard deviation, and coefficient of variance for each Likert item. All ten (100%) of the expert panel members who participated during Round 1 responded to the second questionnaire.

4.2.1 Round 2 Timeline

Round 2 commenced on 5 February 2012 with the researcher contacting the 10 expert panel members from Round 1with the Round Two Participation Message (Appendix G). Seventy (70%) of the expert panel members completed the questionnaire within the allotted 3 days. An email reminder (Appendix I) was sent to the 3 delinquent expert panel members. The researcher received a reply from 1 of the 3 delinquent expert panel members asking for an extension through the weekend of 11-12 February 2012. The extension was granted and the expert panel member submitted his/her responses on 11 February 2012. Of the remaining 2, the researcher received the responses from 1 on 10 February 2012. After not receiving any contact from the final expert panel member after 7 days, the researcher telephonically contacted the expert panel member on 13 February 2012 and left a message that he had called. This telephonic contact may or may not have prompted the final delinquent expert panel member to submit his/her responses; however, the individual did provide his/her responses that same day.

Data collection for Round 2 took 8 days to complete. On average, an expert panel member took 2.95 days to complete the Round 2 questionnaire. The minimum amount of time needed was 0.5 days and the maximum amount of time was 8 days. Table 12 summarizes the data collection timeline for Round 2. All ten (100%) of the expert panel members who participated during Round 1 responded to the second questionnaire.

#	Unique ID	App G Sent	Began Rd 2	Completed Rd 2	App I to be Sent	App I Sent	Extension Granted
1	0147	2/5/12	2/5/12	2/13/12	2/9/12	Y	NA
2	1486	2/5/12	2/5/12	2/11/12	2/9/12	Y	Y – 2/12/12
3	8699	2/5/12	2/5/12	2/6/12	2/9/12	NA	NA
4	3009	2/5/12	2/5/12	2/7/12	2/9/12	NA	NA
5	4992	2/5/12	2/5/12	2/10/12	2/9/12	Y	NA
6	5832	2/5/12	2/5/12	2/7/12	2/9/12	NA	NA
7	7699	2/5/12	2/5/12	2/6/12	2/9/12	NA	NA
8	9622	2/5/12	2/5/12	2/6/12	2/9/12	NA	NA
9	1154	2/5/12	2/5/12	2/8/12	2/9/12	NA	NA
10	8333	2/5/12	2/5/12	2/5/12	2/9/12	NA	NA

Table 12 - Round 2 Data Collection Timeline

4.2.2 Results

Descriptive statistics: mean, median, mode, first and third interquartile ranges (IRQ 1 and 3 respectively), standard deviation, and the coefficient of variance (COV) were calculated for the responses from Round 2. The results for each category are provided in the following sections.

Competencies

Of the 5 competencies voted upon by the expert panel, none received a unanimous vote. Four (4) of the expert panel members strongly agreed all 5 of the competencies would be required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Of the remaining 6 expert panel members, 5 responded with either agree or strongly agree for each listed competency and 1 responded with values ranging from disagreement to strong agreement for each listed competency. Communicating analysis had the lowest COV and evaluating analysis had the highest COV. Tables 13 and 14 show the descriptive statistics and the frequency distribution of the calculated values for COV respectively.

	Competency	Mean	Median	Mode	IRQ 1	IRQ 3	SD	COV
1	Communicating Analysis	3.8	4	4	4	4	0.42	0.11
2	Executing Analysis	3.6	4	4	3	4	0.52	0.14
3	Leading Analysis	3.6	4	4	3.25	4	0.70	0.19
4	Planning Analysis	3.5	4	4	3	4	0.71	0.20
5	Evaluating Analysis	3.4	3.5	4	3	4	0.70	0.21

Table 13 - Competency Descriptive Statistics

Range	Count	%	Range	Count	%
0.00-0.05	0	0.0	0.26-0.30	0	0.0
0.06-0.10	0	0.0	0.31-0.35	0	0.0
0.11-0.15	2	40.0	0.36-0.40	0	0.0
0.16-0.20	2	40.0	0.41-0.45	0	0.0
0.21-0.25	1	20.0	0.46-0.50	0	0.0

Table 14 - Competency COV Frequency Distribution

Based on the results obtained from the second Delphi round with regard to competencies, consensus had been achieved at the conclusion of this round with all 5 of the competencies achieving a value for COV <= 0.5, indicating a strong consensus. Additionally, each competency achieved a median score that warranted its inclusion in the final listing of competencies required for future U.S. Army FA49s to perform their duties within the joint operating environment of the future.

Knowledge

Of the 21 items of knowledge voted upon by the expert panel, none received a unanimous vote. Four (4) of the expert panel members responded with either agree or strongly agree for each listed item of knowledge, 5 of the expert panel members provided responses ranging from disagree to strongly agree, and 1 of the expert panel members provided responses ranging from strongly disagree to strongly agree on which items of knowledge would be required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Knowledge of Joint Operations had the lowest COV and knowledge of leadership had the highest COV. Tables 15 and 16 summarize the descriptive statistics and the frequency distribution of the calculated values for COV respectively.

Based on the results obtained from the second Delphi round with regard to knowledge, consensus had been achieved at the conclusion of this round with all 21 of the areas of knowledge achieving a value for COV <= 0.5, indicating a strong consensus. Additionally, each area of knowledge achieved a median score that warranted its inclusion in the final listing of knowledge required for future U.S. Army FA49s to perform their duties within the joint operating environment of the future.

	Knowledge	Mean	Median	Mode	IRQ 1	IRQ 3	SD	COV
1	Joint Operations	3.2	3	3	3	3	0.42	0.13
2	Joint Processes (e.g. JCIDS (DOTMLPF-P))	3.3	3	3	3	3.75	0.48	0.15
3	Multinational Operations	2.8	3	3	3	3	0.42	0.15
4	Resource Management (includes HRM)	2.8	3	3	3	3	0.42	0.15
5	Army Operations	3.4	3	3	3	4	0.52	0.15
6	Army Organization	3.4	3	3	3	4	0.52	0.15
7	DoD Organization	3	3	3	3	3	0.47	0.16
8	Acquisition Management	3.1	3	3	3	3	0.57	0.18
9	How the DoD Runs	3.1	3	3	3	3	0.57	0.18
10	Operational Environment	3.1	3	3	3	3	0.57	0.18
11	How the Federal Government Runs	2.9	3	3	3	3	0.57	0.20
12	Interagency Operations	2.9	3	3	3	3	0.57	0.20
13	Army Processes (e.g. PPBE)	3.5	4	4	3	4	0.71	0.20
14	Mathematics	3.3	3	3	3	4	0.67	0.20
15	Military Planning Processes (MDMP, JOPP)	3.3	3	3	3	4	0.67	0.20
16	How the Army Runs	3.4	3.5	4	3	4	0.70	0.21
17	Methods/Tools	3.4	3.5	4	3	4	0.70	0.21
18	Role of ORSA	3.4	4	4	3	4	0.84	0.25
19	Economics	2.9	3	3	2.25	3	0.74	0.25
20	Historical Applications of OR	2.6	2.5	2	2	3	0.70	0.27
21	Leadership	3	3	3	3	3.75	0.94	0.31

Table 15 - Knowledge Descriptive Statistics

Range	Count	%	Range	Count	%
0.00-0.05	0	0.0	0.26-0.30	1	4.8
0.06-0.10	0	0.0	0.31-0.35	1	4.8
0.11-0.15	6	28.6	0.36-0.40	0	0.0
0.16-0.20	9	42.9	0.41-0.45	0	0.0
0.21-0.25	4	19.0	0.46-0.50	0	0.0

Table 16 - Knowledge COV Frequency Distribution

Skills

Of the 41 skills voted upon by the expert panel, two received unanimous votes – Problem Solving and Quantitative Analysis. Two (2) of the expert panel members responded with either agree or strongly agree for each listed skill, 6 of the expert panel members provided responses ranging from disagree to strongly agree, and 2 of the expert panel members provided responses ranging from strongly disagree to strongly agree on which skills would be required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Problem Solving and Quantitative Analysis had the lowest COVs while value modeling had the highest COV. Tables 17 and 18 show the descriptive statistics and the frequency distribution of the calculated values for COV respectively.

Based on the results obtained from the second Delphi round with regard to skills, consensus had been achieved at the conclusion of this round with all 41 of the skills achieving a value for COV <= 0.5, indicating a strong consensus. Additionally, each skill achieved a median score that warranted its inclusion in the final listing skills required for future U.S. Army FA49s to perform their duties within the joint operating environment of the future.

	Skill	Mean	Median	Mode	IRQ 1	IRQ 3	SD	COV
1	Problem Solving	4	4	4	4	4	0.00	0.00
2	Quantitative Analysis	4	4	4	4	4	0.00	0.00
3	Effective Communication (Writing, Speaking, Presentation)	3.9	4	4	4	4	0.32	0.08
4	Design of Experiments	3.1	3	3	3	3	0.32	0.10
5	Forecasting	3.1	3	3	3	3	0.32	0.10
6	Goal Programming	3.1	3	3	3	3	0.32	0.10
7	Data Analysis And Interpretation	3.7	4	4	3.25	4	0.48	0.13
8	Decision Analysis (To Include Multi-Objective)	3.7	4	4	3.25	4	0.48	0.13
9	Survey Analysis	3.2	3	3	3	3	0.42	0.13
10	Value Modeling	3.2	3	3	3	3	0.42	0.13
11	Analyzing Data With and/or Without Software	3.6	4	4	3	4	0.52	0.14
12	Qualitative Analysis	3.6	4	4	3	4	0.52	0.14
13	Spreadsheet Modeling	3.6	4	4	3	4	0.52	0.14
14	Optimization	3.3	3	3	3	3.75	0.48	0.15
15	Simulation (General)	3.3	3	3	3	3.75	0.48	0.15
16	Trend Analysis	3.3	3	3	3	3.75	0.48	0.15
17	Active Listening	3.5	3.5	3	3	4	0.53	0.15
18	Process Improvement Analysis	3.5	3.5	4	3	4	0.53	0.15
19	Risk Analysis	3.5	3.5	3	3	4	0.53	0.15
20	Statistical Analysis With and/or Without Software	3.5	3.5	4	3	4	0.53	0.15
21	Cost Benefit Analysis	3.4	3	3	3	4	0.52	0.15
22	Mathematics (Probability, Statistics)	3.4	3	3	3	4	0.52	0.15
23	Metric Development	3.4	3	3	3	4	0.52	0.15
24	Combat Modeling	3	3	3	3	3	0.47	0.16
25	Discrete Event Simulation	3	3	3	3	3	0.47	0.16
26	Conduct Research	3.6	4	4	3.25	4	0.70	0.19

Table 17 - Skill Descriptive Statistics

	Skill	Mean	Median	Mode	IRQ 1	IRQ 3	SD	COV
27	Common software packages (SPSS, GAMS, MATLAB, Minitab, MS Office)	3.2	3	3	3	3.75	0.63	0.20
28	Data modeling	3.2	3	3	3	3.75	0.63	0.20
29	Modeling (general)	3.2	3	3	3	3.75	0.63	0.20
30	Computer modeling	2.6	3	3	2	3	0.52	0.20
31	Prioritization	3.5	4	4	3	4	0.71	0.20
32	Survey development	3	3	3	3	3	0.67	0.22
33	Negotiation	3.1	3	3	3	3.75	0.74	0.24
34	Agent based modeling	2.6	2.5	2	2	3	0.70	0.27
35	Computer Programming (VBA, Java)	2.6	2.5	2	2	3	0.70	0.27
36	Database programming, development, analysis, mining	2.9	3	3	3	3	0.88	0.30
37	Math Programming	2.9	3	2	2	3.75	0.88	0.30
38	Linear Algebra	3	3	3	3	3.75	0.94	0.31
39	Ad hoc (quick turn) modeling	3.1	3	4	3	4	0.99	0.32
40	Leadership	3.1	3	4	3	4	0.99	0.32
41	Military planning processes (MDMP, JOPP)	3.1	3	4	3	4	0.99	0.32

Table 17 - Skill Descriptive Statistics Continued

Range	Count	%	Range	Count	%
0.00-0.05	2	4.9	0.26-0.30	4	9.8
0.06-0.10	4	9.8	0.31-0.35	4	9.8
0.11-0.15	17	41.5	0.36-0.40	0	0.0
0.16-0.20	8	19.5	0.41-0.45	0	0.0
0.21-0.25	2	4.9	0.46-0.50	0	0.0

Table 18 - Skills COV Frequency Distribution

Abilities

Of the 22 abilities voted upon by the expert panel, 2 received unanimous votes – Analytical Thinking and Application of OR Techniques to Military Problems or

Situations. Six (6) of the expert panel members responded with either agree or strongly agree for each listed ability, 2 of the expert panel members provided responses ranging from disagree to strongly agree, and 2 of the expert panel members provided responses ranging from strongly disagree to strongly agree on which abilities would be required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Analytical Thinking and Application of OR Techniques to Military Problems or Situations had the lowest COVs. Making Projections Based on Data ranked last with the highest COV. Tables 19 and 20 summarize the descriptive statistics and the frequency distribution of the calculated values for COV respectively.

	Ability	**Mean**	**Median**	**Mode**	**IRQ 1**	**IRQ 3**	**SD**	**COV**
1	Analytical Thinking	4	4	4	4	4	0.00	0.00
2	Application of OR Techniques to Military Problems or Situations	4	4	4	4	4	0.00	0.00
3	Critical Thinking	3.9	4	4	4	4	0.32	0.08
4	Communicate (Written and Oral Expression)	3.8	4	4	4	4	0.42	0.11
5	Managing a Study	3.8	4	4	4	4	0.42	0.11
6	Problem Solving	3.8	4	4	4	4	0.42	0.11
7	Teamwork (Form, Manage, Lead)	3.7	4	4	3.25	4	0.48	0.13
8	Comprehension (Written and Oral)	3.6	4	4	3	4	0.52	0.14
9	Deductive Reasoning	3.6	4	4	3	4	0.52	0.14
10	Creative Thinking	3.5	3.5	3	3	4	0.53	0.15
11	Inductive Reasoning	3.4	3	3	3	4	0.52	0.15
12	Mathematical Reasoning	3.4	3	3	3	4	0.52	0.15
13	Leadership	3.3	3	3	3	4	0.67	0.20
14	Motivate/Inspire	3	3	3	3	3	0.67	0.22
15	Integrating Information and Data	3.1	3	3	3	3.75	0.88	0.28

Table 19 - Ability Descriptive Statistics

	Ability	Mean	Median	Mode	IRQ 1	IRQ 3	SD	COV
16	Evaluating a Study	3.2	3	3	3	4	0.92	0.29
17	Synthesizing Information and Data	3.3	3.5	4	3	4	0.95	0.29
18	Visualization	3.3	3.5	4	3	4	0.95	0.29
19	Value Focused Thinking	3	3	3	3	3.75	0.94	0.31
20	Problem Sensitivity	2.8	3	3	2.25	3	0.92	0.33
21	Information Ordering	2.9	3	3	3	3.75	1.10	0.38
22	Making Projections Based on Data	2.9	3	3	3	3.75	1.10	0.38

Table 19 – Ability Descriptive Statistics Continued

Range	Count	%	Range	Count	%
0.00-0.05	2	9.1	0.26-0.30	4	18.2
0.06-0.10	1	4.5	0.31-0.35	2	9.1
0.11-0.15	9	40.9	0.36-0.40	2	9.1
0.16-0.20	1	4.5	0.41-0.45	0	0.0
0.21-0.25	1	4.5	0.46-0.50	0	0.0

Table 20 - Abilities COV Frequency Distribution

Based on the results obtained from the second Delphi round with regard to abilities, consensus had been achieved at the conclusion of this round with all 22 of the abilities achieving a value for COV <= 0.5, indicating a strong consensus. Additionally, each ability achieved a median score that warranted its inclusion in the final listing of abilities required for future U.S. Army FA49s to perform their duties within the joint operating environment of the future.

4.2.3 Consensus

Consensus was predetermined, as defined in Chapter 3, as the coefficient of variation <= 0.5 for each listed competency and KSA. Based upon this predetermination, the researcher ruled consensus had been reached at the end of Round 2 for each listed competency and KSA. With consensus achieved, no further Delphi rounds were necessary.

4.2.4 Inclusion

It was also predetermined in Chapter 3 that only those competencies and KSAs with median ratings equaling Agree or Strongly Agree would be included in the final compilation. The value ranges for the levels of agreement were: Strongly Agree – 3.26 – 4.00, Agree – 2.50 – 3.25, Disagree – 1.75 – 2.49, and Strongly Disagree – 1.00 – 1.74. Based upon these predetermined levels, the researcher concluded that the 5 competencies, 21 items of knowledge, 41 skills, and 22 abilities rated by the expert panel members were to be included as being required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Table 21 shows the distribution of agreement for competencies and KSAs.

	Agree	**Strongly Agree**
Competency	0.0%	100.0%
Knowledge	81.0%	19.0%
Skill	65.9%	34.1%
Ability	45.5%	54.5%

Table 21 - Agreement Distribution

4.3 Summary

This chapter presented the results and interpreted the findings of the data collection effort associated with this Delphi study. The results and interpretations began with the first Delphi round discussed to include the formation of the 10 member expert panel and the first Delphi round's timeline. This presentation was followed by an examination of the demographics of the expert panel members and a detailed evaluation of the results obtained during the exploratory phase of this study. During this exploratory phase, the researcher used a data analysis schema associated with Grounded Theory to compile a list of technical competencies and KSAs required for future U.S. Army FA39s to perform their duties within the joint operating environment of the next twenty-five years. These compiled listings were subsequently introduced back to the expert panel members to be voted upon during the second Delphi round, seeking levels of agreement or disagreement amongst the expert panel members. Once the detailed evaluation of the results obtained during the first Delphi round was completed, the focus shifted to the second Delphi round. The second Delphi round, the evaluation phase, was then discussed to include Round 2's timeline. The results for Round 2 were then quantitatively analyzed, presented, and evaluated. Finally, considerations regarding consensus and inclusion of the evaluation phase's results were then proposed. Chapter 5 provides conclusions, contributions, and areas for potential future research stemming from this study.

CHAPTER 5

CONCLUSIONS, IMPLICATIONS, & FUTURE RESEARCH

This chapter provides a discussion of the conclusions drawn from the execution of the research design and the emergent results, the implications of the results, and areas for potential future research stemming from this study.

5.1 Conclusions

This section of the chapter discusses the conclusions drawn from the execution of the research design and the emergent results. As presented in Chapter 2, the review of the scholarly literature made it quite clear that the identification of competencies and KSAs required by a future operations researcher has not been accomplished. This research was initiated to fill that gap.

In summary, the purpose of this study was to use the Delphi methodology to identify the technical competencies and KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Based on this purpose, one primary and three secondary research questions guided this study:

> ***Primary Research Question (PRQ)*** – *What are the technical competencies required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*
>
> ***Secondary Research Question 1 (SRQ1)*** – *What knowledge facilitates mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*

Secondary Research Question 2 (SRQ2) – *What skills facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*

Secondary Research Question 3 (SRQ3) – *What abilities facilitate mastery of a technical competency required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s?*

Of singular importance to the conclusions drawn from this research study is whether or not the research purpose was met, and whether the primary and secondary research questions were answered. Based upon the results derived from the two Delphi rounds, the researcher has concluded that the research design did unequivocally accomplish its objective by producing the following outcomes, which supported the overall research purpose: identification of 5 technical competencies, 21 areas of knowledge, 41 skills, and 22 abilities that are required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years as perceived by contemporary expert U.S. Army FA49s.

5.2 Implications

The implications of the results of this research are addressed in this section.

First, while the Delphi methodology may not be unknown to the engineering management community, its use and application to identify competencies and/or KSAs is limited to a relatively small number of studies, none of which focused on ORSA competencies or KSAs. This study has added to the existing body of knowledge in engineering management theory and methodology by presenting and substantiating that the Delphi process is capable of identifying pertinent issues and future and/or forecasting requirements with regard to the identification of ORSA competencies and KSAs. The rigorous use of Delphi in this study makes a significant contribution to the body of knowledge on qualitative research in engineering management. The increased use of qualitative methods, common in the domains of psychology and sociology, in engineering management research may be instrumental to the comprehension of a variety of issues within the field.

Second, it contributed to engineering management literature by providing a basis for the expansion of the domain of competencies and KSAs for the operations research field. Through the use of the Delphi technique, this research helped close a gap in the understanding of required competencies and KSAs for operations researchers. The operations research field and the concepts of competencies and KSAs have been established in the literature for quite a while; however, this rigorous study was the first to wed the two areas and attempt to provide insights. Additionally, since no studies have been conducted on competency and KSA identification this study and its results may be indicative of where operations research may be headed.

Third, being the first rigorous research study based on ORSA technical competencies and KSAs for the U.S. Army FA49 field, this research has provided areas for future research that suggest the conduct of additional studies that can be used to potentially extend the findings to the wider operations research community as a whole (i.e. beyond the military ORSA domain).

Finally, this research contributed to the identification of competencies and KSAs that are germane to the development of engineering management (operations research focus) and military educational curricula. As such, development of these curricula may bring clarity and enhancements to human resource life-cycle developmental models that may assist with both human resource career management and career advancement issues.

5.3 Future Research Recommendations

A role of rigorous scholarly research is to provide a 'way-ahead' for future endeavors. This section of the chapter takes into consideration the current state of the body of knowledge and its relationship to the research findings. Cumulatively, these demonstrate robust areas for future research.

The following list of areas of potential future research is not all encompassing with regard to technical competencies and KSAs as they relate to an operations researcher or military operations researcher; however, these potential future research areas hold promise in paying significant dividends if additional philosophical, theoretical, axiological, methodological, and practical (including extensions to this study) research were to be applied.

5.3.1 Philosophical Issues

This area for future research is focused on the need to address two philosophical issues in the operations research and military operations research domains. These two issues are:

- Why has no research been accomplished or attempted at identifying the competencies and KSAs required of an operations researcher or military operations researcher?

- Are there differences in operations research and military operations research?

The reason for the first issue may quite possible stem from the underlying context of the positivistic versus naturalistic paradigms inherently associated with the fields of operations research and military operations research. The speculation of possible differences between operations research and military operations research and whether they are two distinct fields, parallel but complementary, or possibly one being a subset of the other is thought provoking. Future research may provide a clearer understanding for both of these issues.

5.3.2 Theoretical Issues

The primary discussion in the literature review and in the data collected in this research study focused upon trying to identify competencies and KSAs. Areas not covered by this study include developing the theory for competency and KSA development to include their nature and role in operations research and military operations research and identifying the theoretical roots for competency and KSA development in both operations research and military operations research. Research should move forward to develop these theoretical constructs and frameworks. Developing these constructs and frameworks would go beyond the identification pursued in this study and move the body of knowledge closer to defining what these concepts mean.

5.3.3 Axiological Issues

Axiological issues and their discussions were noticeably absent from the literature with regard to operations research and military operations research engendering the researcher to question what, if any, ethical considerations for operations research and military operations research exist. An investigation into the ethics, the right and good, of operations research and military operations research could possibly lead to an identification of principles regarding values and beliefs associated with these fields.

5.3.4 Methodological Issues

This area for future research is focused on the need to address the methodological issues and addresses a way forward. There are methodological issues associated with the philosophical and theoretical issues discussed above regarding operations research and military operations research. If the philosophical and theoretical concepts can be clearly articulated, then there is a need to establish the methodological bases upon which operations research and military operations research rest.

5.3.5 Practical Issues

Practical issues to include logical extensions to the current research study are the crux of this section. There is a need to expand upon the current research presented in this study by applying its approach across a larger sample (all ranks of U.S. Army FA49s) and/or covering a broader scope of individuals (other DOD or government service personnel with FA49-like monikers). A few logical extensions of the current study that would address the aforementioned practical issue are:

- The first extension lies in attempting to link or correlate the technical competencies and KSAs identified in this study. Referring back to Chapter 1 and taking into account the definition of a competency and a technical competency, one would find it reasonable to attempt to see if a correlation or linkage exists between the identified technical competencies and KSAs. In doing do, one could correlate or link every identified KSA to a single (possibly multiple) competency(ies) and thus build or identify a hierarchical relationship between the identified technical competencies and KSAs.

- The second extension lies in attempting to determine if degrees of relevance could be identified for varying levels of U.S. Army FA49s. In doing so, one could possibly affect military curricula development as well as life-cycle developmental models thus assisting with both human resource career management and career advancement issues.

- The third extension lies in applying a change to the research design by using the identified technical competencies and KSAs as "seed" information for a modified Delphi study that canvases the entire U.S. Army FA49 expert community.

- A fourth extension would maintain the current research design but would change the delimitations to the original population. In making changes to the delimited population, one would thus be expanding the breadth of the research to encompass other ranks, service branches, active and reserve components, and/or the DOD civilian sector. Such an expansion would allow for different perspectives (worldviews) to be analyzed and correlations to be examined.

5.4 Summary

This chapter presented the conclusions drawn from the execution of the research design and the emergent results, specifically addressing the successful answering of the PRQ and SRQs and the unequivocal meeting of the research's purpose. Implications were then offered. Finally, recommendations for potential future research efforts stemming from this study were provided to include two philosophical issues, the first focusing on the positivistic versus naturalistic paradigm with regard to the identification of competencies and KSAs in operations research and military operations research and the second focusing on the possible differences between operations research and military operations research; two theoretical issues, one being theory development for competency and KSAs with respect to operations research and military operations research and the second being identification of the theoretical roots for competency and KSA development with respect to operations research and military operations research; one axiological issue, understanding the ethical considerations for operations research and military operations research; one methodological, establishment of the methodological based upon which operations research and military operations research lie; and one practical effort, expansion of the study by providing a larger sample and/or by covering a broader scope of individuals.

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APPENDICES

APPENDIX A: REQUEST FOR PARTICIPATION MESSAGE

Name of Prospective Expert Panel Member,

As part of my doctoral program in Engineering Management and Systems Engineering at Old Dominion University, I am conducting research to identify Operations Research Systems Analysts' (ORSA) technical analytical competencies. The purpose of this study is to use contemporary expert U.S. Army FA49s to identify the technical analytical competencies and their associated knowledge, skills, and abilities (KSAs) required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. Because of your experience, I am reaching out to you, and I am inviting you to be an expert panel member in this research study.

To identify these technical analytical competencies and their associated KSAs, this study will employ a Delphi methodology, which allows a panel of experts to anonymously reach consensus on a topic. Ideally and typically, Delphi studies conclude with an expert panel reaching consensus within three rounds of questioning.

This study will be conducted in two stages, which should take no more than 1-3 hours sum total of your time. During the first stage (first round of questioning) of this study, I will ask you to list technical analytical competencies and their associated KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

During the second stage (second and subsequent rounds of questioning) of this study, I will provide you with Likert scales to reply to questions concerning a compiled listing of technical analytical competencies and their associated KSAs drawn from the expert panel. Your answers to these questions will aid in identifying which technical analytical competencies and their associated KSAs will be required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

Please carefully read the attached Informed Consent Letter. Then, if you are willing to participate, retain a copy of the Informed Consent Letter for your records and contact me via email wwink001@odu.edu or telephonically 717-552-1737 to give your consent to join this research study. If you have any questions that you feel need answered prior to making a decision about participating in this research study, please do not hesitate in contacting me. I look forward to working with you in this unique research endeavor!

Very respectfully,

Wink

COL W. Todd "Wink" Winklbauer
Ph.D. Candidate - Engineering Management and Systems Engineering
Old Dominion University
Norfolk, Virginia 23529

APPENDIX B: INFORMED CONSENT

IDENTIFYING OPERATIONS RESEARCH SYSTEMS ANALYSTS' TECHNICAL COMPETENCIES: A DELPHI APPROACH

Informed Consent Letter

The purpose of this study is to use contemporary expert U.S. Army FA49s to identify the technical analytical competencies and their associated knowledge, skills, and abilities (KSAs) required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. To identify these technical analytical competencies and their associated KSAs, this study will employ a Delphi methodology, which allows a panel of experts to anonymously reach consensus on a topic.

It is very important you realize that:

A. Your participation in this study is completely voluntary. There are no special, direct incentives or benefits for participating and there are no negative consequences for not participating. The researcher is unable to give you any payment for participating in this study. By participating in this study, you and others may generally benefit by contributing to the knowledge base which may aid: (a) in bringing clarity to the critical competencies that future U.S. Army FA49s will need in the coming quarter century, (b) in the designing of future professional military curricula for U.S. Army FA49s, (c) in the designing of curricula to entities external to the U.S. Army, and (d) in clarifying and enhancing the life-cycle development model for U.S. Army FA49s and thus assist with both human resource career management issues and career advancement issues.

B. It is OK for you to say NO. You are free to withdraw your consent to participate in this study at any time. Even if you elect to participate now, you can at any time simply walk away or withdraw from this research study.

C. Your participation in this project will require you to electronically complete approximately three (3) questionnaires that may require a sum total of 1-3 hours of your time. This study will be conducted in two stages. During the first stage (first round of questioning) of this study, I will ask you to list technical analytical competencies and their associated KSAs required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years. During the second stage (second and subsequent rounds of questioning) of this study, I will provide you with Likert scales to reply to questions concerning a compiled listing of technical analytical competencies and their associated KSAs drawn from the expert panel. Ideally and typically, Delphi studies conclude with an expert panel reaching consensus within three rounds of questioning.

D. All information you provide will be anonymous to everyone but the researcher. All information you provide will be treated with complete confidentially. No personally identifiable information (PII) should ever be disseminated. No one but the researcher will ever see or know your name or identity. All data will be encoded to protect the identity of the expert panel members. A number will be used to code each survey and electronic response. Documentation will be numbered by order of receipt. You will only be identified to the expert panel and in the researcher's written reports, presentations, and publications through an ID number.

E. All digital documentation will be password protected and encrypted (128 bit) and stored against both physical and non-physical theft. The researcher will secure a backup copy of the data in a locked file cabinet at his residence. Only the researcher will have access to the complete file associated with the study. All hard copies produced of the original data instruments will be destroyed upon completion of the research study. All digital records will be destroyed at a date no earlier than three years and no later than five years after the successful defense of the researcher's dissertation. The destruction of the digital records will be accomplished by incineration or executing an option that meets U.S. DOD 5220-22 M standards for securely erasing magnetic media. To avoid inadvertent disclosure of an expert panel member's email address, only individually addressed email responses between the researcher and individual expert panel members will be used.

F. If you decide to participate in this study you may face a risk of inadvertent disclosure of PII. The researcher will attempt to mitigate this risk by following the procedures outlined in paragraphs C and D above. While your ID number may link you to your responses, to the researcher's knowledge there should be nothing in your responses that could reasonably place you at risk of criminal or civil liability or be damaging to your financial standing, employability, or reputation. You may at any time refuse to answer any question(s).

G. The results of this study may be used in reports, presentations, and publications, but you will not be identified by PII, only through an ID number.

H. This research study is in no way associated with the U.S. Army. The opinions contained within this research study are expressly those of the researcher.

If you have any questions that you feel need answered prior to making a decision about participating in this research study or at any time during the research study, please do not hesitate in contacting COL W. Todd "Wink" Winklbauer, the researcher and doctoral candidate for this research study, at email wwink001@odu.edu or by telephone at 717-552-1737.

An alternative point of contact for this research endeavor would be Dr. Charles B. Keating, my faculty advisor, at Old Dominion University, Frank Batten College of Engineering & Technology, Department of Engineering Management and Systems Engineering. Dr. Keating may be reached at email ckeating@odu.edu or by telephone at (757) 683-5753.

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. George Maihafer, the current Institutional Review Board Chair, at 757-683-4520, or the Old Dominion University Office of Research at 757-683-3460.

Researcher's Statement
I certify that I have explained to this prospective expert panel member the nature and purpose of this research study to include benefits, risks, costs, and any experimental procedures. I have not pressured, coerced, or falsely enticed this subject into participating. I have described the protections and rights afforded to human subjects. I am aware of my obligations under federal and state laws and promise compliance.

Researcher's signature:

Expert panel members will annotate their acceptance and understanding by checking the Informed Consent box on the Round One Questionnaire.

APPENDIX C: ROUND ONE PARTICIPATION MESSAGE

Name of Expert Panel Member

I would like to thank you for agreeing to participate as an expert panel member in this research study. As a reminder, the purpose of this study is to use contemporary expert U.S. Army FA49s to identify the technical analytical competencies and their associated knowledge, skills, and abilities (KSAs) required for future U.S. Army FA49s to perform their duties within the joint operating environment of the next twenty-five years.

Tomorrow's joint operating environment will demand U.S. Army FA49s who will be ingenious, proactive, and multi-talented; proficient in their core competencies as military leaders leading during times of intricacy and multidimensionality as well as being proficient in their technical analytical competencies as problem solvers. In order to adapt and be prepared for the joint operating environment of the next quarter century, U.S. Army FA49s will have to possess both core leadership and technical analytical competencies in order to successfully perform their duties as officers and analysts.

A difficult challenge for the U.S. Army FA49 community may be to develop the abstraction for what the future U.S. Army FA49 needs to look like to meet ever-evolving U.S. Army requirements so that the future U.S. Army FA49 is competent as both a leader and an analyst. The core leadership competencies and their associated components and actions required of all U.S. Army Officers are outlined in the U.S. Army's Field Manual 6-22, *Army Leadership - Competent, Confident, and Agile*; however, the technical analytical competencies and their associated KSAs for a U.S. Army FA49 have not been found to exist in the literature. This is why I have reached out to you. Your expertise as a U.S. Army FA49 may aid in developing an abstraction for future U.S. Army FA49s.

This first questionnaire should be the most time consuming and detailed questionnaire for this research study, but it is also the most important part of this research study. You will have seven (7) days to complete the questionnaire. Rest assured your responses will be anonymous and your identity will be kept confidential. To aid me in ensuring your anonymity and confidentiality, please use the provided unique ID number when you complete your questionnaire.

Your unique ID number is - **xxxxxx**.

Please follow this link to the questionnaire https://xxx.xxx.xxx. If the link does not work then copy and paste the URL information into your browser. You should be able to access the questionnaire with any current web browser.

A copy of U.S. Joint Forces Command's JOE 2010, The Joint Operating Environment is attached for your use if you are not familiar with it or if you would just like to refresh yourself with its contents.

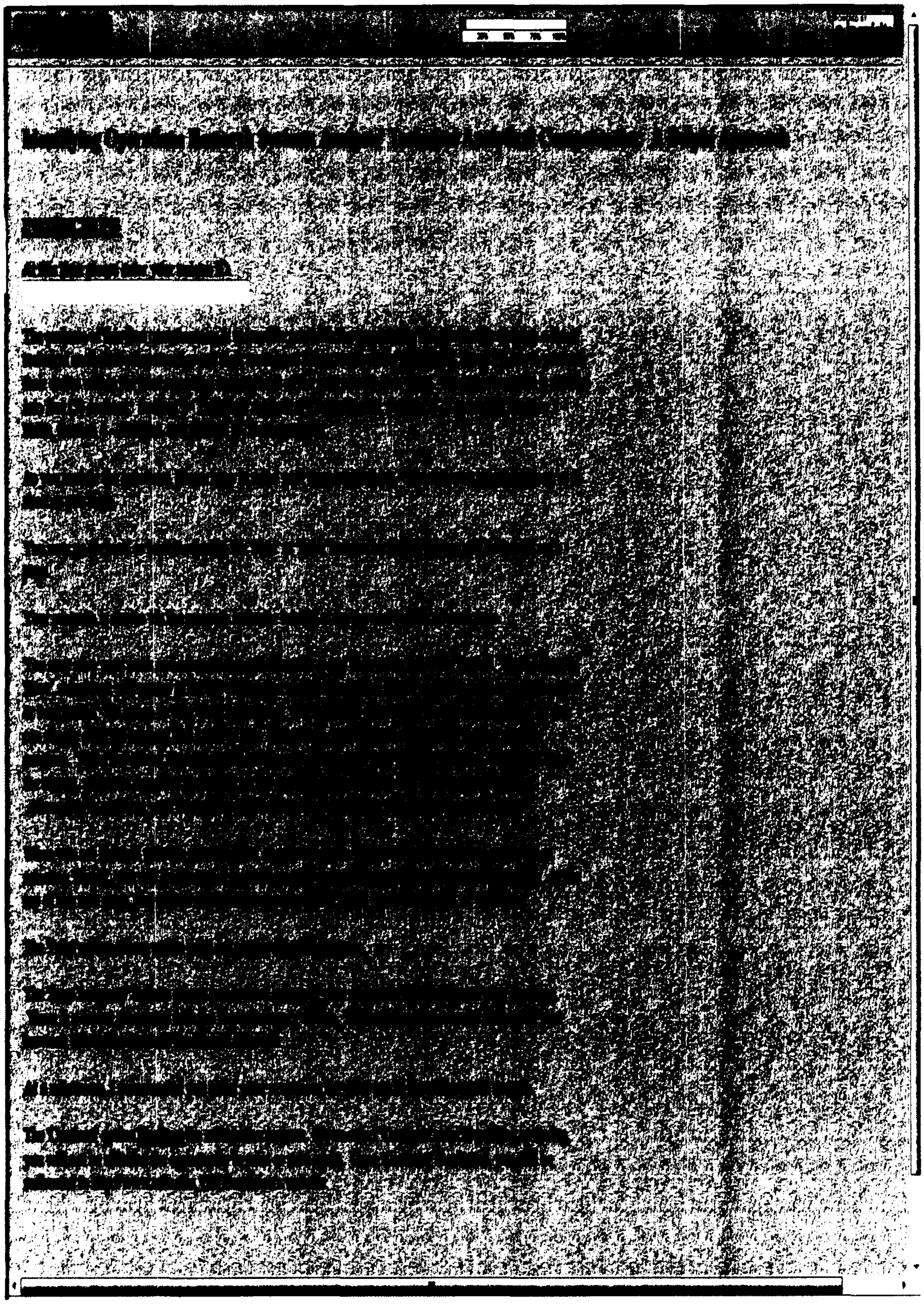
I thank you in advance for participating and lending me your assistance. If you have questions or problems, please, do not hesitate to email or call me.

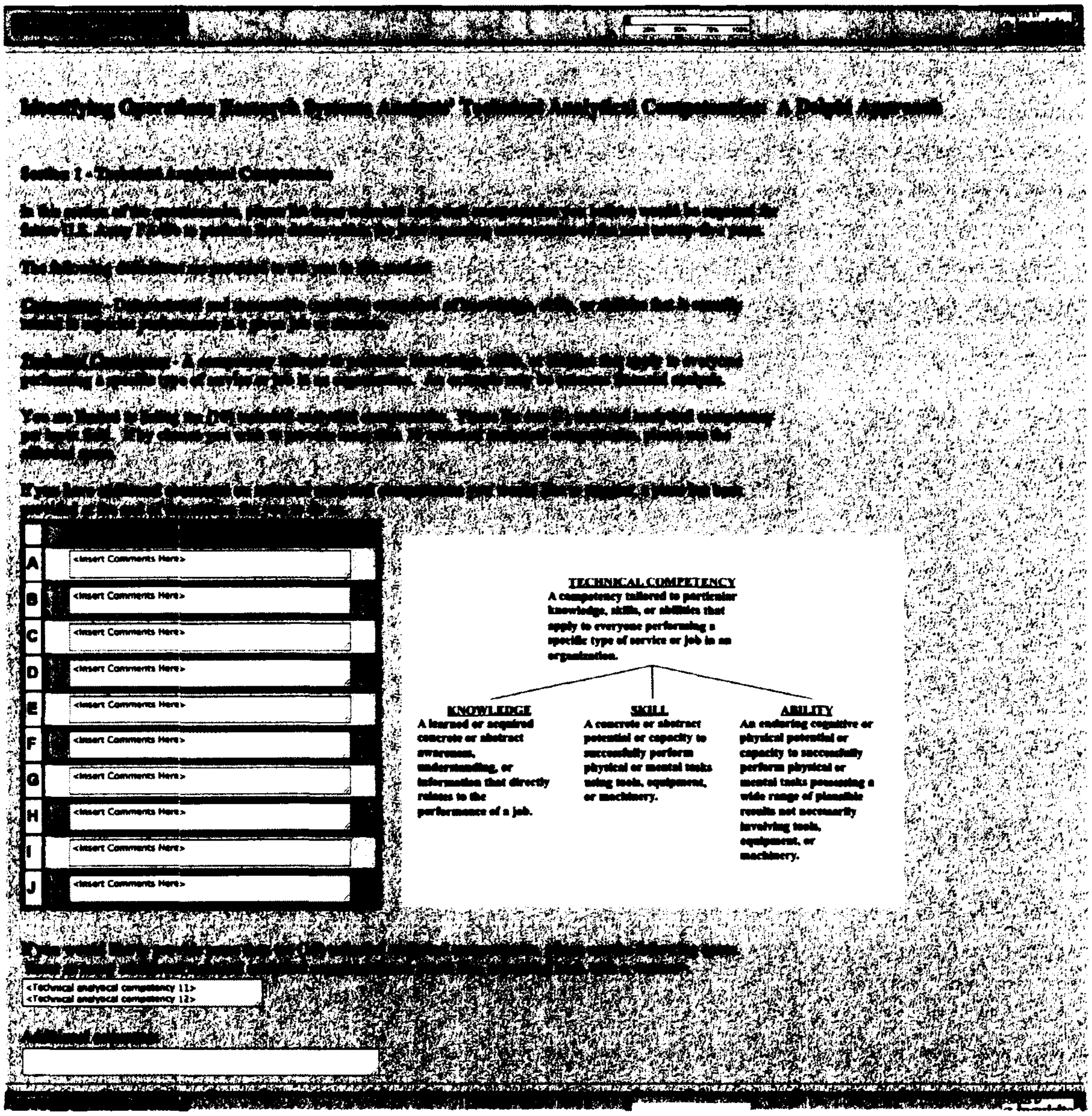
Once I have compiled the results, you will receive another message from me for the start of the second round.

Very respectfully,

Wink
wwink001@odu.edu
717-552-1737

APPENDIX D: ROUND ONE QUESTIONNAIRE




A
<Insert Comments Here>
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H
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I
<Insert Comments Here>
J
<Insert Comments Here>
TECHNICAL COMPETENCY
A competency tailored to particular knowledge, skills, or abilities that apply to everyone performing a specific type of service or job in an organization.
KNOWLEDGE
A learned or acquired concrete or abstract awareness, understanding, or information that directly relates to the performance of a job.
SKILL
A concrete or abstract potential or capacity to successfully perform physical or mental tasks using tools, equipment, or machinery.
ABILITY
An enduring cognitive or physical potential or capacity to successfully perform physical or mental tasks possessing a wide range of plausible results not necessarily involving tools, equipment, or machinery.
<Technical analytical competency 11>
<Technical analytical competency 12>

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach

Section 3 - Knowledge

In this section of the questionnaire, [illegible]

The following definition is provided to aid you in this section:

Knowledge - A learned or acquired concrete or abstract awareness, understanding, or information that directly relates to the performance of a job. [illegible] Planning, Programming, Budgeting, and Execution System (PPBES).

You are limited to listing ten (10) items of knowledge. Please list one (1) item of knowledge per input field. If by chance you wish to provide more than 10 items of knowledge, please use the allotted space.

If you have additional comments on knowledge you would like to make, a place has been provided at the end of this section for you to do so.

A	<Insert Comments Here>
B	<Insert Comments Here>
C	<Insert Comments Here>
D	<Insert Comments Here>
E	<Insert Comments Here>
F	<Insert Comments Here>
G	<Insert Comments Here>
H	<Insert Comments Here>
I	<Insert Comments Here>
J	<Insert Comments Here>

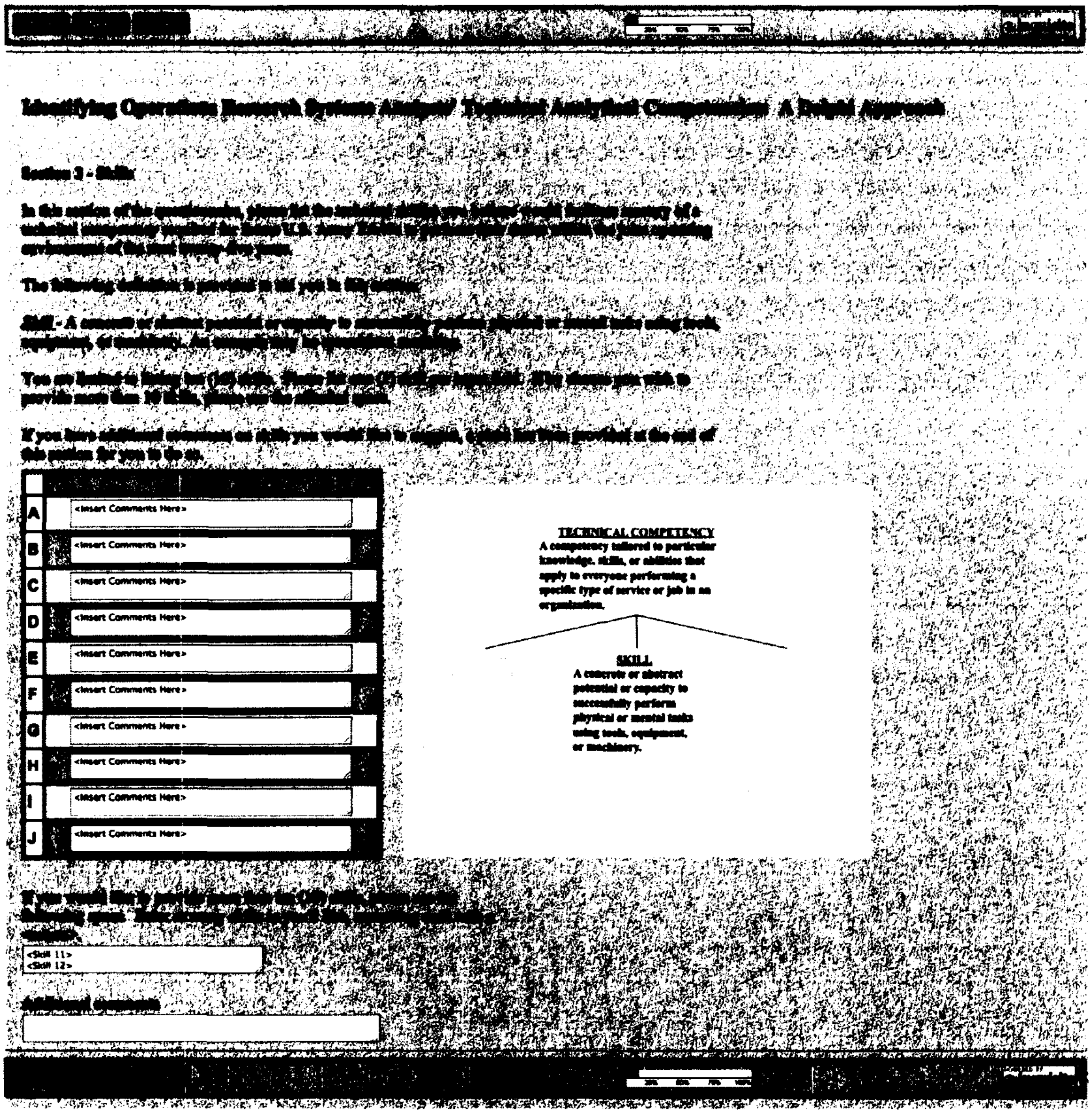
TECHNICAL COMPETENCY
A competency tailored to particular knowledge, skills, or abilities that apply to everyone performing a specific type of service or job in an organization.

KNOWLEDGE
A learned or acquired concrete or abstract awareness, understanding, or information that directly relates to the performance of a job.

[illegible]

<Knowledge 11>
<Knowledge 12>

Additional Comments:


A
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G
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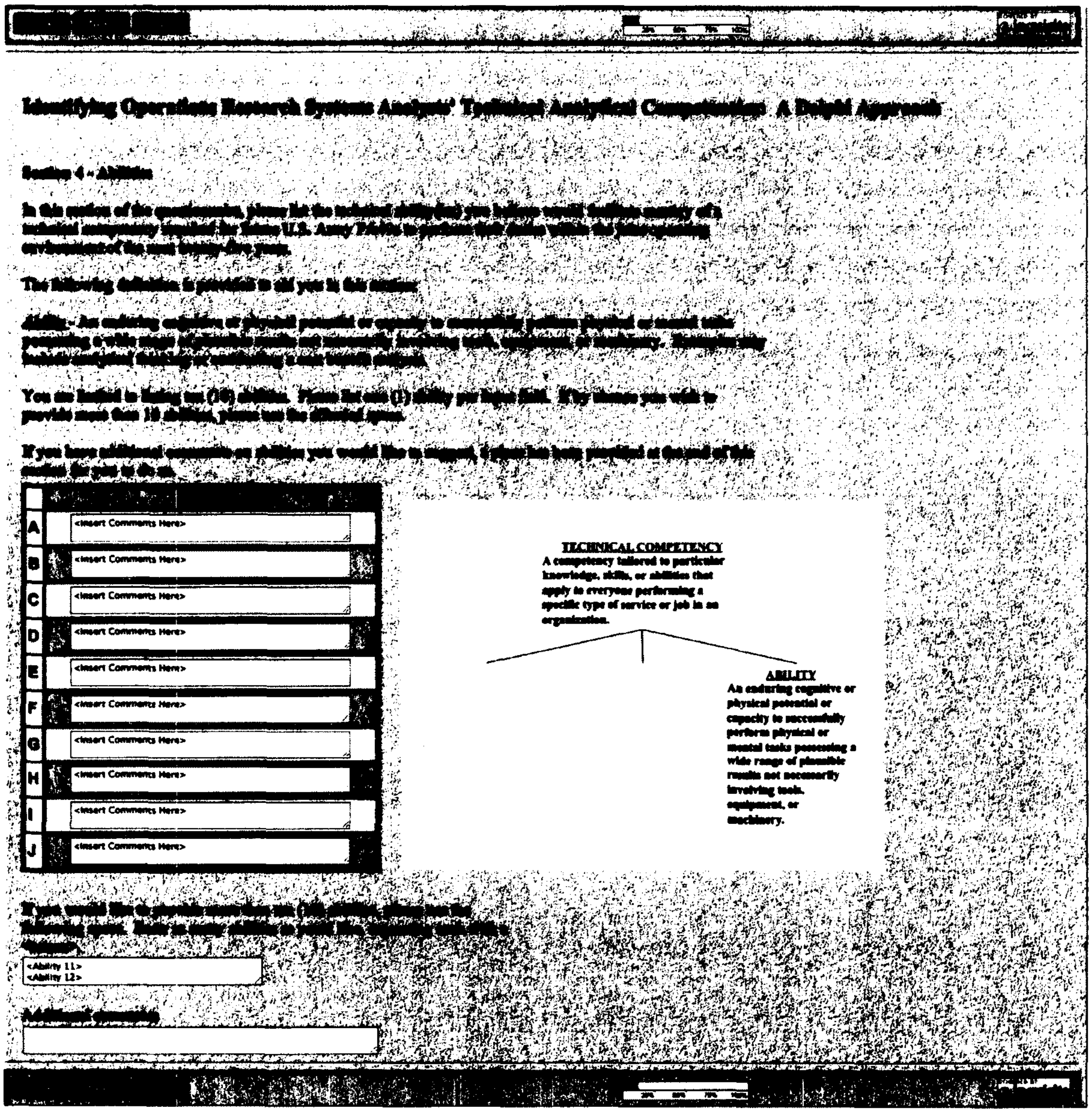
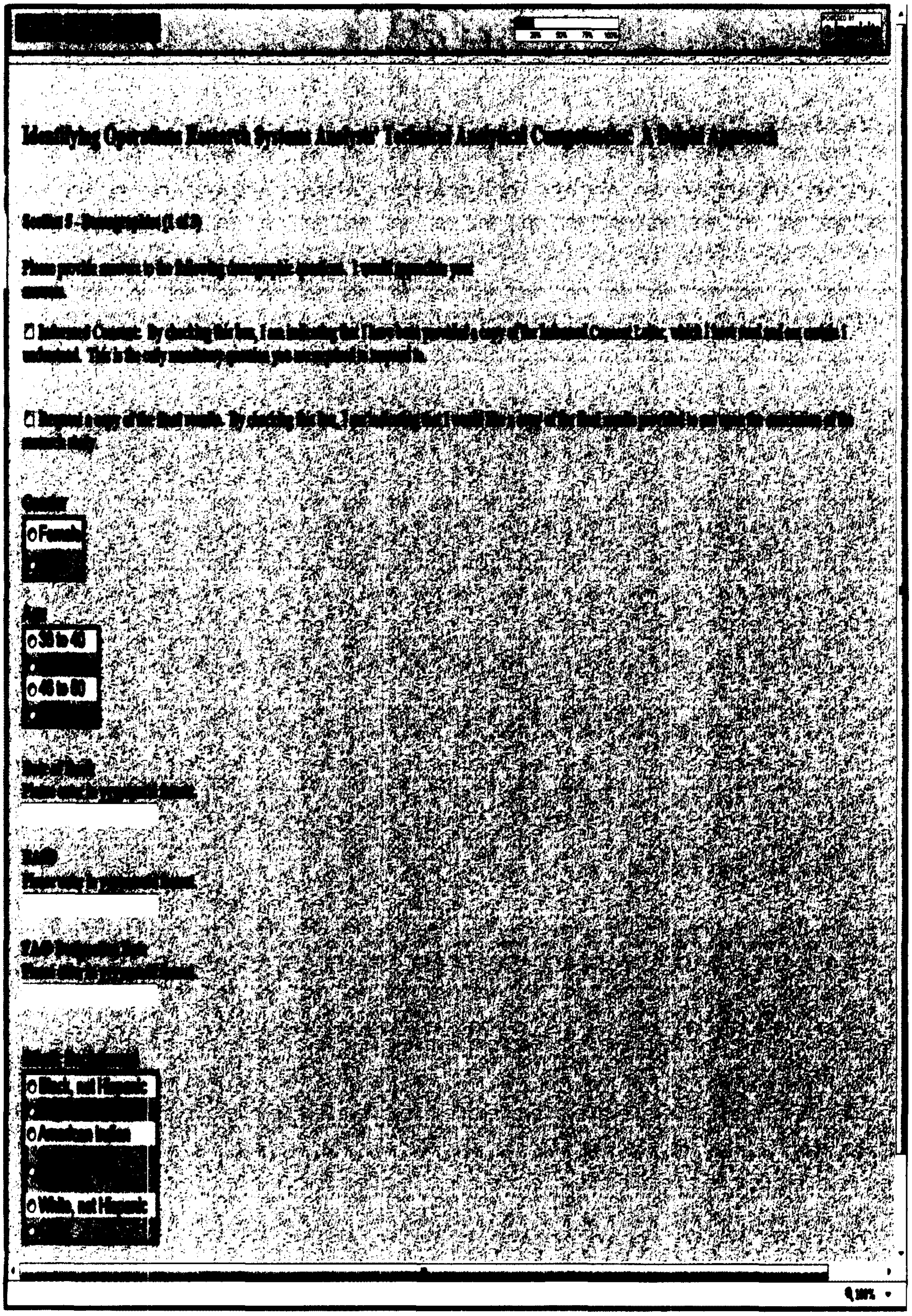
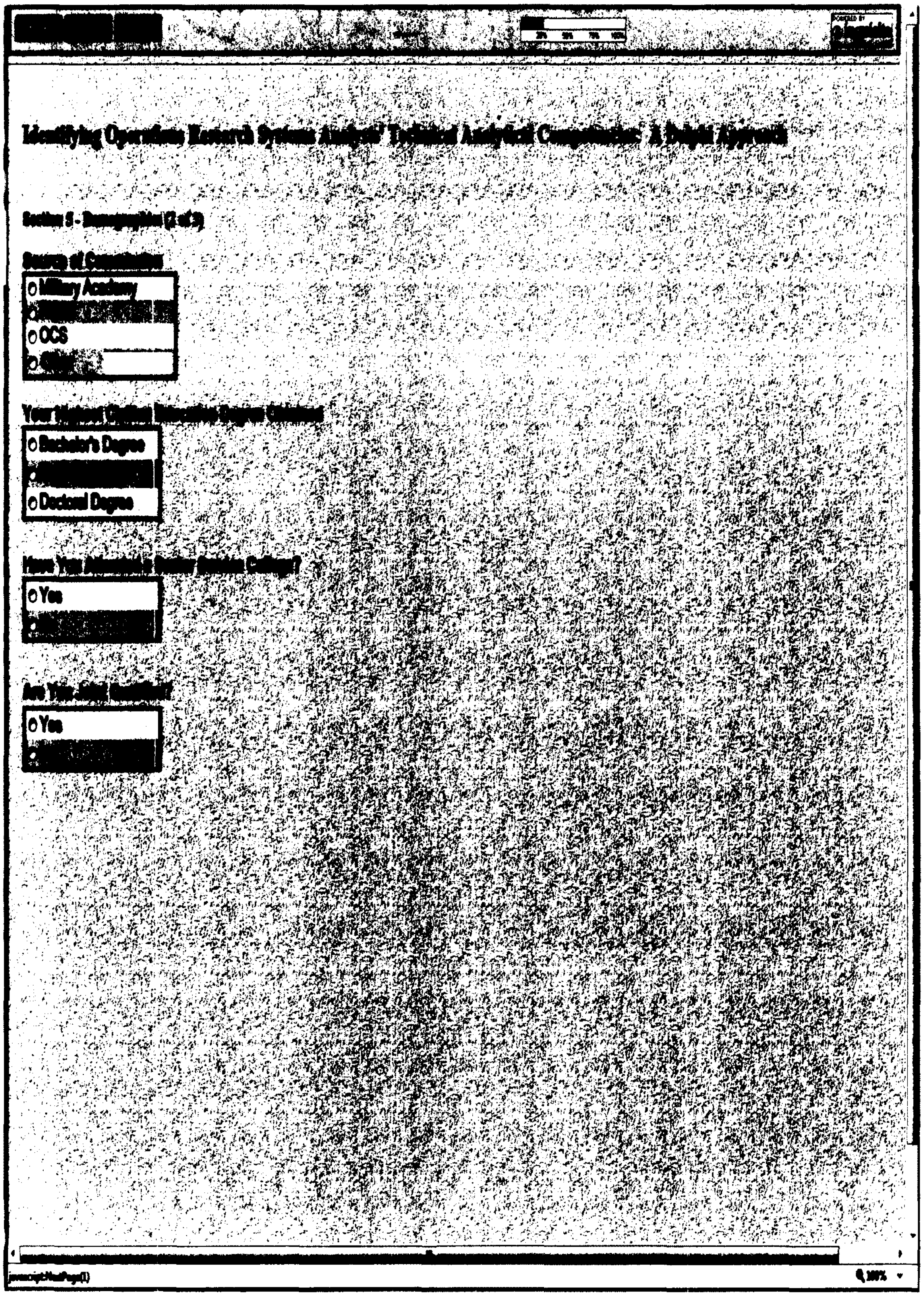
H
<Insert Comments Here>
I
<Insert Comments Here>
J
<Insert Comments Here>
TECHNICAL COMPETENCY
A competency tailored to particular knowledge, skills, or abilities that apply to everyone performing a specific type of service or job in an organization.
SKILL
A concrete or abstract potential or capacity to successfully perform physical or mental tasks using tools, equipment, or machinery.
<Skill 11>
<Skill 12>


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Section 4 - Abilities
A <Insert Comments Here>
B <Insert Comments Here>
C <Insert Comments Here>
D <Insert Comments Here>
E <Insert Comments Here>
F <Insert Comments Here>
G <Insert Comments Here>
H <Insert Comments Here>
I <Insert Comments Here>
J <Insert Comments Here>
TECHNICAL COMPETENCY
A competency tailored to particular knowledge, skills, or abilities that apply to everyone performing a specific type of service or job in an organization.
ABILITY
An enduring cognitive or physical potential or capacity to successfully perform physical or mental tasks possessing a wide range of plausible results not necessarily involving tools, equipment, or machinery.
<Ability 11>
<Ability 12>


Female
Black, not Hispanic
American Indian
White, not Hispanic



Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach

Section 5 - Demographics (2 of 3)

Source of Commission

- Military Academy
- [illegible]
- OCS
- [illegible]

Your Highest Civilian Education Degree Obtained

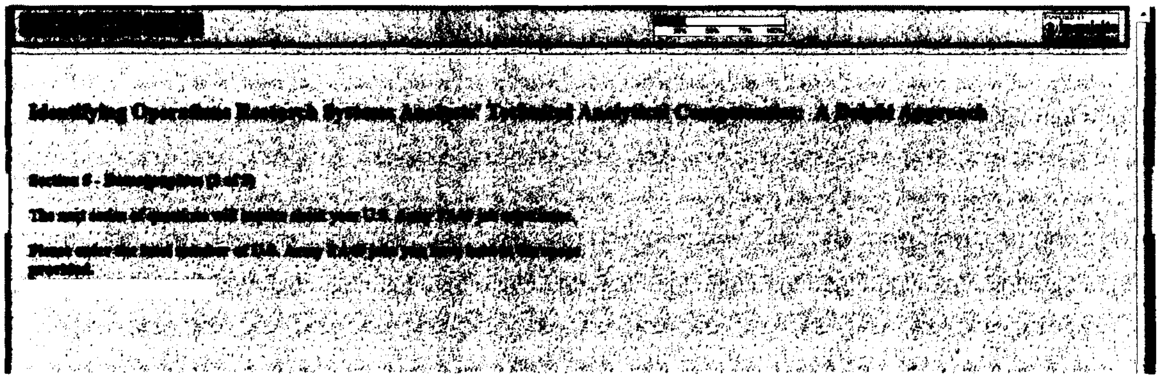
- Bachelor's Degree
- [illegible]
- Doctoral Degree

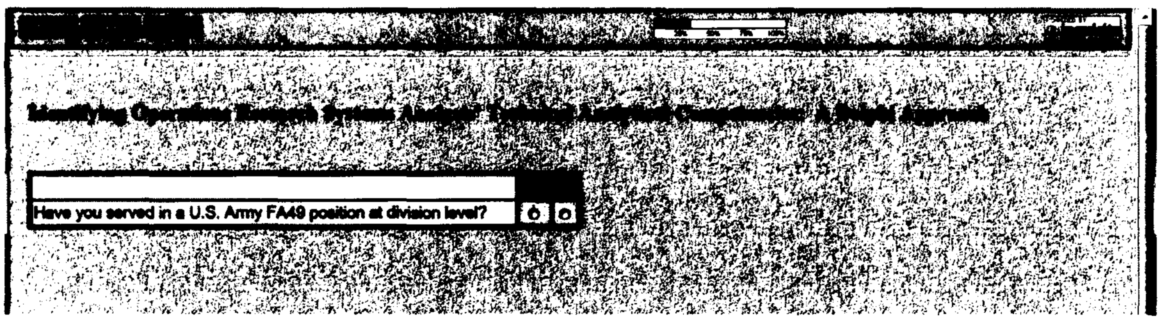
Have You Attended a Senior Service College?

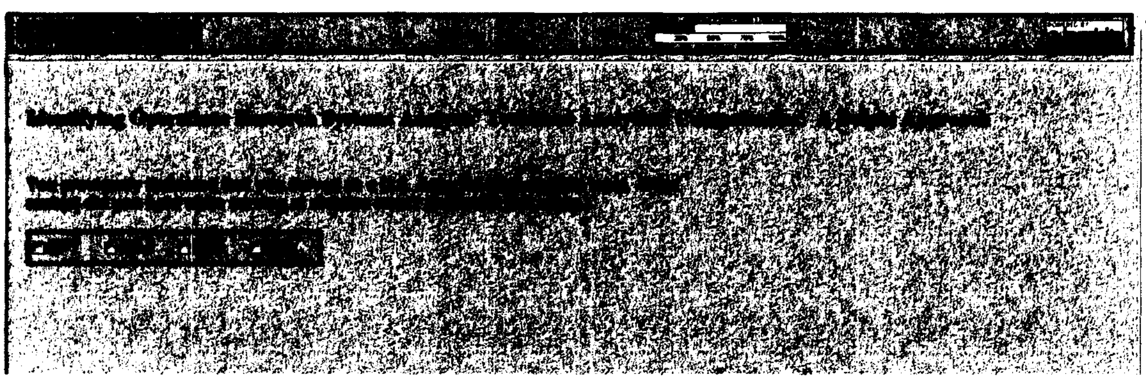
- Yes
- [illegible]

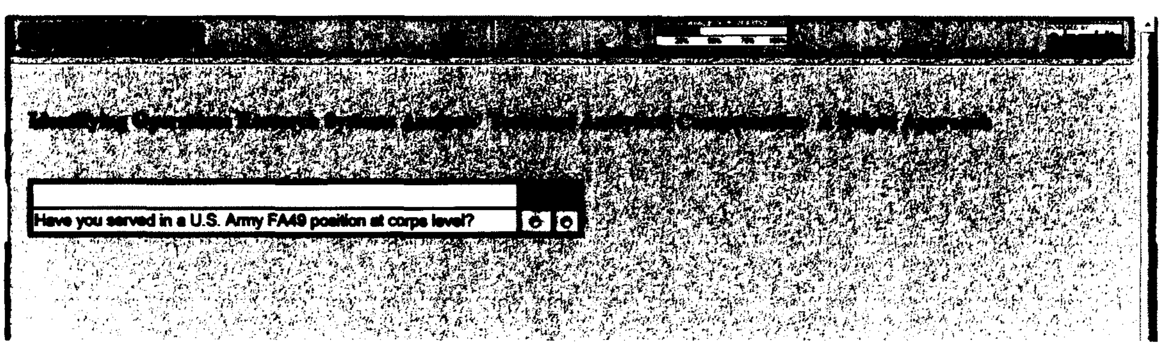
Are You Joint Qualified?

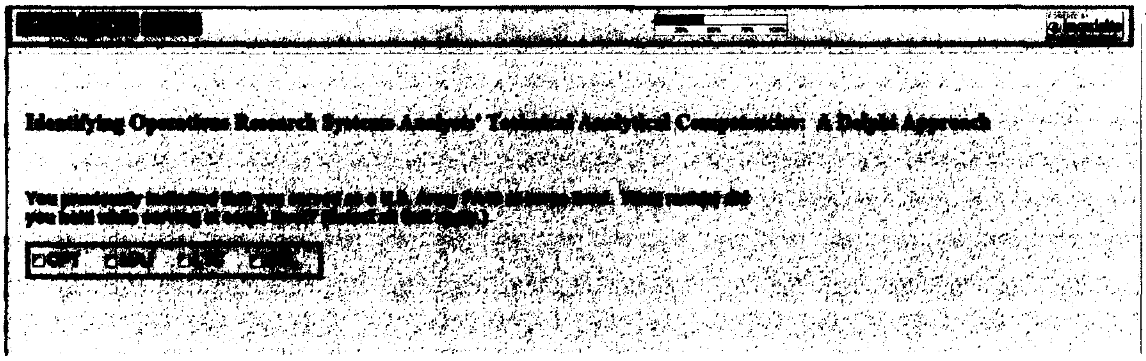
- Yes
- [illegible]

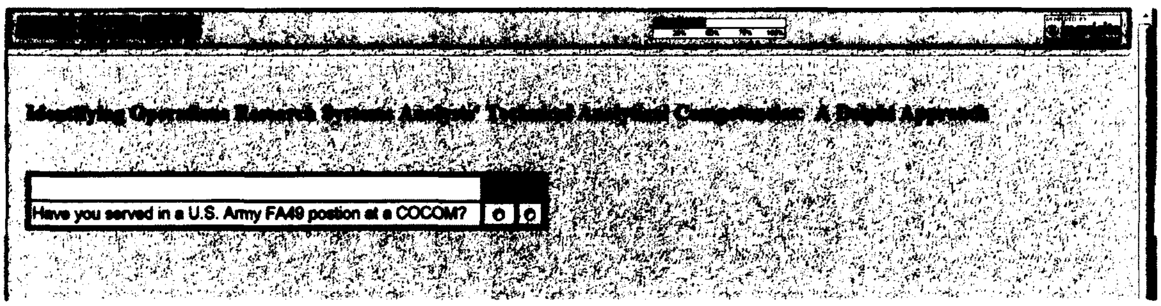


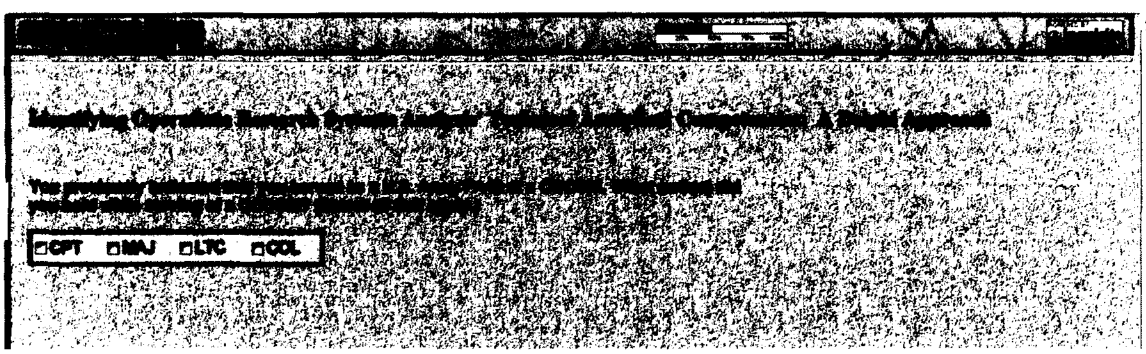

Have you served in a U.S. Army FA49 position at division level?

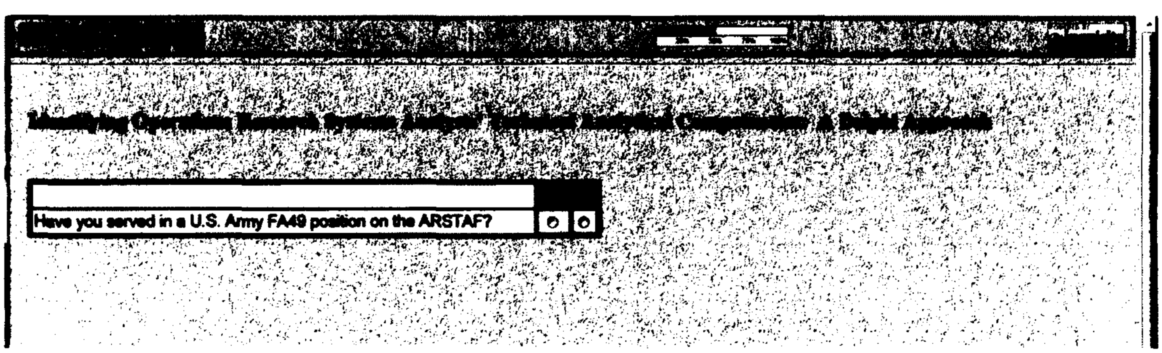


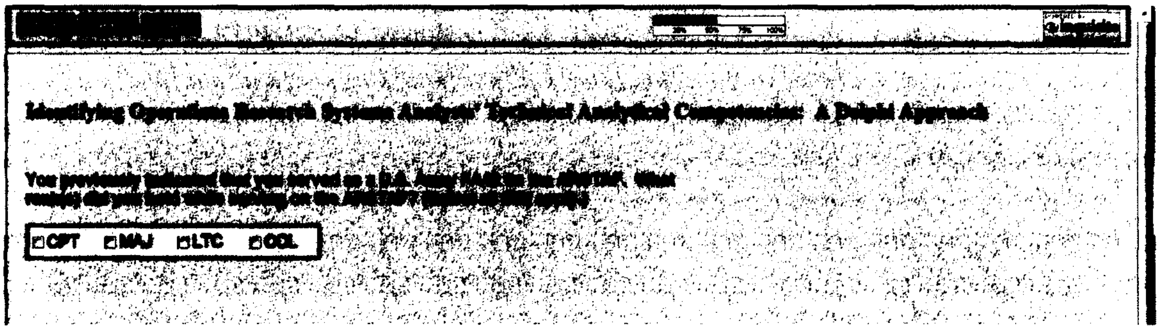

Have you served in a U.S. Army FA49 position at corps level?




Have you served in a U.S. Army FA49 position at a COCOM?


CPT
MAJ
LTC
COL


Have you served in a U.S. Army FA49 position on the ARSTAF?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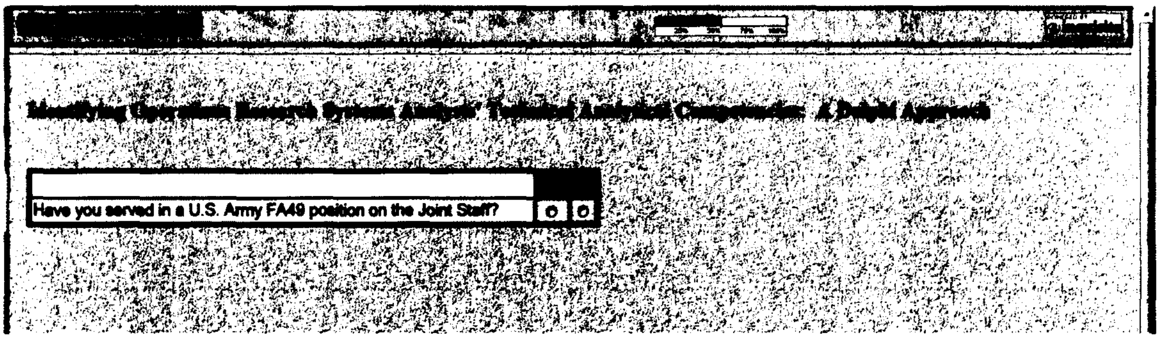
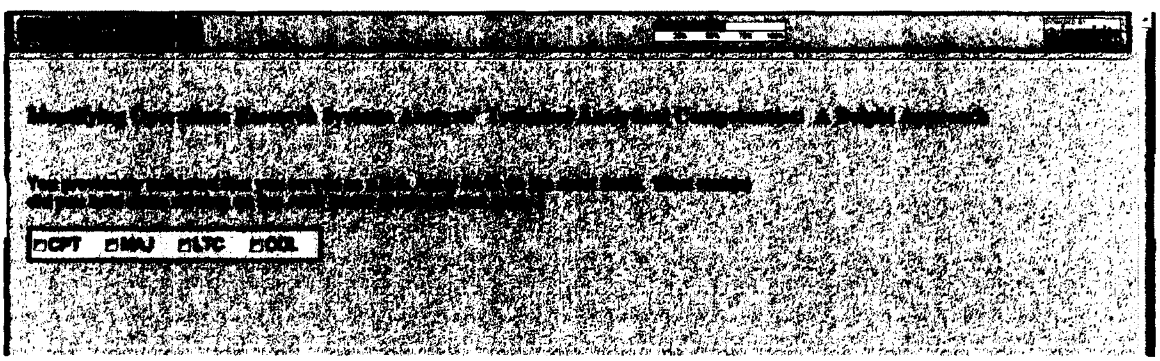
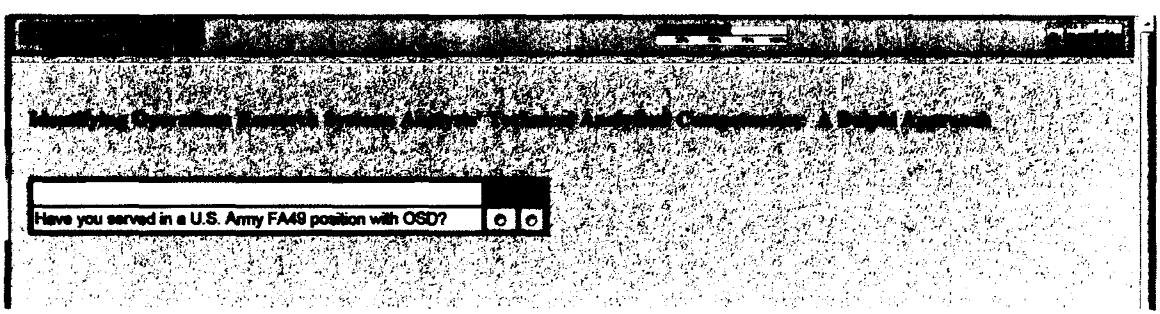
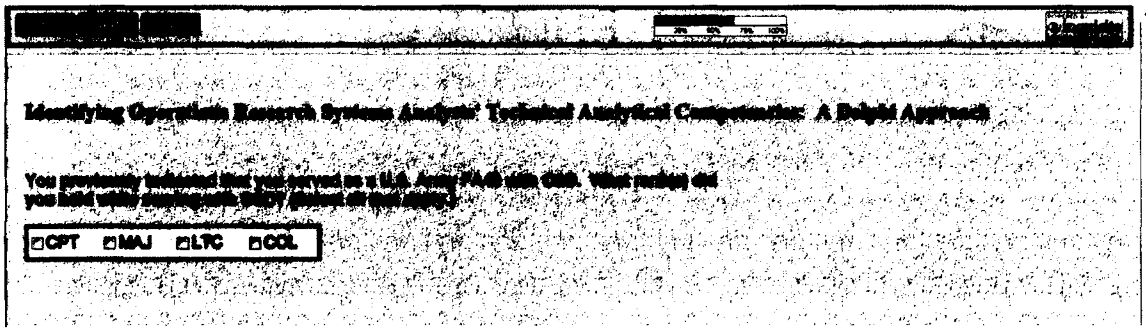
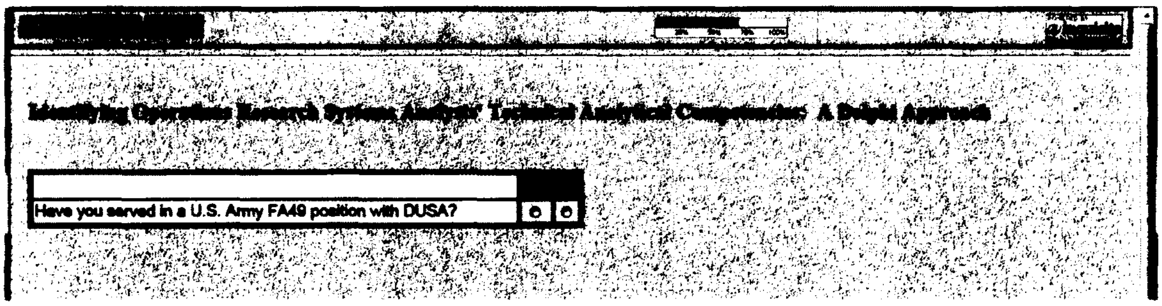
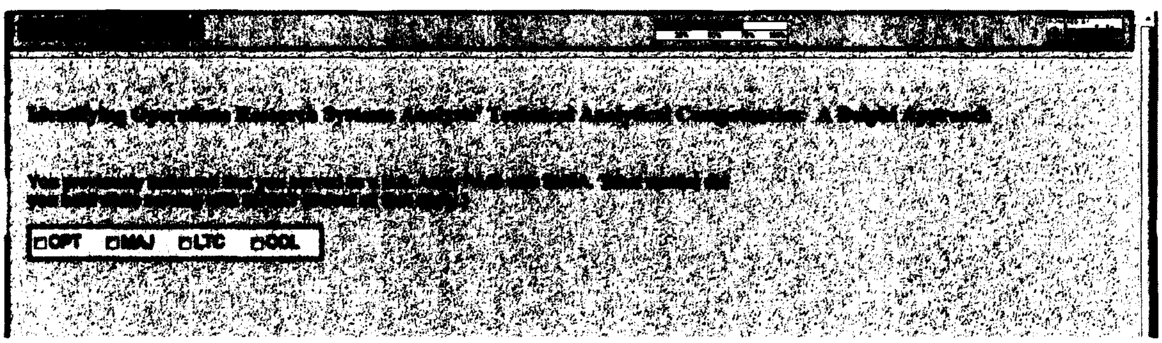

Have you served in a U.S. Army FA49 position on the Joint Staff?

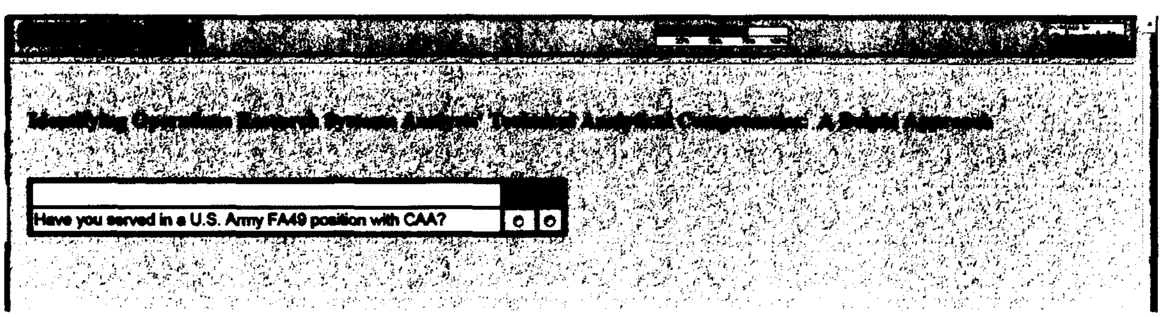

CPT
MAJ
LTC
COL

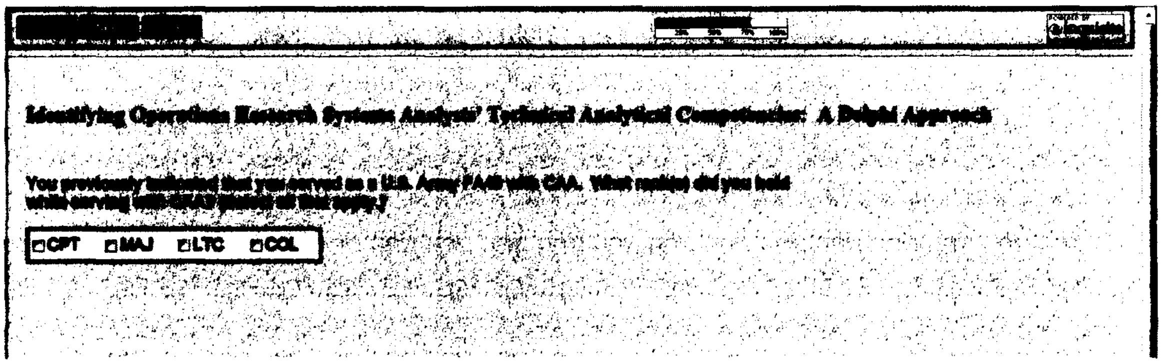

Have you served in a U.S. Army FA49 position with OSD?

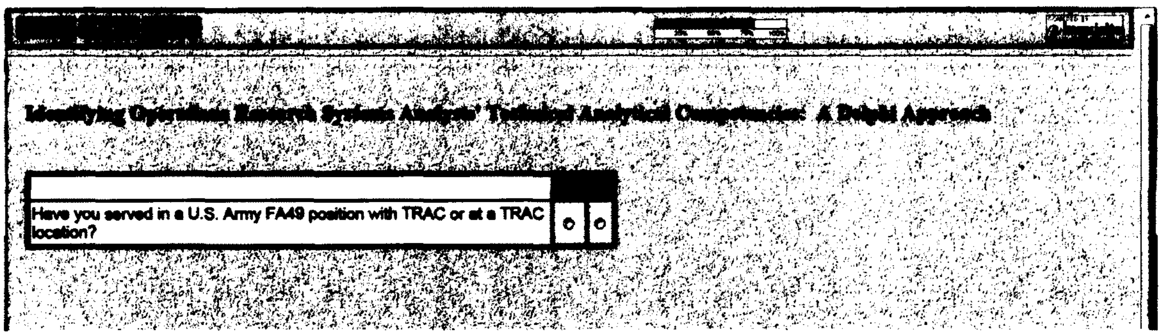

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
CPT
MAJ
LTC
COL

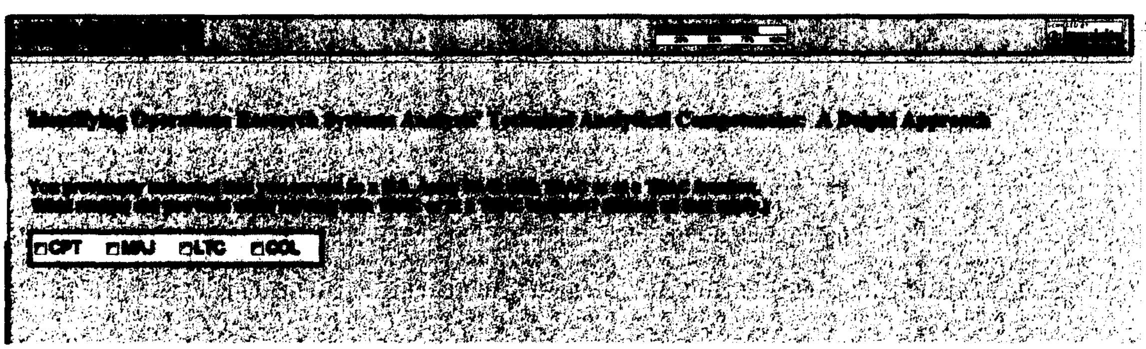

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Have you served in a U.S. Army FA49 position with DUSA?

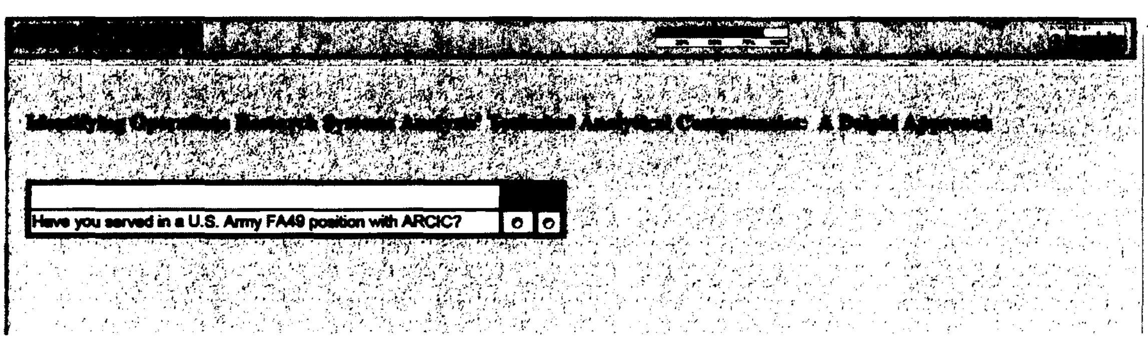

CPT
MAJ
LTC
COL

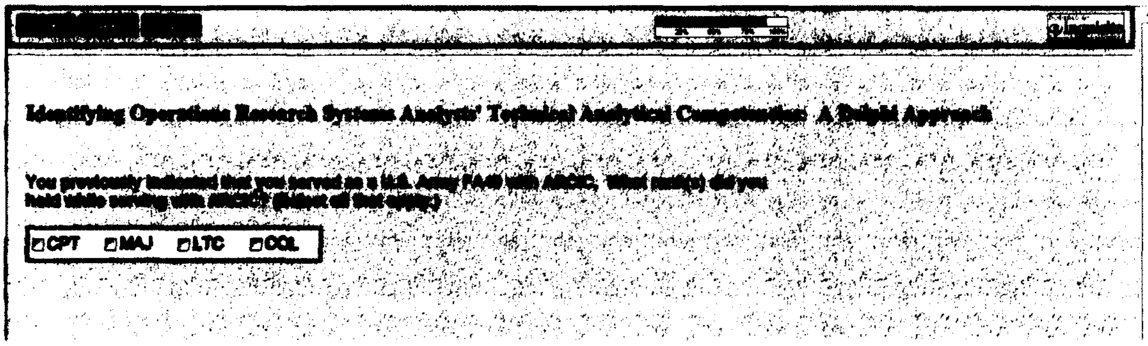

Have you served in a U.S. Army FA49 position with CAA?

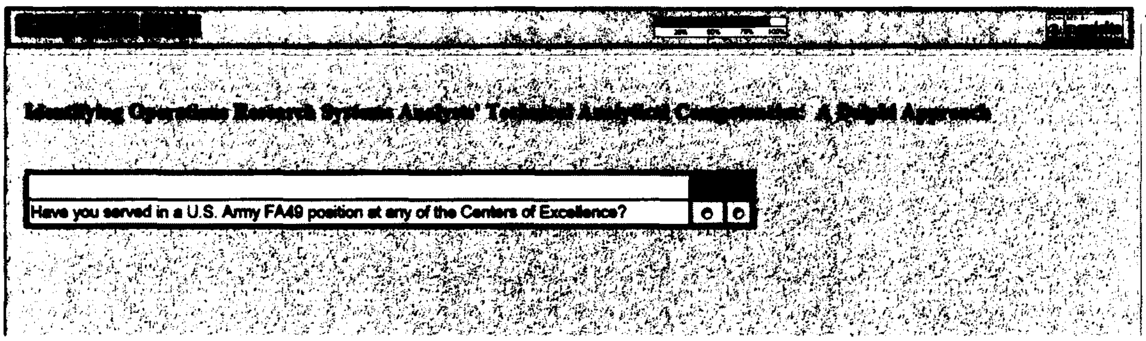

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
You previously indicated that you served as a U.S. Army FA49 with CAA. What rank(s) did you hold
CPT
MAJ
LTC
COL

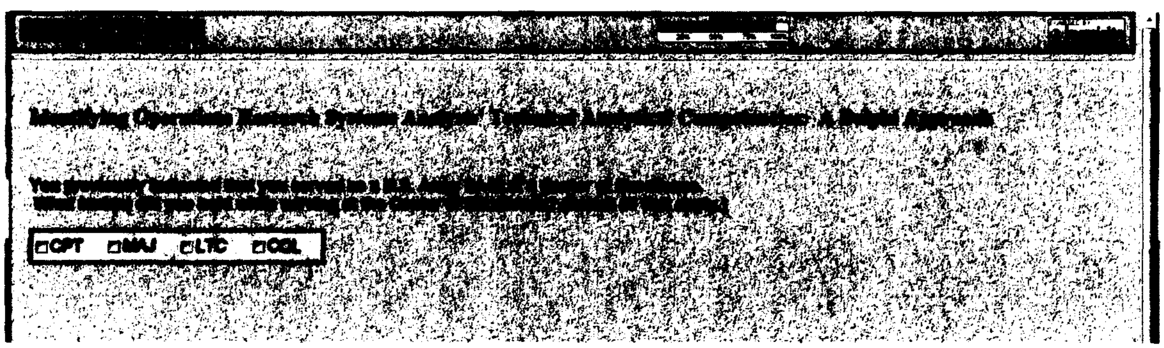

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Have you served in a U.S. Army FA49 position with TRAC or at a TRAC location?


CPT
MAJ
LTC
COL


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Have you served in a U.S. Army FA49 position with ARCIC?


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
You previously indicated that you served as a U.S. Army FA49 with ARCIC. What rank(s) did you hold while serving with ARCIC? (Select all that apply.)
CPT
MAJ
LTC
COL


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Have you served in a U.S. Army FA49 position at any of the Centers of Excellence?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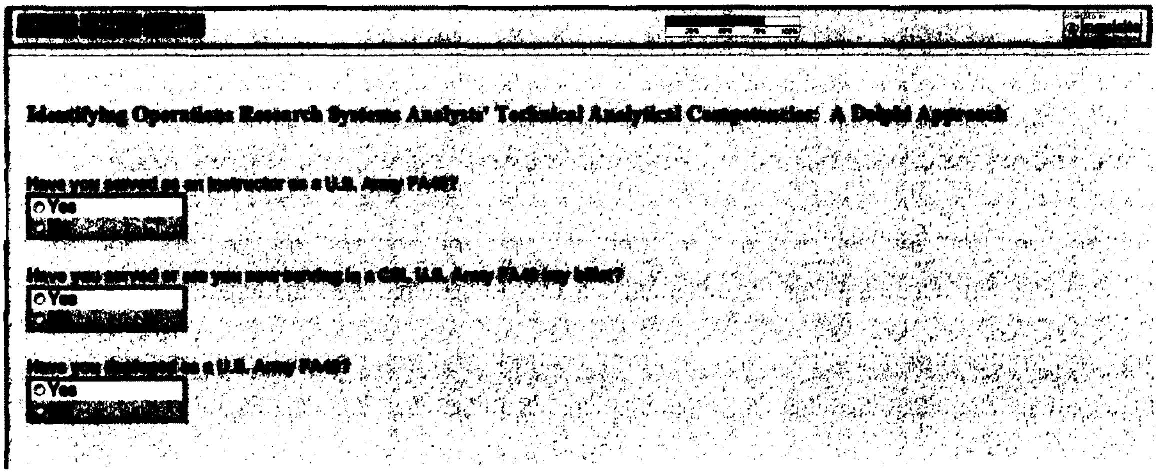
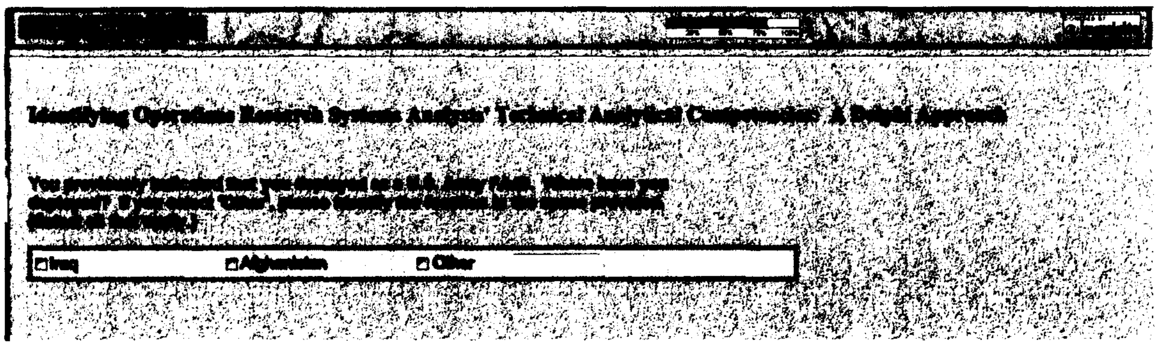
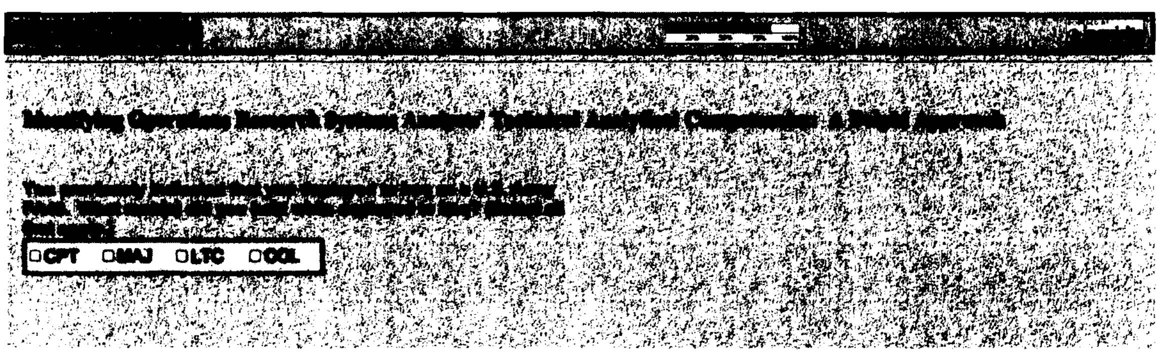
MAJ
LTC
COL


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Have you served as an instructor as a U.S. Army FA49?
Yes
Have you deployed as a U.S. Army FA49?
Yes


Iraq
Afghanistan
Other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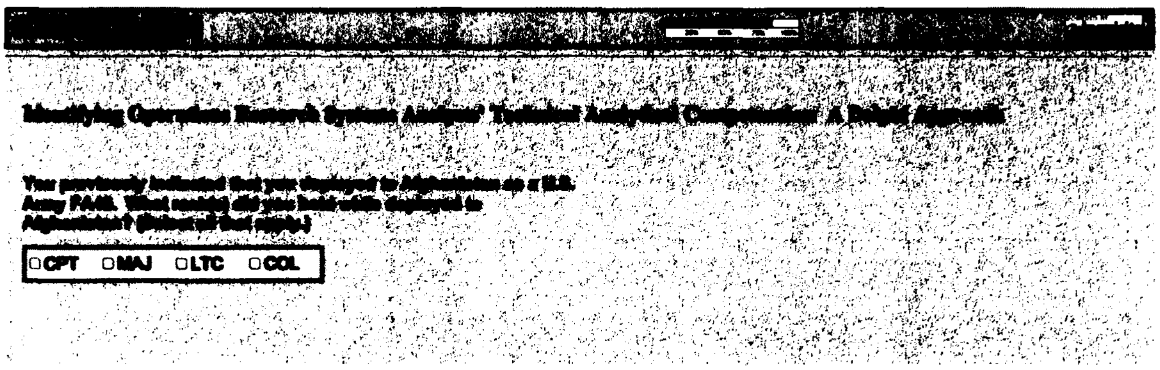
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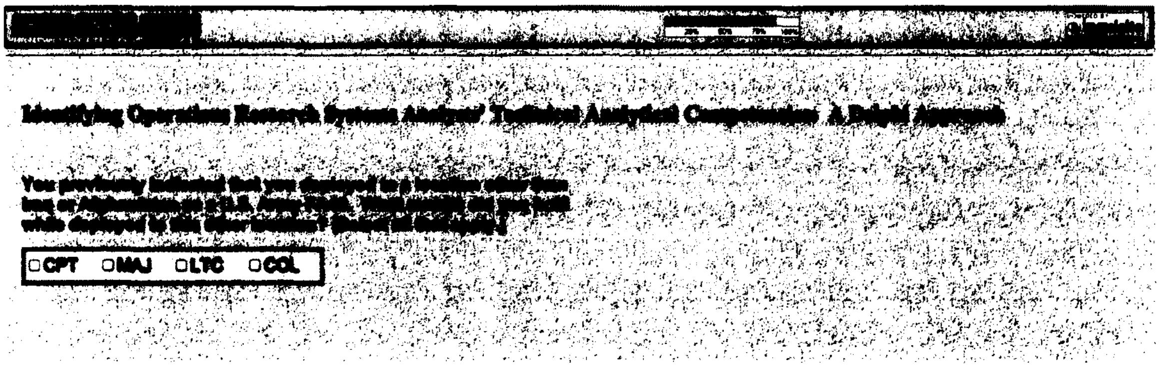
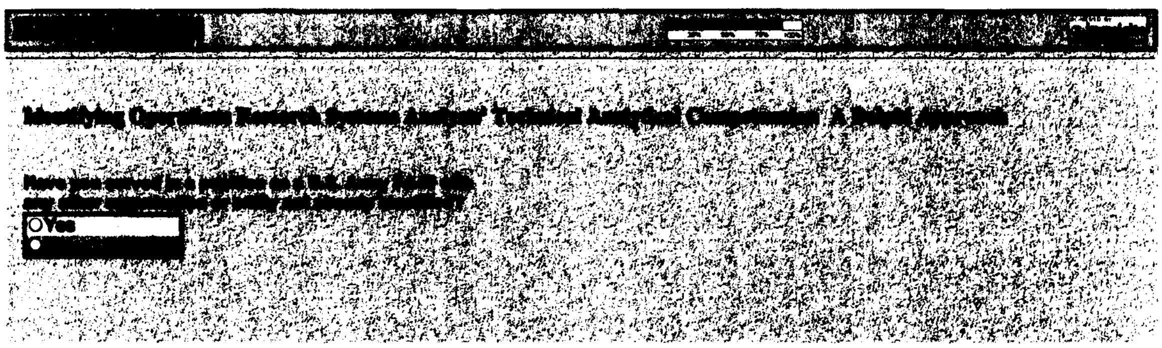
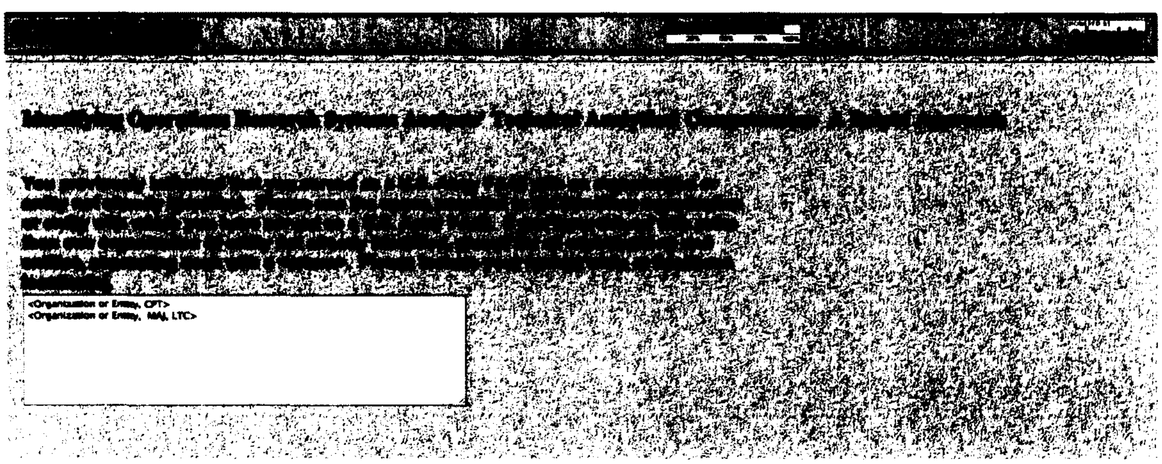

Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
CPT MAJ LTC COL


Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach
Yes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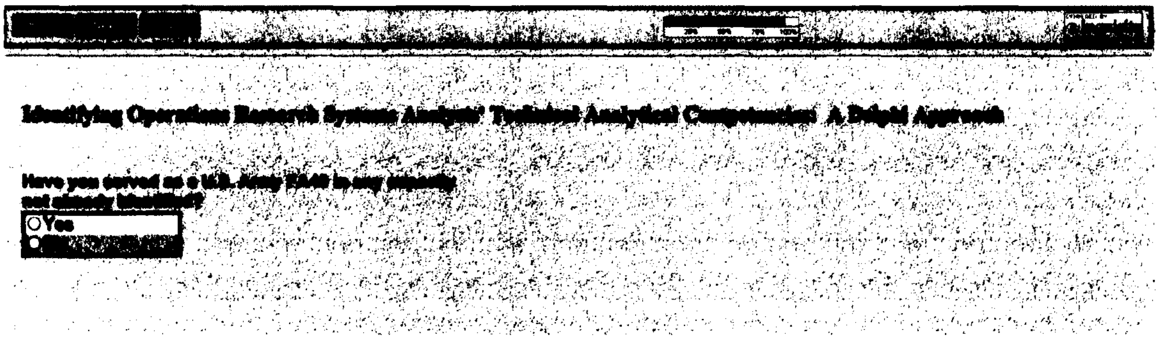
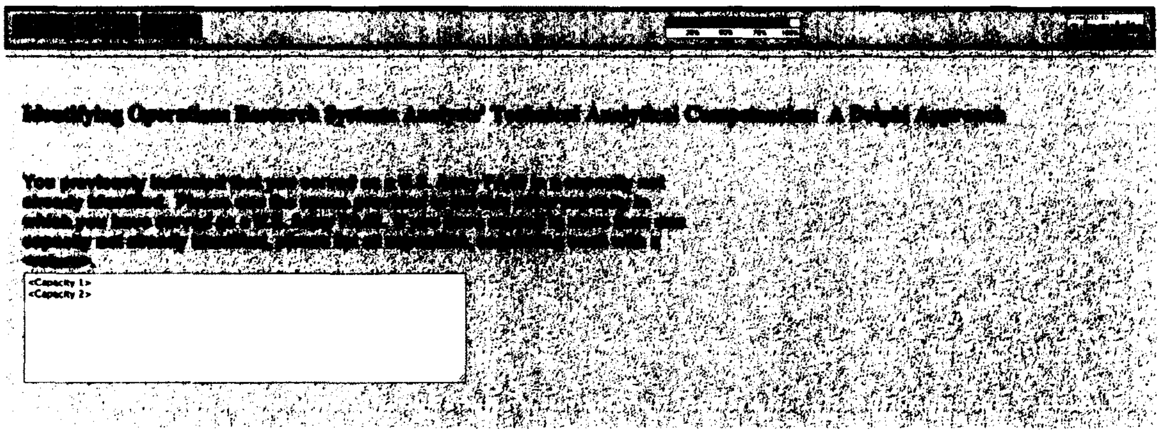

Yes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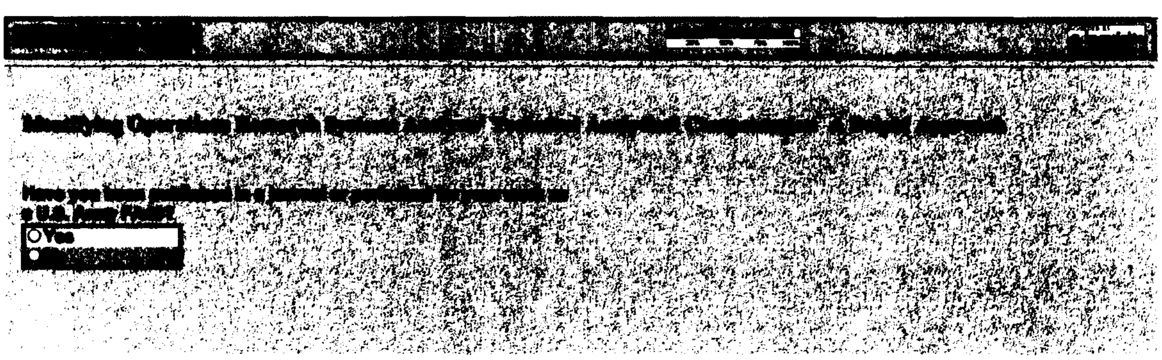
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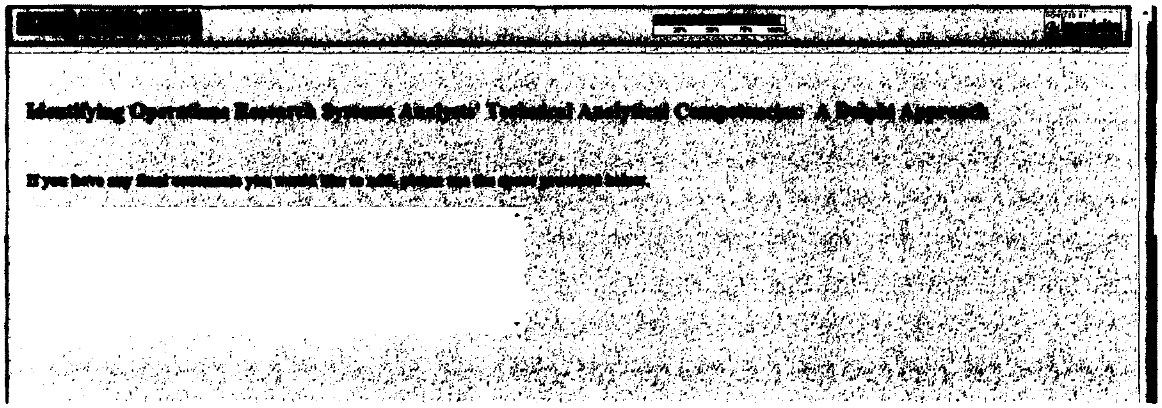
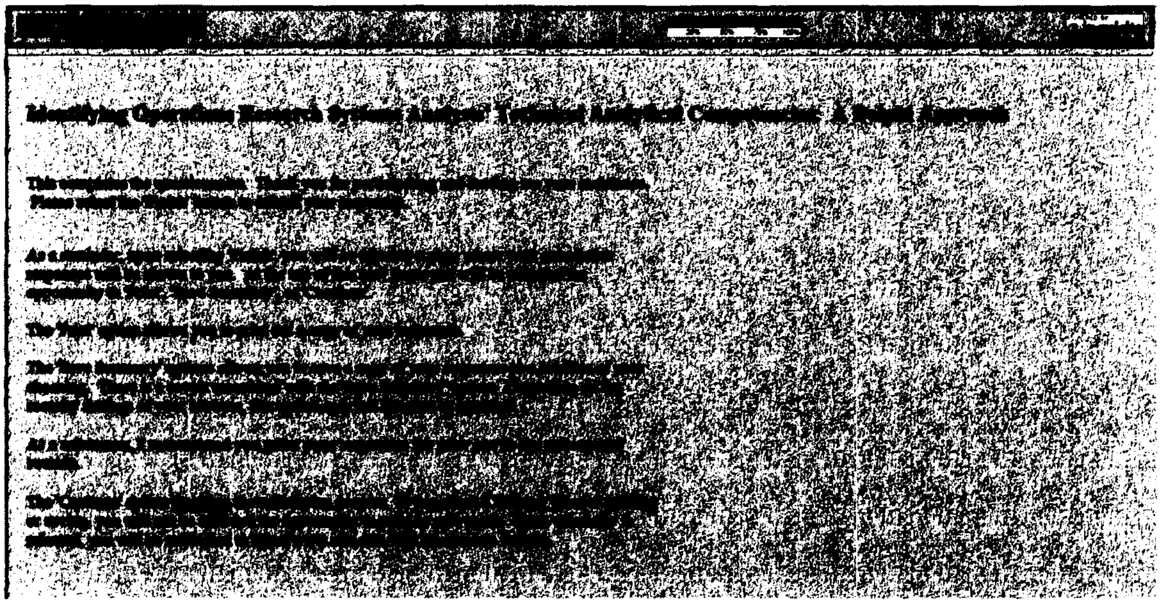




Print Save Summary Continue

Your Submitted Responses for "Identifying Operations Research Systems Analysts' Technical Competencies: An Updated Delphi Approach"
Started Date: 11/2/2011 14:42:31
Completed Date: 11/2/2011 14:42:51

Page 1

At this time please enter your unique ID.
{Enter text answer}
[ ]

Page 2

A
{Enter answer in paragraph form}
[<Insert Comments Here>]

B
{Enter answer in paragraph form}

APPENDIX E: ROUND ONE FOLLOW-UP MESSAGE

This is a reminder that your responses to the Round One questionnaire for the research study entitled *Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach* are past due. If you are no longer able to participate, I completely understand. I thoroughly know how invaluable your time is; however, your input as a contemporary U.S. Army FA49 expert panel member would be immeasurable to this research study and I would appreciate your contribution.

Again, I thank you for your time. If you have questions or problems, please, do not hesitate to email or call me.

Very respectfully,

Wink
wwink001@odu.edu
717-552-1737

APPENDIX F: PEER DEBRIEFING

Peer debriefing steps:

1. Provided Overview of Research Study
    a. Background
    b. Design
    c. Data collection
    d. Data analysis

2. Open Coding
    a. Did the researcher appear to remain unbiased?
    b. Was the researcher consistent with his coding?
    c. Was the researcher consistent with his methodology for data reduction?
    d. Was the researcher consistent with his methodology for data placement?
    e. Were the category names (first level of abstraction) logically chosen from the corpus of the data?

3. Focused Coding
    a. Did the researcher appear to remain unbiased?
    b. Was the researcher consistent with his coding?
    c. Was the researcher consistent with his methodology for data reduction?
    d. Was the researcher consistent with his methodology for data placement?
    e. Were the category names (second level of abstraction) logically chosen from the corpus of the data?

	OPEN CODING QUESTIONS				
	A	B	C	D	E
Peer #1	Yes	Yes	Yes	Yes	Yes
Peer #2	Yes	Yes	Yes	Yes	Yes

	FOCUSED CODING QUESTIONS				
	A	B	C	D	E
Peer #1	Yes	Yes	Yes	Yes	Yes
Peer #2	Yes	Yes	Yes	Yes	Yes

Main feedback comment:

Why didn't you use software for your analysis? Given the terse nature of the majority of the responses from the expert panel members as well as the limited number of total responses received, the payback for the time necessary to learn a new software package was minimal at best.

APPENDIX G: ROUND TWO PARTICIPATION MESSAGE

Name of Expert Panel Member

I would like to thank you for continuing to participate as an expert panel member in this research study.

This second round questionnaire should take much less time to complete than the first round questionnaire. Once you begin, I anticipate it will take you no more than thirty (30) minutes to complete. Please submit your answers to this questionnaire within three (3) days.

Please use the same ID number from the first round. Your ID number is - **xxxxxx**.

Please follow this link to the questionnaire https://xxx.xxx.xxx. If the link does not work then copy and paste the URL information into your browser. You should be able to access the questionnaire with any current web browser.

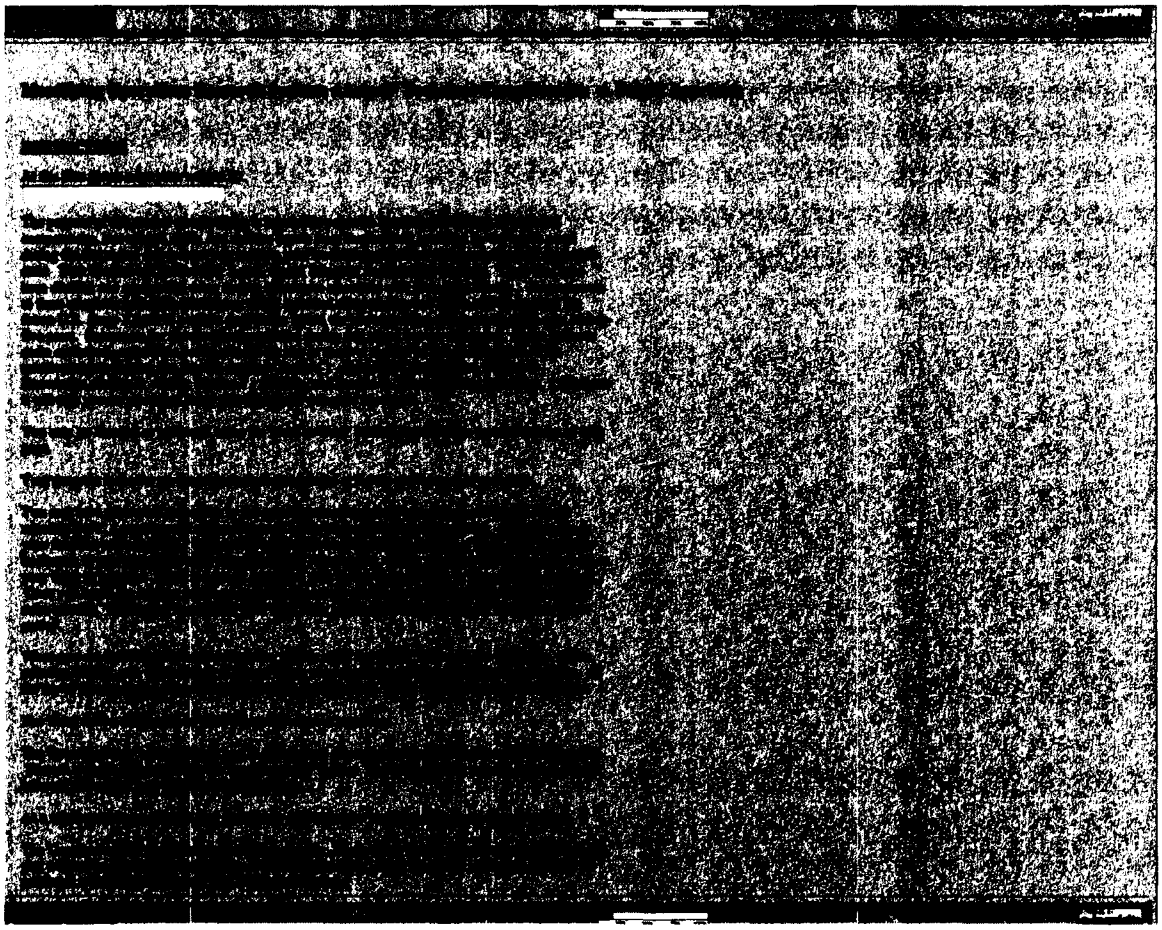
I thank you in advance for your continued participation and contribution. If you have questions or problems, please, do not hesitate to email or call me.

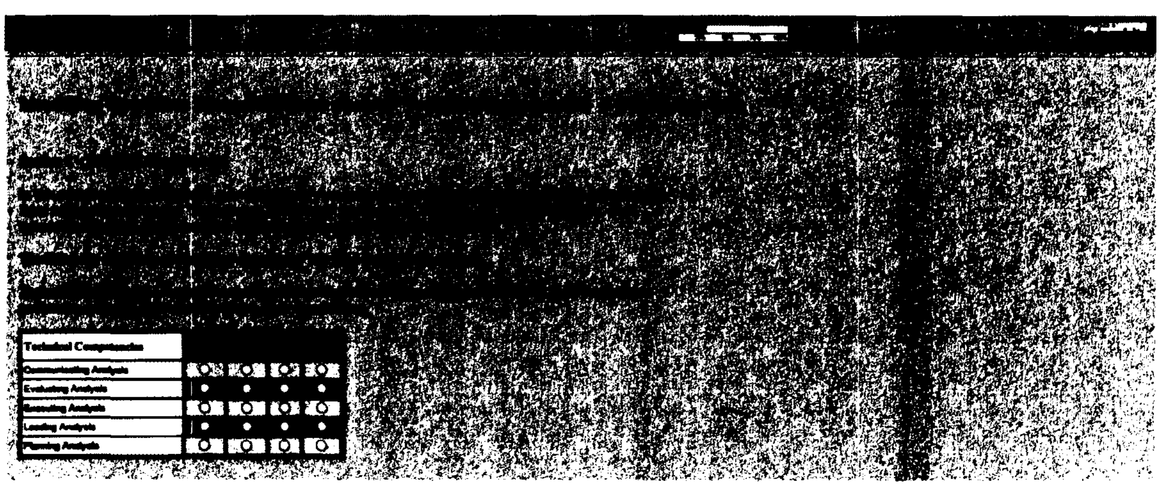
Once I have compiled the results, you will either receive a message from me for the start of a third round or a message indicating the expert panel has reached consensus.

Very respectfully,

Wink
wwink001@odu.edu
717-552-1737

APPENDIX H: ROUND TWO QUESTIONNAIRE





Knowledge				
Acquisition Management				
Army Operations				
Army Organization				
Army Processes (e.b. PPBE)				
DoD Organization				
Economics				
Historical Applications of OR				
How the Army Runs				
How the DoD Runs				
How the Federal Government Runs				
Interagency Operations				
Joint Operations				
Joint Processes (e.g. JCIDS (DOTMLPF-P))				
Leadership				
Mathematics				
Methods/Tools				
Military Planning Processes (MDMP, JOPP)				
Multinational Operations				
Operational Environment				
Resource Management (Includes HRM)				
Role of ORSA				

Identifying Operations Research Systems Analysts' Technical Competencies & Delphi Approach

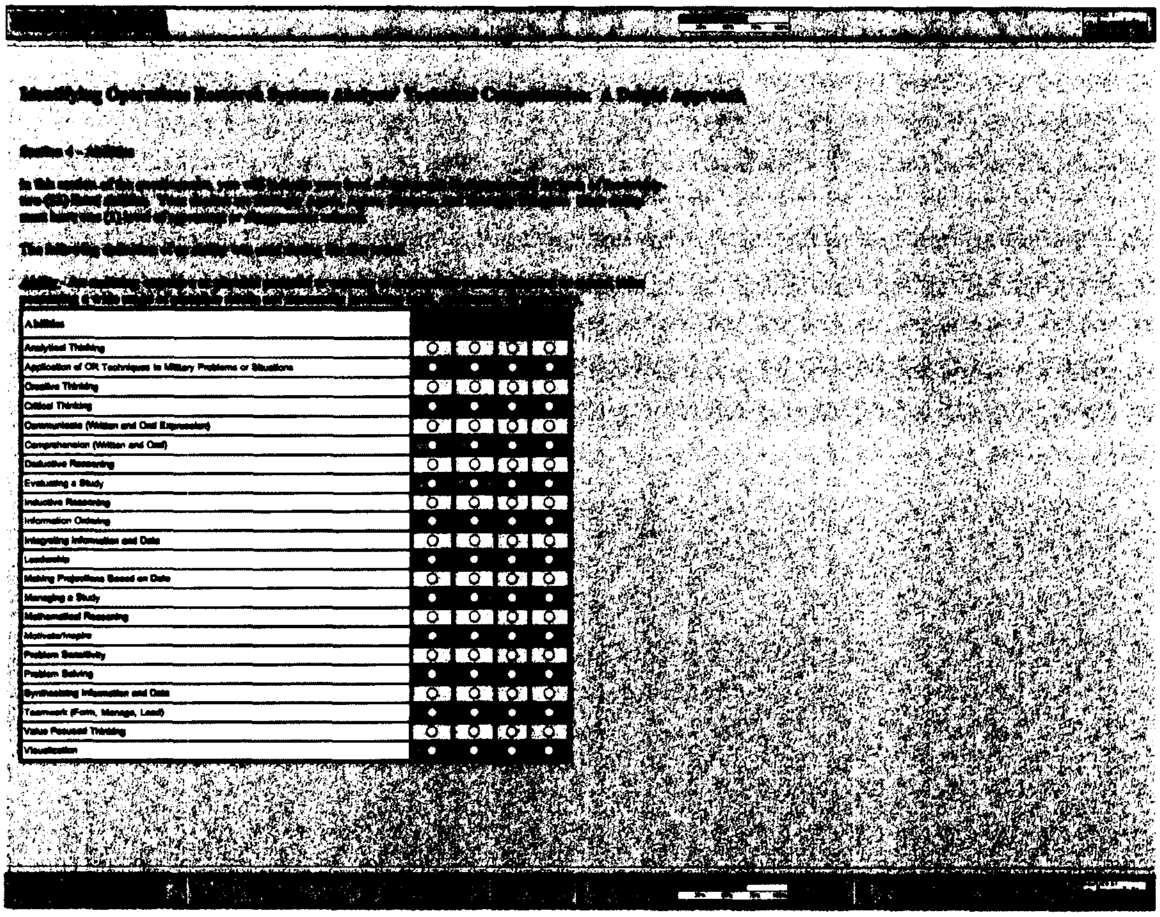
Section 2 - Skills

[illegible]

[illegible]

[illegible]

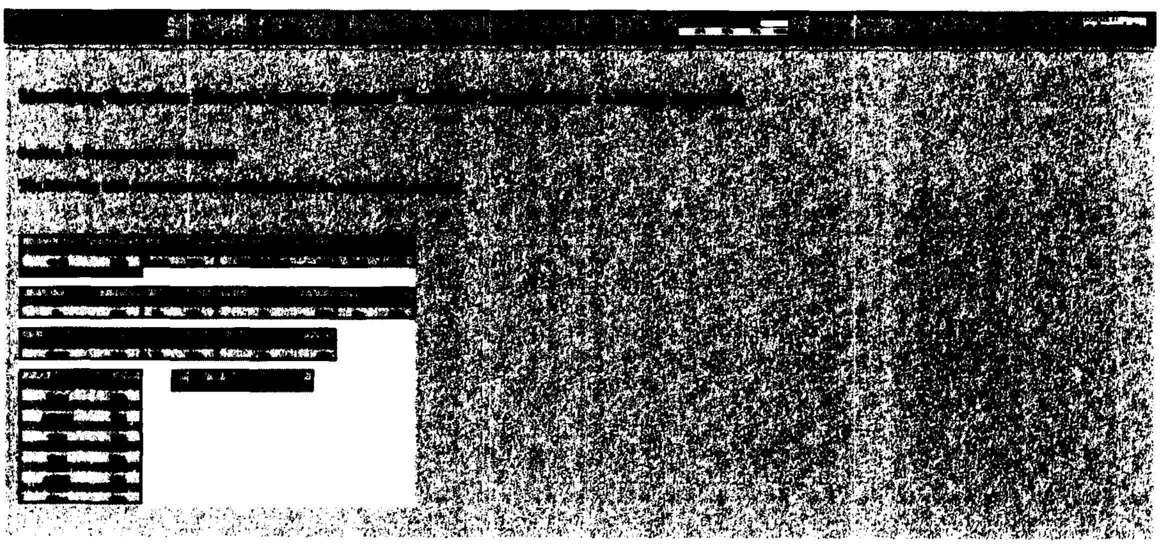
Skills				
Active Listening	○	○	○	○
Ad Hoc (Quick Turn) Modeling	○	○	○	○
Agent Based Modeling	○	○	○	○
Analyzing Data with and/or without Software	○	○	○	○
Combat Modeling	○	○	○	○
Common Software Programs/Packages (SPSS, GAMS, MATLAB, Minitab, MS Office)	○	○	○	○
Computer Modeling	○	○	○	○
Computer Programming (VBA, Java)	○	○	○	○
Conducting Research	○	○	○	○
Cost Benefit Analysis	○	○	○	○
Data Analysis and Interpretation	○	○	○	○
Data Modeling	○	○	○	○
Database Programming, Development, Analysis, Mining	○	○	○	○
Decision Analysis (includes Multi-objective)	○	○	○	○
Design of Experiments	○	○	○	○
Discrete Event Simulation	○	○	○	○
Effective Communication (Writing, Speaking, Presenting)	○	○	○	○
Forecasting	○	○	○	○
Goal Programming	○	○	○	○
Leadership	○	○	○	○
Linear Algebra	○	○	○	○
Math Programming	○	○	○	○
Mathematics (Probability, Statistics)	○	○	○	○
Metric Development	○	○	○	○
Military Planning Processes (MDMP, JOPP)	○	○	○	○
Modeling (general)	○	○	○	○
Negotiating	○	○	○	○
Optimization	○	○	○	○
Prioritization	○	○	○	○
Problem Solving	○	○	○	○
Process Improvement Analysis	○	○	○	○
Qualitative Analysis	○	○	○	○
Quantitative Analysis	○	○	○	○
Risk Analysis	○	○	○	○
Simulation (general)	○	○	○	○
Spreadsheet Modeling	○	○	○	○
Statistical Analysis with and/or without Software	○	○	○	○
Survey Analysis	○	○	○	○
Survey Development	○	○	○	○
Trend Analysis	○	○	○	○
Value Modeling	○	○	○	○

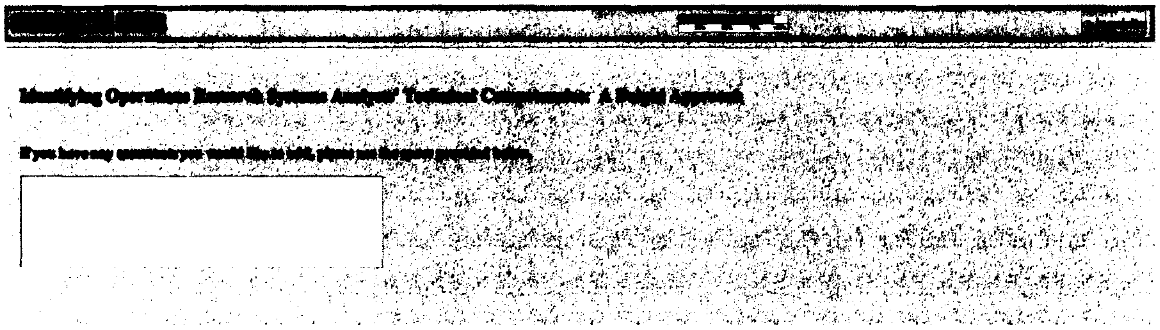


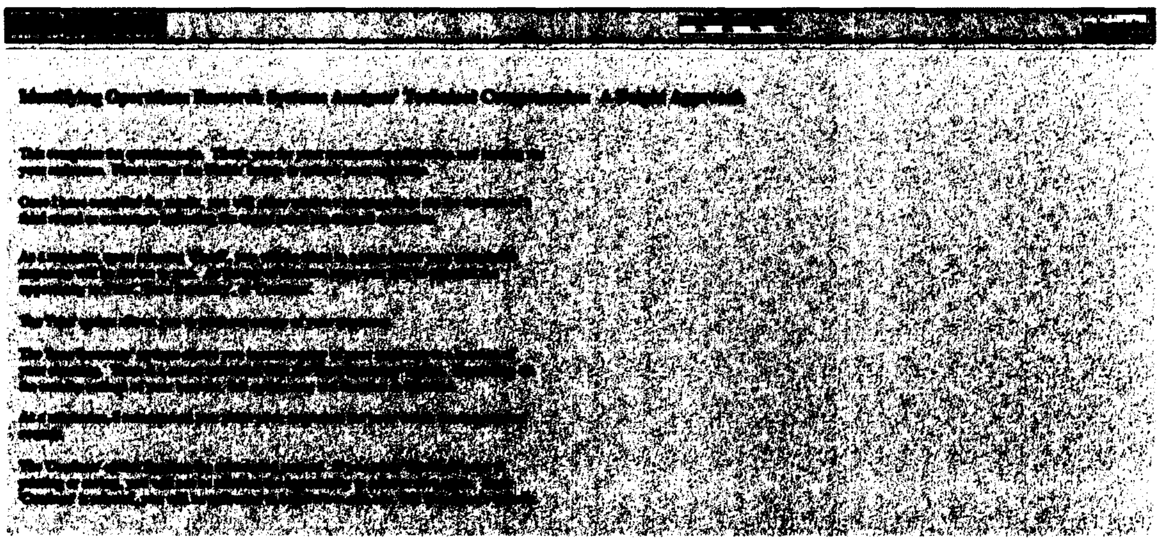
Identifying Operations Research Systems Analysts' …

Section 4 – Abilities

Abilities				
Analytical Thinking	○	○	○	○
Application of OR Techniques to Military Problems or Situations	○	○	○	○
Creative Thinking	○	○	○	○
Critical Thinking	○	○	○	○
Communicate (Written and Oral Expression)	○	○	○	○
Comprehension (Written and Oral)	○	○	○	○
Deductive Reasoning	○	○	○	○
Evaluating a Study	○	○	○	○
Inductive Reasoning	○	○	○	○
Information Ordering	○	○	○	○
Integrating Information and Data	○	○	○	○
Leadership	○	○	○	○
Making Projections Based on Data	○	○	○	○
Managing a Study	○	○	○	○
Mathematical Reasoning	○	○	○	○
Motivate/Inspire	○	○	○	○
Problem Sensitivity	○	○	○	○
Problem Solving	○	○	○	○
Synthesizing Information and Data	○	○	○	○
Teamwork (Form, Manage, Lead)	○	○	○	○
Value Focused Thinking	○	○	○	○
Visualization	○	○	○	○







Your Submitted Responses for "Identifying Operations Research Systems Analysts' Technical Competencies: A Delphi Approach"
Started Date: 2/9/2012 10:21:38
Completed Date: 2/9/2012 10:35:21

Page 1

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{Enter text answer}
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Page 2

Communicating Analysis
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Agree
(*) Strongly Agree

Evaluating Analysis
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Agree
(*) Strongly Agree

Executing Analysis
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Agree
(*) Strongly Agree

Leading Analysis
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Agree
(*) Strongly Agree

Planning Analysis
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Agree
(*) Strongly Agree

APPENDIX I: ROUND TWO FOLLOW-UP MESSAGE

This is a reminder that your responses to the Round Two questionnaire for the research study entitled *Identifying Operations Research Systems Analysts' Technical Analytical Competencies: A Delphi Approach* are past due. If you are no longer able to participate, I completely understand. I thoroughly know how invaluable your time is; however, your input as a contemporary U.S. Army FA49 expert panel member would be immeasurable to this research study and I would appreciate your continued contribution.

Again, I thank you for your time. If you have questions or problems, please, do not hesitate to email or call me.

Very respectfully,

Wink
wwink001@odu.edu
717-552-1737

APPENDIX J: ROUND 1 CUMULATIVE RESPONSES - COMPETENCY

1. Budget analysis
2. Cost estimation
3. Model building
4. Ability to combine multiple types of analysis
5. Synthesize disparate systems, outcomes, views, objectives
6. Relate current tasks and objectives to the big picture and the long term goals
7. Build, operate, and analyze simulations
8. Understand the real problem, including the political aspects
9. Markova chain type if-then analysis to get at 3rd, 4th order and beyond effects or possible effects
10. Briefing skills
11. Analytical decision support - this includes the ability to communicate to decision makers and stakeholders
12. Program Analysis and Evaluation
13. Knowledge and Information Management
14. Business process reengineering
15. Research design and execution to include design of experiments
16. Economic Analysis
17. Modeling and simulation
18. Optimization
19. Army Officer
20. Advanced use of basic analytical software (Excel)
21. Basic use of advanced analytical software (e.g. Minitab, SPSS
22. Use Military Decision Making Process and Joint Operational Planning Process
23. Model processes using software (e.g. Simprocess, ARENA)
24. Be able to translate model methodology, assumptions, and outputs to a senior military decision maker
25. Conduct analytical studies on topics with little existing knowledge
26. Build, lead, and manage diverse teams
27. Master and apply basic probability and statistics to military problems
28. Develop a strong foundation in basic Army skills and operations
29. Be comfortable with complex, ill defined and structured problems
30. Problem Solving
31. Decision Analysis
32. Regression
33. Statistics
34. Modeling
35. Write a technical report
36. Make a logical/ persuasive argument
37. Communicate complex ideas in simple terms the common person can understand
38. Conduct numerical computations
39. Develop Decision Analysis tools
40. Define Aims and Objectives and ways to measure them to inform Strategic Decision Making

41. Conduct/ Lead Military Decision Making Process (Problem-Solving Process) Problems
42. Conduct Design of Experiments
43. Execute Statistical Methods in Research
44. Conduct Linear and mathematical programming
45. Optimizing techniques
46. Risk assessment
47. Must have the ability to build and analyze spread sheet models and program in VBA or its successor
48. Must have the ability to manipulate and analyze data in data bases (Access, SQL, or some successor application)
49. Must have the ability to conduct statistical analyses on data
50. Must have the ability to construct discrete event simulations using commercial software applications
51. Must have the ability to build and solve linear, mixed integer, or goal programs in a commercial mathematical software application such as GAMS or MATLAB
52. Must be able to apply decision analysis techniques.
53. Must be able to run large scale analytical models, such as a theater campaign model.
54. Must be able to organize and present study results in a succinct, coherent manner.
55. Information management
56. Database manipulation
57. Programming
58. Exploratory data analysis
59. Model development
60. Problem solving
61. Technical writing
62. Oral presentation
63. Statistical analysis (forecasting & prediction)
64. Design of experiments
65. Cost Benefit Analysis
66. Analysis of Alternatives
67. Resource Allocation
68. Multi Attribute Decision Analysis techniques
69. Value Based Modeling techniques.
70. Ability to develop metrics representative of assessable objectives
71. Ability to distil a complex problem to its root issues.
72. Ability to translate ORSA concepts to a variety of domains (budget, personnel, planning, etc.)
73. Ability to identify and involve stakeholders at all levels throughout the entire analytical process.
74. Integrate a team
75. Ability to clearly communicate ideas in technical and non-technical terms to various audiences.
76. Ability to communicate through the WRITTEN WORD
77. Ability to recognize when the value of making a decision is greater than the value of more supporting information

78. Understand major Army processes - Requirements, Budget, Acquisition, ARFORGEN
79. Broad analytic skill set - see 600-3, NPS curriculum
80. Understand the Joint Environment - COCOM alignment of priorities
81. Write concisely
82. Understand the appropriate use of Modeling and Simulation
83. Understand the appropriate use of mathematical models/tools
84. Lead and mentor others that may be civilian

APPENDIX K: STAGE 1 CODING CATEGORIES - COMPETENCY

Writing
Oral
Communicating
Lead
Techniques
Performing
Analysis
Evaluate
Planning
Knowledge
Process

APPENDIX L: STAGE 2 CODING CATEGORIES - COMPETENCY

Communicating Analysis	Leading Analysis	Executing Analysis	Evaluating Analysis	Planning Analysis
Writing Oral Communicating	Lead	Techniques Performing	Analysis Evaluate	Planning Knowledge Process

APPENDIX M: ROUND 1 CUMULATIVE RESPONSES - KNOWLEDGE

1. The different types of problems and how they have been solved in the past in order to determine how they might relate or offer new possibilities to current or future challenges
2. Understanding of what constitutes a wicked problem
3. Organization's vision, goals, and mission
4. PPBE
5. Army Doctrine
6. Joint doctrine
7. Flaws and weaknesses of each, in particular and understanding of where the seams are between the various doctrines
8. Knowledge of how to lead (this includes practicing leadership)
9. Understanding of current and future challenges and how we might apply ORSA skills to help overcome those issues
10. Joint and Army planning processes
11. How the Army Runs (PPBE, FM, JCIDS, etc.) (Processes)
12. How the Army, DoD, and partners are organized
13. Economics
14. Lean Six Sigma
15. Scientific Method
16. Current information, data, and numbers availability, reliability, and applicability
17. How DoD and the Federal Government run
18. Research and analytical framework
19. Knowledge of small unit tactics
20. Knowledge of joint, interagency, international, and multinational operations
21. Understanding of the global environment
22. Understanding of basic principles of economics and sociology
23. Knowledge of group dynamics and leadership
24. Knowledge of the wide range of analytical tools and techniques
25. Knowledge of decision-making processes
26. Knowledge of analytical commercial and govt software
27. Knowledge of assessment terms and methodologies
28. Programming
29. Requirements Formulation
30. How the Army Runs
31. Force Structure
32. Manpower
33. Equipping
34. Installations
35. Training & OPTEMPO
36. Military Decision Making Process/ Problem-Solving Process
37. Analysis of Alternatives in support of Acquisition Programs
38. Commander's Combat/ Deployment Assessments (How well is the commander achieving the mission?)
39. Commander's Strategic Assessment (How well is the Commander executing his Strategy?)

40. Cost-Benefit Analysis
41. Optimizing Systems
42. Design of Experiments
43. Decision Theory
44. Mathematics of Optimization
45. Pattern Recognition
46. Must know statistical analysis concepts.
47. Must know forecasting concepts.
48. Must know linear programming, mixed integer programming, and goal programming concepts.
49. Must know principles of data base management.
50. Must know principles of decision analysis.
51. Must know principles of modeling and simulation.
52. Must know how to organize and present data.
53. Must know how the operational Army fights, and how the institutional Army generates forces.
54. Statistics
55. Army organizations
56. Army operations
57. Joint operations
58. JTF operations and organizations
59. Theater operations
60. Interagency functions
61. Acquisition process
62. Requirements development process
63. Risk analysis
64. PPBE
65. Logistics
66. Human Resource Management
67. System Acquisition
68. Political Processes
69. Operational Art
70. Tactical Simulations
71. Model VV&A
72. Joint Processes
73. Information Management
74. Budgeting Process
75. Personnel system
76. Business Education (i.e. MBA)
77. G5/J5 Future Planning
78. Army Organization
79. Joint Operations
80. What LSS can be used for and what it should not
81. General Knowledge of Simulations
82. Statistics
83. Optimization

84. Network Theory
85. Modeling and Simulation
86. Combat Models
87. Stochastics
88. Decision Theory
89. Economics/Cost Analysis
90. Supply Chain Analysis
91. Manufacturing Methods/Techniques

APPENDIX N: STAGE 1 CODING CATEGORIES - KNOWLEDGE

Historical Application of OR
Role of ORSA
Economics
Army Processes
How the Army Runs
Organizations
Army Operations
Joint Processes
Acquisition Management
Joint Operations
Leadership
Planning Processes
Operational Environment
Interagency Operations
Multinational Operations
Methods/Tools
Resource Management
Mathematics

APPENDIX O: STAGE 2 CODING CATEGORIES - KNOWLEDGE

Stage 1 Categories	Reevaluation	Stage 2 Categories
Historical Application of OR		Historical Application of OR
Running	**Running**	Role of ORSA
Economics	How the Army Runs	Economics
Army Processes	How the DoD Runs	Army Processes
Role of ORSA	How the Federal Government runs	How the Army Runs
Army Operations		How the DoD Runs
Organizations	**Organizations**	How the Federal Gov't runs
Joint Processes	Army Organization	Army Organization
Acquisition Management	DoD Organization	DoD Organization
Joint Operations		Army Operations
Leadership		Joint Processes
Planning Processes		Acquisition Management
Operational Environment		Joint Operations
Interagency Operations		Leadership
Multinational Operations		Planning Processes
Methods/Tools		Operational Environment
Resource Management		Interagency Operations
Mathematics		Multinational Operations
		Methods/Tools
		Resource Management
		Mathematics

APPENDIX P: ROUND 1 CUMULATIVE RESPONSES - SKILL

1. Briefing
2. Critical Thinking
3. Writing
4. Managing the media
5. Leadership
6. Computer Modeling
7. Spreadsheet Modeling
8. Ad hoc or quick turn modeling
9. Create simple diagrams to explain complex concepts
10. Work independently or as a member or leader of a group
11. Communication ^ written, presentation, oral, etc
12. Teamwork
13. Research
14. Empathy
15. Integrity
16. Work Ethic
17. Intelligence
18. Conflict resolution and negotiations
19. Basic use of discrete event modeling software
20. Basic use of analytical software (Minitab, SPSS)
21. Spreadsheet modeling
22. Advanced spreadsheet calculations for use by others
23. Database use and query
24. Automate spreadsheets (VBA) for use by others
25. Use software for operational assessment
26. Multi-tasking
27. Learning Computer Software Packages
28. Prioritization
29. Technical Writing Skills
30. Argumentative Essay Writing Skills
31. Numeric Computation Skills (Spreadsheet, Data Base and Statistical Software skills)
32. Decision Analysis skills
33. Military Decision Making Process (Problem Solving Process) skills
34. Strategic Analysis Skills (The ability to measure how well one is achieving one's objectives)
35. Commander's Assessment Skills (The ability to measure a unit's performance
36. Critical Thinking Skills
37. Computer Programming Skills
38. Negotiation Skills (working towards a common interest or goal)
39. Must be able to do spread sheet modeling.
40. Must be able to manipulate and analyze databases.
41. Must be able to model and analyze linear, mixed integer, and goal programming problems using commercial software applications like GAMS or MATLAB.

42. Must be able to build discrete event simulations using commercial software applications like ARENA or Pro Model.
43. Must be able to apply decision analysis techniques.
44. Must be able to apply statistical analysis techniques using a commercial software package.
45. Must be able to apply forecasting techniques using spread sheet models.
46. Must be able to drive a large scale simulation, like a theater campaign model.
47. Must be able to build presentations using a commercial software application like power point.
48. Problem solving
49. Agent based modeling
50. Spreadsheet modeling
51. Risk analysis
52. Decision analysis
53. Communication skills
54. Optimization
55. Data Analysis
56. Statistics (Descriptive, Inferential, Testing)
57. Economics
58. Data Modeling
59. Test Design
60. Programming (e.g. Visual Basic, Java, etc.)
61. Modeling & Simulation
62. Office Automation
63. Technical Writing
64. Value Modeling
65. Attribute representation
66. Weighting/prioritization techniques
67. Risk analysis
68. Optimization
69. Statistics
70. Written communication
71. Oral communication
72. Cost benefit analysis
73. Simulation interpretation
74. Pivot Tables
75. Data Encapsulation
76. COP Development
77. Spreadsheet Modeling
78. Appropriate Statistical analysis

APPENDIX Q: STAGE 1 CODING CATEGORIES - SKILL

Leadership
Modeling
Forecasting
Design of Experiments
Negotiation
Conduct Research
Cost Benefit Analysis
Military Planning Processes
Problem Solving
Metric Development
Optimization
Prioritization
Data Analysis
Database Programming
Simulation
Common Software Packages
Mathematics
Decision Analysis
Risk Analysis
Effective Communication
Computer Programming
Trend Analysis
Survey Development
Survey Analysis
Qualitative Analysis
Quantitative Analysis
Process Improvement Analysis
Active Listening

APPENDIX R: STAGE 2 CODING CATEGORIES - SKILL

Stage 1 Categories	Reevaluation
Leadership	
Modeling	**Modeling**
Forecasting	Modeling
Design of Experiments	Spreadsheet Modeling
Negotiation	Computer Modeling
Conduct Research	Ad hoc Modeling
Cost Benefit Analysis	Value Modeling
Military Planning Process	Agent Based Modeling
Problem Solving	Linear Algebra
Metric Development	Math Programming
Optimization	Goal Programming
Prioritization	Data Modeling
Survey Development	Combat Modeling
Database Programming	
Simulation	**Simulation**
Common Software Packages	Simulation
Risk Analysis	Discrete Event Simulation
Decision Analysis	
Mathematics	**Mathematics**
Effective Communication	Mathematics
Computer Programming	Statistical Analysis with and/or without software
Trend Analysis	
Data Analysis	**Data Analysis**
Survey Analysis	Analysis & Interpretation
Qualitative Analysis	Analyzing Data with and/or without software
Quantitative Analysis	
Process Improvement Analysis	
Active Listening	

Stage 2 Categories
Leadership
Modeling
Spreadsheet Modeling
Computer Modeling
Ad hoc Modeling
Value Modeling
Agent Based Modeling
Linear Algebra
Math Programming
Goal Programming
Data Modeling
Combat Modeling
Forecasting
Design of Experiments
Negotiation
Conduct Research
Cost Benefit Analysis
Military Planning Process
Problem Solving
Metric Development
Optimization
Prioritization
Data Analysis & Interpretation
Analyzing Data with and/or without software
Database Programming
Simulation
Discrete Event Simulation
Common Software Packages
Mathematics
Statistical Analysis with and/or without software
Decision Analysis
Risk Analysis
Effective Communication
Computer Programming
Trend Analysis
Survey Development
Survey Analysis
Qualitative Analysis
Quantitative Analysis
Process Improvement Analysis
Active Listening

APPENDIX S: ROUND 1 CUMULATIVE RESPONSES – ABILITY

1. Leadership
2. Risk Analysis
3. Cost Benefit Analysis
4. Ability to discern variables, constraints, and fixed values wrt time
5. Qualitative assessments
6. Quantitative assessments
7. Conducting and analyzing surveys
8. Decision analysis
9. Evaluating quality of input data and relating that to spectrum and likelihood of possible outcomes
10. Listening
11. The ability to understand the real issue, not merely the question that is being asked - the ability to define the problem
12. The ability to translate technical analysis into terse but lucid decision support for the range of folks that constitute senior leaders - different intelligence, experience, analytical, and social backgrounds, and the understanding that the translation is not the same for all of these folks. How is the analysis relevant to them and what does it help them do?
13. Push back. A fundamental understanding that when working on a problem intellectual interchange is critical to producing the best product. Good ideas matter more than rank or experience although the latter can often help with the former.
14. Role of analysis. The analyst's role is to support decision making by the senior leader. This means neither simply providing support for a predetermined decision, nor does it mean that a senior leader should be backed into a corner. Analysis should clearly articulate the trade space available to the decision maker and the costs and benefits of the range of options within that trade space.
15. A fundamental understanding of the role, value, and potential issues surrounding assumptions. Too often analysts ignore the implicit assumptions, do not understand that the assumptions chosen actually drove the result, do not do a robustness check on assumptions that are potentially not going to hold, or do not check at the end of the analysis to verify that the assumptions have not been violated (most common one I see here are the basic assumptions underlying ordinary least squares regressions).
16. Understanding that numbers are not data. Too often numbers are taken as data or facts when they may be estimates, guesses, or something worse. How good the data is, often drives how much confidence we should have in the conclusions of the analysis.
17. Conduct Military Decision Making Process
18. Conduct process improvement analysis (e.g. Lean Six Sigma)
19. Conduct cost benefit analysis
20. Conduct joint operational planning process
21. Use operational design
22. Form, manage and lead diverse teams
23. Conduct trend analysis
24. Understand cause and effect relationships
25. Understand correlation of factors, not causation
26. Translate technical language into language for a military decision maker

27. Understand and lead staffs through the assessment process
28. Leadership
29. Analytical Thinking
30. Cost Benefit Analysis
31. Communicate in simple terms that a common person can understand
32. Motivate individuals to work as a team
33. Develop relationships
34. Share information
35. Solve complex problems using the Military Decision Making Process (or Problem Solving Process)
36. Negotiate with others
37. Cooperate with others
38. Lead and inspire a team to accomplish a common goal or mission
39. Write a persuasive argument
40. Speak plainly and concisely
41. Ability to think analytically/critically.
42. Ability to frame an actual problem statement.
43. Ability to communicate with clients, particularly to elicit critical information related to the problem being analyzed.
44. Ability to work as part of a larger study group or team.
45. Ability to apply OR techniques to military problems or situations.
46. Communication
47. Leadership
48. Flexibility
49. Mental toughness
50. Endurance
51. Critical thinking
52. Systems analysis
53. Cost-Benefit Analysis
54. Visualization
55. Story telling
56. Integration/Synthesis
57. Discerning Complexity and Complicated
58. Stakeholder Analysis
59. Design
60. Interpretation
61. Patience
62. Attention to detail
63. Creative thinking
64. Critical thinking
65. Ability to break down a problem into like parts
66. To logically represent qualitative answers in a quantitative format
67. Logical analysis
68. Diverse method/tool usage
69. Reference Selection
70. Problem solving method - it should be similar from problem to problem

71. Incorporation of other perspectives - Intell/Strat Planners
72. Integration of other inputs - Interagency, DHS, etc.
73. Survey Design and Implementation

APPENDIX T: STAGE 1 CODING CATEGORIES – ABILITY

Leadership
Managing a Study
Teamwork
Motivate/Inspire
Visualization
Analytical Thinking
Critical Thinking
Creative Thinking
Application of OR Techniques
Communicate
Comprehension
Problem Sensitivity
Value Focused Thinking
Information Ordering
Evaluating a Study
Integrating Information and Data
Synthesizing Information and Data
Problem Solving
Making Projections Based on Data

APPENDIX U: STAGE 2 CODING CATEGORIES – ABILITY

Stage 1 Categories	Stage 2 Categories
Leadership	Leadership
Managing a Study	Managing a Study
Teamwork	Teamwork
Motivate/Inspire	Motivate/Inspire
Visualization	Visualization
Analytical Thinking	Inductive Reasoning
Critical Thinking	Deductive Reasoning
Creative Thinking	Application of OR Techniques
Application of OR Techniques	Communicate
Communicate	Comprehension
Comprehension	Problem Sensitivity
Problem Sensitivity	Value Focused Thinking
Value Focused Thinking	Information Ordering
Information Ordering	Evaluating a Study
Evaluating a Study	Integrating Information and Data
Integrating Information and Data	Synthesizing Information and Data
Synthesizing Information and Data	Problem Solving
Problem Solving	Making Projections Based on Data
Making Projections Based on Data	

Stage 2 Categories	Stage 2 Categories Revised
Leadership	Leadership
Managing a Study	Managing a Study
Teamwork	Teamwork
Motivate/Inspire	Motivate/Inspire
Visualization	Visualization
Inductive Reasoning	Mathematical Reasoning
Deductive Reasoning	Application of OR Techniques
Application of OR Techniques	Communicate
Communicate	Comprehension
Comprehension	Problem Sensitivity
Problem Sensitivity	Value Focused Thinking
Value Focused Thinking	Information Ordering
Information Ordering	Evaluating a Study
Evaluating a Study	Integrating Information and Data
Integrating Information and Data	Synthesizing Information and Data
Synthesizing Information and Data	Problem Solving
Problem Solving	Making Projections Based on Data
Making Projections Based on Data	

Stage 2 Categories Final
Leadership
Managing a Study
Teamwork
Motivate/Inspire
Visualization
Mathematical Reasoning
Inductive Reasoning
Deductive Reasoning
Analytical Thinking
Critical Thinking
Creative Thinking
Application of OR Techniques
Communicate
Comprehension
Problem Sensitivity
Value Focused Thinking
Information Ordering
Evaluating a Study
Integrating Information and Data
Synthesizing Information and Data
Problem Solving
Making Projections Based on Data

VITA

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B.S. Chemistry, United States Military Academy, West Point, NY, May 1989

U.S. Army FA49 Professional Experience:

Chief, Operations Analysis Branch, United States Forces Korea, Combined and Joint Future Operations Plans, Republic of Korea, July 2006 – July 2008

Chief, Ground and Logistics Analysis, United States Forces Korea, Combined and Joint Future Operations Plans, Republic of Korea, July 2005 – July 2006

Inspector General, 1st Cavalry Division, Fort Hood, TX and Operation IRAQI FREEDOM, Baghdad, Iraq, March 2004 – July 2005

Deputy Inspector General, 1st Cavalry Division, Fort Hood, TX, August 2002 – March 2004

Operations Analyst, Director of Combat Developments, Headquarters Training and Doctrine Command, Fort Monroe, VA, April 1999 – October 2000

Professional Memberships:

American Legion – Life Member
Army Aviation Association of America – Life Member
Association of the United States Army – Life Member
Engineering Management Honor Society – Epsilon Mu Eta
Golden Key International Honor Society
Institute for Operations Research and the Management Sciences
Military Officers Association of America – Life Member
Military Operations Research Society
Phi Kappa Phi Honor Society – Life Member