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Investigating the Perceived Influence of Data Warehousing and Business Intelligence Maturity on Organizational Performance: A Mixed Methods Study

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Investigating the Perceived Influence of Data Warehousing and Business
Intelligence Maturity on Organizational Performance:
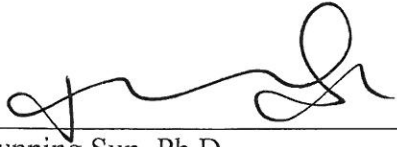A Mixed Methods Study

by

Charles Frederick Perkins

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctorate of Philosophy
in
Information Systems

College of Engineering and Computing
Nova Southeastern University

2017

We hereby certify that this dissertation, submitted by Charles Perkins, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.
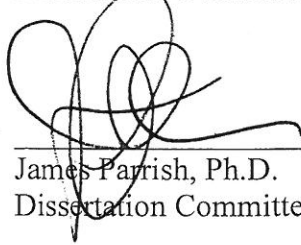
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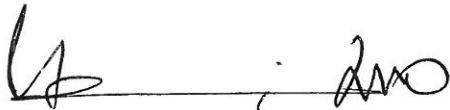_____   11/20/2017
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2017

An Abstract of a Dissertation Submitted to Nova Southeastern University
in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

Investigating the Perceived Influence of Data Warehousing and Business Intelligence Maturity on Organizational Performance: A Mixed Methods Study

by
Charles Frederick Perkins
November 2017

Over the past two decades organizations have made considerable investment in implementing data warehousing and business intelligence to improve business performance through facts-based decision-making. Although many of these organizations reap the rewards of their investments, others find that realizing the full value proposition is elusive. While the literature is rich with studies regarding data warehousing and business intelligence, much of the existing research focused on the initial experiences of adoption and implementation, and few yielded empirical data that reflected post-implementation conditions that lead to mature capabilities and improved business performance.

Sited at the Defense Intelligence Agency where data warehousing and business intelligence capabilities have been in place for 10 years, this study investigated the perceived influences of data warehousing and business intelligence maturity on organizational performance through the perceptions of end users and senior leaders. This study employed mixed methods to examine the linkages between organizational support, information technology capabilities, practices, use, and organizational performance. Using survey responses from end users ($N = 29$ respondents), the researcher employed linear regressions, and mediation analyses to test hypotheses and assess correlations among maturity variables and their effect on organizational performance. Conversely, the qualitative phase included semi-structured interviews with six senior leaders to understand their perceptions of existing data warehousing and business intelligence capabilities. The quantitative results and qualitative findings indicated significant correlations between the perceptions of organizational support, information technology capabilities, and use in predicting organizational performance.

The discoveries resulting from this research represent an original contribution to the body of knowledge by providing empirical data to aid in advancing the scholarship and practice of the data warehousing and business intelligence maturity phenomenon.

Acknowledgements

I extend my sincerest appreciation and gratitude to my advisor, Dr. Junping Sun, and dissertation committee, Drs. James Parrish and Ling Wang, for their outstanding support throughout this dissertation process. Dr. Sun's comments, recommendations, and mentorship demonstrated the importance of an engaged and responsive dissertation advisor to student success. The insight and considerations offered by Drs. Parrish and Wang were invaluable toward improving my dissertation.

I am extremely grateful to the study participants at the Defense Intelligence Agency, the staff of the National Intelligence University, and my academic advisor, Ms. Kerry-Anne Billings, who through their collective contributions made completing my dissertation possible. I am especially thankful to Mr. James Manzelmann and Ms. Suzanne White for their support and approval for data collection. I hope this research provides insights that help in advancing DIA's enterprise data warehousing/business intelligence efforts and contributes to the future direction of the organization.

The path to achieving a PhD is an endeavor not to be taken lightly. The journey is long, daunting, and demands extraordinary personal commitment. These attributes increase exponentially for the adult student endeavoring to reach this pinnacle of academic achievement while balancing full-time employment and a family of five. Throughout this dissertation process my wife, Kimberly, and our children, Kari, CJ, and Olivia, have sacrificed a considerable amount of time away from me as a husband and father— yielding regularly to my academic aspirations. I am extremely humbled by their love, understanding, and support.

Finally, I believe there is no greater satisfaction than realizing a goal that has sustained for a lifetime. It is with great pride that I dedicate this dissertation to my grandparents, James and Sarah Washington, who served as extraordinary role models, demonstrated unconditional love, and provided unwavering support and encouragement for as long as I can remember. I miss them both.

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Chapter 1

Introduction

The nature of the contemporary business environment has changed considerably. As private and public-sector organizations amass high volumes of data, executives and managers are recognizing the importance of having the right information available at the right time to enable faster, fact-based decision-making (Davenport, 2010). Moreover, as a consequence of economic downturn and fiscal constraints, U.S. public-sector organizations are relying more on fact-based decision-making to aid in examining business operations and organizational budgets (Vesset & McDonough, 2009). The realities of this modern-day business environment, coupled with increased regulatory and governance requirements, elevate the importance of establishing and maintaining a corporate information technology (IT) infrastructure that facilitates enterprise data integration and provides analytical capabilities that aid organizations in being more agile when making strategic, operational, and tactical-level decisions (Davenport, 2006; Turban, Sharda, Delen, & King, 2011; Vesset & McDonough, 2009).

The data warehouse (DW) has emerged as a significant information systems development that enhances data access, distribution, and information sharing envisioned to enable facts-based decision support in answering complex business questions at all organizational levels (Popovic & Jaklic, 2010; Ramamurthy, Sen, & Sinha, 2008b; Watson, Goodhue, & Wixom, 2002). Since its conceptualization nearly 25 years ago, the DW has fashioned a rich heritage. In practice, its strategic value is undeniable as the core

IT that enables business intelligence (BI) within organizations (Sen, Ramamurthy, & Sinha, 2012; Watson & Wixom, 2007b; Wixom & Watson, 2010). Premised on the analysis of revenue, costs, and business performance, many organizations are using DW and BI cooperatively as a strategic enabling capability that integrates and stages enterprise transactional data to support fact-based decision-making (Williams, 2004).

Although many organizations are experiencing real benefits from their DW/BI investments, some find that realizing the business value of DW/BI is elusive (Hawking & Sellitto, 2010; Gonzales, Bagchi, Udo, & Kirs, 2011; Watson et al., 2002). Research indicates the difference between these two scenarios resides in the extent that organizations place emphasis on continuously improving the DW/BI environment (Elbashir, Collier, & Davern, 2008; Elbashir, Collier, Sutton, Davern, & Leech, 2013; Yeoh & Koronios, 2010). This concept of continuous improvement is referred to as DW/BI maturity, in which DW/BI technologies and associated processes have evolved wholly and assimilated fully into the organization to the point of becoming metaphorically woven into the cultural fiber and viewed as integral to business operations (Lahrmann, Marx, Winter, & Wortmann, 2011; Raber, Wortmann, & Winter, 2013; Wixom, Watson, Reynolds, & Hoffer, 2008). DW/BI maturity is premised on the notion that DW/BI capabilities must evolve as organizational business needs evolve (March & Hevner, 2007; Popovic, Hackney, Coelho, & Jaklic, 2012; Wixom et al., 2008; Yeoh & Koronios, 2010).

Researchers have published volumes of literature on DW and BI from different perspectives; however, much of the research is characterized as descriptive or normative and limited to the initial experiences of DW/BI adoption and implementation (Wieder,

Ossimitz, & Chamoni, 2012). In response, several researchers have introduced maturity

models to examine the current state of an organization's DW/BI initiative. However, the

concept that underpins maturity models often provides inconsistent representations of the

problem domain. Some models focus on DW/BI solely as a technology initiative with

emphasis on applications, data, and infrastructure and limited emphasis on the

organization and the organization's strategy (Lahrmann et al., 2011). Few studies have

yielded empirical data that reflect post-implementation maturity requirements for DW/BI

initiatives or emphasized the facilitating conditions that lead to mature DW/BI

capabilities (Raber, Winter, & Wortmann, 2012; Wixom et al., 2008). This shortage of

empirical data is exacerbated when endeavoring to comprehend or explicate the linkage

between the organization, technology, usage, and performance (Eybers, Kroeze, &

Strydom, 2013; Lahrmann et al., 2011; Raber et al., 2012; Raber et al., 2013).

Understanding this linkage within a public-sector organizational setting formed the basis

of this research. The purpose of this study was to develop and conduct a comprehensive

examination of the linkage between organization, DW/BI technology, DW/BI usage, and

organizational performance from the perspectives of constituents representing the IT and

business segments of the Defense Intelligence Agency (DIA), a combat support agency

of the U.S. Department of Defense (Defense Intelligence Agency [DIA], n.d.).

  The remainder of this introductory chapter includes a discussion of the research

problem, goals of the study, research questions and hypotheses, followed by a description

of the relevance and significance of the study. This chapter also presents barriers, issues,

limitations, and delimitations to the study. Moreover, this chapter provides relevant

definitions to clarify terms used throughout the study. A summary concludes the chapter.

Problem Statement

The problem addressed in the study was the influence of DW/BI maturity on organizational performance at the DIA. The foundation of DW/BI capabilities at the DIA is the organization's enterprise data warehouse (EDW). The DIA has operated its EDW for more than 10 years. In 2011, the EDW was approved by the agency's director as a critical capability that supports the organization's senior business executives and managers with dashboards and operational performance reporting (Flynn, 2014). However, since implementing the EDW in September 2007, the agency has made nominal progress in using the EDW to assimilate data from across business segments to support data-driven or facts-based resource management decisions that optimize performance relevance as described in the organization's strategic plan (DIA, 2012). Despite its potential to yield timely, relevant, and accurate information to improve executive and managerial decision-making processes, the EDW project has struggled to sustain organizational funding and support. The literature suggests without full assimilation, an organization, such as DIA, is less likely to experience the benefits of DW/BI (Ramamurthy et al., 2008b; Watson, 2002).

Researchers estimate that between 70% and 75% of organizations with systems referred to as EDWs have failed to expand the DW as an enterprise capability and have neglected to focus on the enterprise in its entirety (Edjlali, Fienberg, Beyer, & Adrian, 2012; Ranjan, 2008). Consequently, the perceptions that emerge as a result of these implementations are assumed project failure or heightened executive-level concerns regarding the business value of the project. These perceptions cast a dark shadow that risks further investment in the maturation of DW/BI capabilities (Edjlali et al., 2012;

Elbashir et al., 2013; Gonzales et al., 2011; Hawking & Sellitto, 2010; Presthus, Ghinea, & Utvik, 2012). However, there is consensus in the literature that a mature DW/BI environment provides the best opportunity for organizations to realize business value (Popovic, Coelho, & Jaklic, 2009; Williams & Williams, 2007). Because many DW/BI initiatives tend to stagnate in the early stages of the project, researchers emphasize the importance for organizations to take deliberate measures toward achieving mature DW/BI capabilities if they are to experience the full benefits of their DW/BI investments (Ong, Siew, & Wong, 2011; Popovic et al., 2009; Williams, 2004). Most medium-to-large organizations that have leveraged DW/BI for more than five years have experienced favorable results and demonstrate commitment to the project by continuing to invest in improvement initiatives to increase capabilities to a level of maturity that fully integrate and align with enterprise business operations (Mannino & Walter, 2006).

Dissertation Goal

The goal of this study was to integrate and extend previous research on DW/BI maturity by examining the linkage between organization, technology, usage, and organizational performance in the context of DW/BI maturity. In conducting this study, the researcher explored key factors derived from DW/BI success and maturity literature perceived as influential in improving DW/BI towards enhanced performance outcomes. The results of this dissertation research will aid in deepening the discussion on DW/BI maturity and provide additional insights to academic and nonacademic communities.

Research Questions

The research questions for this study were fundamental to investigating the perceptions related to DW/BI maturity and organizational performance. This study evolved based on the central research question, "What are the influences of DW/BI maturity on organizational performance as perceived by constituents directly involved in DW/BI at the DIA?"

To address the central research question, the researcher formulated nine supporting research questions and associated hypotheses to guide this study. The researcher formulated Supporting Research Questions 1 through 5 to examine the perceived influences of DW/BI maturity on organizational performance using the constructs of organizational support, information technology (IT) capabilities, practices, and use. The researcher formulated Supporting Research Questions 6 through 9 to examine the mediating relationships among the constructs. The following are the supporting research questions, hereafter referred to as Research Questions (RQ) 1 through 9, and the hypotheses for this study.

> **RQ1.** What is the perceived influence of organizational support on DW/BI information technology?
>
> *H1.* High levels of organizational support will have a positive influence on DW/BI information technology
>
> **RQ2.** To what extent does organizational support influence DW/BI practices?
>
> *H2.* High levels of organizational support will have a positive influence on DW/BI practices.

RQ3. How does DW/BI information technology motivate constituents to use DW/BI in organizational decision-making?

H3. High levels of DW/BI information technology will have a positive influence on DW/BI use.

RQ4. To what extent do DW/BI practices inspire or influence pervasive DW/BI use across the organization?

H4. High levels of DW/BI practices will have a positive influence on DW/BI use.

RQ5. To what extent does DW/BI use influence organizational performance?

H5. High levels of DW/BI use will have a positive influence on organizational performance.

RQ6. What is the influence of perceived DW/BI information technology in mediating the relationship between organizational support and DW/BI use?

H6. Perceptions of information technology capabilities mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.

RQ7. What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?

H7. Perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.

RQ8. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI information technology and organizational performance?

H8. Perceptions of DW/BI use mediate the relationship between perceptions of information technology capabilities and perceptions of organizational performance.

RQ9. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?

H9. Perceptions of organizational use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance.

Relevance and Significance

The focus on DW/BI maturity is highly relevant in the 21st century. The Internet and innovative technology advancements have introduced new sources and types of data. End users are technologically savvy and demand high levels of access, fast data refresh rates, and superior data quality (Sen et al., 2012). Increasingly, organizational constituents are calling for near real-time data to enable decision-making at the strategic, operational, and tactical levels (Dayal, Castellanos, Simitsis, & Wilkinson, 2009).

Relevance of Research

The DW is a significant phenomenon in practice that has sustained a prominent position in information systems literature for more than two decades (Devlin & Murphy, 1988; Wixom & Watson, 2001). Within the literature, the DW has garnered accolades for its enterprise integration prowess and business value, while being dichotomously at

the core of criticism for its extraordinary costs and high failure rates (March & Hevner,

2007). Despite the criticism, DW sales experienced a 12% growth in 2008, with

projections to increase annually by 7.4% (Schuff, Corral, & Turetken, 2011). Chaudhuri,

Dayal, and Narasayya (2011) suggested decreasing costs of data acquisition and storage

fuel this growth in product sales and services. Moreover, chief information officers have

elevated DW/BI investment as one of their top spending priorities (Sen et al., 2012;

Wieder et al., 2012). This significant growth through sustained investment and

implementation challenges suggests that DW/BI will continue to thrive as a major

component of organizations DW/BI strategies (Goeke & Faley, 2007).

Even though DW/BI is not a new concept, it is an innovation that can have

profound organizational influences. These influences can manifest in a variety of ways,

such as shifts in data ownership, alterations in access and usage patterns, modifications to

business processes, and changes to how jobs are performed (Ramamurthy, Sen, & Sinha,

2008a). Although DW/BI offers remarkable promise, organizations do not miraculously

realize the major strategic benefits solely by installing the system (Ramamurthy et al.,

2008a; Wixom & Watson, 2001). Researchers and practitioners agree that a DW/BI

initiative is an evolutionary journey, not a destination. DW/BI capabilities need to evolve

along the same evolutionary trajectories as the businesses these initiatives are intended to

support (March & Hevner, 2007; Watson et al., 2002; Wixom et al., 2008).

Significance of Research

This study is significant to the information systems domain because of the

increased focus on DW/BI maturity and the influence of DW/BI on organizational

performance. Although studies about DW and BI separately and collectively are

abundant and have been ongoing for more than 25 years, the topic is increasingly important in an era where DW/BI is viewed as a mission-critical enabling capability (Sen et al., 2012). Organizations are aggressively moving toward data integration and interoperability in an ambitious effort to align IT and business processes to improve business performance. Commonly, these organizations host disparate information systems and proprietary data sources scattered across enterprises with limited ability to cooperate in an integrated environment. Patrick (2005) described these disparate resources metaphorically as "silos" of vertical architectures.

Niranjan, Anand, and Kunti (2005) posited that although silos have provided an effective means for day-to-day operations, the systems and the data contained within them have perpetuated an epidemic that contributes to poor visibility across enterprises. Consequently, organizations recognize that any attempt to remedy this epidemic using legacy technology and proprietary data sources place heavy burdens on participating users and applications. Such burdens include (a) understanding where data reside; (b) understanding how to access the data; (c) understanding the relational aspects of the data; and (d) transforming the data into a unified view (Bennett & Bayrak, 2011; Patrick, 2005). Thus, researchers have contributed to the information systems literature regarding the strengths of using DW/BI to integrate data from across the enterprise and providing analytic capabilities to support executive and managerial decision-making at the strategic, operational, and tactical organizational levels (Bennett & Bayrak, 2011; Elbashir et al., 2008; Popovic et al., 2009; Ramamurthy et al., 2008a).

Motivations for Research

Academic research on DW/BI maturity is sparse. The current literature addresses DW/BI maturity primarily through the introduction of maturity models (Mukherjee & D'Souza, 2003; Sen et al., 2012; Watson et al., 2002). Few empirical studies have investigated DW/BI maturity in organizational settings and scholarly research that reflects the actual application of DW/BI maturity models remains inconclusive (Wixom & Watson, 2001).

Moreover, much of the literature on DW/BI and its contributions to increased business value and organization performance is presented within the context of benefits that aid organizations in achieving competitive advantage and increased revenue or profit (Williams & Williams, 2007). However, these attributes do not apply in public-sector organizations, such as the U.S. federal government. Therefore, research that highlights the influence of DW/BI maturity on organizational performance within an organization of the federal government makes a significant contribution to the DW/BI literature, particularly in an environment where fiscal prudence and stewardship of taxpayer contributions are fundamental measures of performance.

Last, this research was motivated by a gap in the information systems research domain regarding the linkage between organizational support and practices related to DW/BI, enabling technologies, usage, and the effect on organizational performance (Lahrmann et al., 2011). In this study, the researcher explored these linkages within the context of DW/BI maturity.

Barriers and Issues

Conducting this study at the DIA required several approvals to proceed through the dissertation process. The study required approvals from the Nova Southeastern University (NSU) Institutional Review Board (IRB) and the National Intelligence University (NIU) IRB on behalf of DIA prior to working with human subjects. Data collection required approval from DIA's deputy director for mission services and the chief financial officer (CFO), and the final dissertation report required prepublication review and approval by the DIA Office of Corporate Communications, which stipulated approval for public release does not represent DIA's endorsement. The results, findings, and conclusions that emanate from this study are based on survey responses and interviews and do not reflect the official policy or position of the Defense Intelligence Agency, the Department of Defense, or the United States Government.

A barrier in conducting this study was the inability to use personal audio equipment to record interviews during the qualitative data collection process. The DIA is member of the U.S. intelligence community, and as such, its sites are highly secure and generally, personal electronic devices, audio, and video recording equipment are not authorized in facilities. Consequently, the IRB approval letter for the NIU stipulated that personal audio and video recording equipment could not be used in this study.

Assumptions, Limitations, and Delimitations

This researcher employed mixed methods design to address the research problem and research questions. Data collection included conducting semi-structured interviews, administering a survey instrument, and reviewing organizational documents. This study did not require access to data stored in the EDW.

Although qualitative and quantitative research methods have inherent strengths, qualitative research is often criticized for its subjectivity. Maxwell (2005) contended two threats to the validity of qualitative research are researcher bias and participant reactivity. Researcher bias is synonymous with researcher subjectivity, and participant reactivity describes participants' reactions to the researcher as an interviewer. A limitation considered in conducting this study was the potential for the researcher's own subjectivity and bias as an employee of the DIA.

Another limitation was the reaction of participants to the researcher as the interviewer. Because some of the participants knew or were familiar with the researcher, a potential existed that such relationship could influence responses. This influence may have manifested as participants' desire to provide responses they perceive as useful to the researcher, or as the reluctance to provide candid responses to interview questions. The intent of the researcher was not to eliminate these threats to qualitative research validity, but rather to recognize the existence of these threats within the context of this study and to mitigate or minimize the threats through self-awareness and scholarly objectivity throughout the interview process.

The researcher conducted this study within a single organizational setting at DIA headquarters in Washington, DC. The DIA is a large organization with several departments and mission areas, but not all mission areas are subject to using the organization's DW/BI capabilities. This study's design bounded the research to the people, processes, and technologies that make up DIA's back office business environment. This environment is comprised of contracting, facilities, finance, human resources, information systems, logistics, and training (DIA, n.d.).

Definition of Terms

Back office: A collective term that refers to organizational departments, operations, and enabling systems that focus exclusively on sustaining the infrastructure of the business. Back office departments usually include accounting, human resources, and IT (Tatum & Harris, 2014).

Business intelligence (BI): An encompassing term that describes the information technologies, applications, and processes used for gathering, storing, accessing, and analyzing data to support decision-making (Wixom & Watson, 2010).

Business Intelligence Competency Center (BICC): A dedicated organizational structure chartered to facilitate DW/BI stewardship, service delivery, program management, and user engagement relationships (Turban et al., 2011; Viaene, 2008).

Data integration: The process of combining data that reside at different sources to provide a unified or consolidated view of these data (Bennett & Bayrak, 2011).

Data Warehouse (DW): A specialized database that serves as a central data repository that supports the collection of data from operational databases and other data sources within an organization. The general premise of the DW is to enable business reporting and analysis to support executive and managerial decision-making through the acquisition, integration, transformation, and interpretation of organizational data (March & Hevner, 2007; Watson, 2002).

DW/BI assimilation: The extent that an organization uses data warehousing or BI to support its business strategies and value chain related activities (Elbashir et al., 2013).

DW/BI capabilities: The critical processes, technologies, and practices that synergize to enable agile decision-making and improve business performance (Isik, Jones, & Sidorova, 2013; Watson & Wixom, 2007b).

DW/BI environment: A business setting that features the coalescence of data warehousing, BI, and analytic capabilities in concert with resources and support activities that provide knowledge workers access to reliable, high quality, and relevant business information that enables timely and effective decision-making (English, 2005; Popovic, Turk, & Jaklic, 2010; Williams & Williams, 2007).

Enterprise Data Warehouse (EDW): The EDW is similar to the data warehouse but is broader in scope. The EDW is a specialized highly scalable database that serves as a central data repository that supports the conglomeration of data staging and presentation activities for the entire enterprise (Kimball & Ross, 2002). In the context of DW/BI maturity, organizations aspire to achieve a fully operational EDW through the evolution of DW/BI capabilities (Ariyachandra & Watson, 2010). In this study, EDW is the project name of the target organization's DW/BI initiative; therefore, the terms EDW and DW/BI are synonymous.

Enterprise resource planning (ERP): A configurable online transaction processing system that integrates information and information-based processes that span some or all the business functions of the entire enterprise. Enterprise resource planning systems employ a relational database management system to integrate enterprise data and is capable of real or near real-time reporting (Kimball & Ross, 2002).

Evolution: Evolution is "a process of change in a certain direction" or "the process of working out or development" (Evolution, n.d.) DW/BI development is an ongoing task in which new requirements are constantly being added (Maté & Trujillo, 2014). Through this study, the researcher employed the term evolution to describe the progression from an initial state to a target state of DW/BI maturity.

Extract, transform, and load (ETL): Refers to a set of processes responsible for extracting data from an operational data source; cleansing, integrating, and transforming the data into the appropriate format; and then loading the data into the data warehouse (Dayal et al., 2009; Kimball & Ross, 2002).

Maturity: A state of being fully developed or having attained a final or desired state of quality based on deliberate considerations and methodologies (Maturity, n.d.). In this study, maturity was operationalized as a measure of the extent that organizational and technological DW/BI capabilities and processes have been defined, managed, measured, and enriched through continuous improvement and are assimilated fully into the organization.

Organizational performance: The extent to which DW/BI has promoted improvement in the efficiency and effectiveness of individual and organizational processes through increased time savings, assimilation, and use (Elbashir et al., 2008; Gable, Sedera, & Chan, 2008; Popovic et al., 2009).

Summary

Considerable research exists pertaining to the investigation of DW/BI from different perspectives. However, a review of the literature suggests few researchers have investigated DW/BI maturity and its influence on organizational performance within a public-sector organization. Although the use of DW/BI within organizations has been in existence for more than two decades, challenges with implementation and evolution make it difficult for organizations to realize the value proposition, which is to improve decision support for organizational leaders and managers.

The remainder of this dissertation consists of Chapters 2 through 5 that collectively provide support, analysis, and findings related to this study. Specifically, Chapter 2 provides a review of extant literature that establishes and supports the motivation and necessity for studying the organizational and technological linkages relevant to DW/BI maturity and organizational performance. Chapter 3 discusses the research methodology and outlines the strategies used for data collection and analysis. Chapter 4 presents the research findings and results based on the analysis of qualitative and quantitative investigation. Finally, in Chapter 5, the researcher interprets study results and findings and presents conclusions and recommendation for future research.

Chapter 2

Review of the Literature

Introduction

In both research and practice, data warehousing and business intelligence (BI) are important areas of study within the management information systems domain (Hawking & Sellitto, 2010; Hwang & Xu, 2007). Since the early 1990s, the data warehouse (DW) has emerged as the foundation of advanced decision support tools and generally is the core information technology (IT) in an organization's BI strategy (Schuff et al., 2011). As a consequence of this highly regarded relationship, considerable literature about the DW exists in the BI domain, whereby researchers describe the DW as a key component of the BI information supply chain (Dayal et al., 2009; Inmon, Strauss, & Neushloss, 2008; Kimball, Ross, Thornthwaite, Mundy, & Becker, 2008; Lahrmann et al., 2011).

This chapter includes an examination of existing literature through an interdisciplinary lens of DW and BI to understand the current research on DW/BI, maturity, and organizational performance. This review begins with a discussion of the foundations of DW/BI, DW/BI maturity and the efficacy of maturity models, and elements of DW/BI success and maturity. This chapter concludes with a discussion of the research model used in this study and a summary of this segment of the dissertation report.

Foundations of Data Warehousing and Business Intelligence

Researchers have used the terms DW and BI interchangeably in some literature and together in others (Gonzales et al., 2011; Khan, 2012). Although distinct differences exist between the two concepts, the relationship has evolved to where the DW is central to enabling BI and analytics that aid organizations in achieving increased decision performance (Raber et al., 2013). To contextualize this study efficiently, it is essential to differentiate between the DW and BI concepts and highlight the relationship that exists.

Data Warehousing

Devlin and Murphy (1988) articulated the concept of data warehousing as an architecture designed to coalesce data originating from disparate transactional business systems into an integrated repository to enable corporate reporting and data analysis. Bill Inmon and Ralph Kimball are prominent authors who have contributed significantly in defining and advancing concepts related to data warehouse architecture design (Curran, 2012; Goede, 2011; Sen & Sinha, 2005). In 1996, Inmon was credited with devising the term DW and was called the father of data warehousing (Curran, 2012; Goede, 2011). Curran described Inmon's philosophy as promoting the establishment of large enterprise data warehouses (EDW) that employ relational data models and advocate a top-down design. Inmon advised against the use of the traditional software development lifecycle approach when devising a DW implementation strategy, in favor of a reverse software development lifecycle approach premised on the notion that DW development should be data-driven, rather than requirements-driven (Goede, 2011; Sen & Sinha, 2005).

Kimball offered an alternative approach to Inmon's DW philosophy and introduced a de-normalized user-centric model. Kimball's model emphasized using the

data mart bus architecture with linked dimensional data marts (Ariyachandra & Watson, 2010; Curran, 2012). Kimball advocated for a bottom-up design grounded in a requirements-driven lifecycle methodology (Curran, 2012; Goede, 2011; Sen & Sinha, 2005).

Inmon et al. (2008) defined the DW as a subject-oriented, integrated, nonvolatile, and time variant collection of an organization's digitally stored data that supports management's decision-making processes. Table 1 presents these DW characteristics more descriptively.

Table 1

Data Warehouse Characteristics

Characteristic	Description
Subject-oriented	Organized around key subjects that span the enterprise. For example, major subject areas for an insurance company that sells auto, health, life, and casualty products might be customer, policy, premium, and claim. In a manufacturer scenario, major subject areas may be product, order, vendor, bill of material, and raw goods.
Integrated	Process of converting, reformatting, resequencing, and summarizing data by employing consistent naming conventions, formats, encoding structures, as data are ingested into the data warehouse from multiple heterogeneous data sources.
Nonvolatile	Data in the data warehouse are non-updateable by users; changes in the data warehouse represent changes loaded or refreshed from operational systems.
Time-variant	Data in the data warehouse contain a time dimension to facilitate maintenance of historical records.

Note. Adapted from *Building the Data Warehouse* (2nd ed.), by W. H. Inmon, 1996. New York, NY: Wiley.

Alternatively, Kimball et al. (2008) defined the DW as a copy of transaction data originating from external data sources specifically structured for query and analysis. Kimball et al.'s definition suggested a departure from the core architecture discussion, redirecting the focus toward the functionality and purpose of the DW, Wrembel (2009) explained. The DW provides an IT capability that enables the integration of multiple heterogeneous, autonomous data sources within the business enterprise to facilitate advanced and efficient analysis of these integrated data (Wrembel, 2009).

The DW literature (March & Hevner, 2007; Sen et al., 2012; Watson, 2002) distinguished between a DW and the act of data warehousing. Although the DW is characterized as the physical repository for hosting integrated data, the term "data warehousing" represents a broader function that encompasses the people, processes, and the technology needed to develop, manage, operate, and define how data are collected, integrated, interpreted, and used by the organization (Kimball et al., 2008; March & Hevner, 2007). Kimball et al. (2008) argued the end-to-end data warehousing paradigm is synonymous with the characterization of BI; therefore, Kimball et al. favored using the amalgamated phraseology data warehouse/business intelligence (DW/BI) to reinforce the dependency that exists between the two concepts.

Business Intelligence

Business intelligence has been a topic of research interest for many years. Dresner of the Gartner Group introduced the term in 1989 to describe a set of concepts and methods aimed at helping business managers with facts-based decision-making by analyzing and reporting on data stored within the DW (Kimball et al., 2008; Nylund, 1999; Power, 2007). However, the literature suggested Luhn (1958) introduced the

fundamental concept of BI as an automatic system for conducting data analysis and

disseminating information to organizational constituents with a business need (Luhn,

1958; Presthus et al., 2012; Raber et al., 2012).

Business intelligence is an evolution in decision support systems and executive

support systems (Power, 2007). Industries such as finance, health care, and supply chain

management use BI to collect and analyze corporate data to support performance

management and decision-making (Elbashir & Williams, 2007; Turban et al., 2011;

Williams & Williams, 2007). Coincidently, with the emergence of initiatives to address

challenges brought about by the increased volume, velocity, and variety of data

originating from new and often uncommon sources, BI is reinvigorated within academia

as an extension of research endeavors aimed to address the "big data" phenomenon

(Wixom et al., 2014). However, despite its proliferation, no standard definition for BI

exists (Raber et al., 2012; Wixom & Watson, 2010). As a result, researchers have

proposed a variety of definitions. Isik et al. (2013) described BI as "a system comprised

of technical and organizational elements that presents its users with historical information

for analysis to enable effective decision-making and management support, with the

overall purpose of increasing organizational performance" (p. 13). Gonzales et al. (2011)

summarized BI as "a set of concepts and methodologies to improve decision-making in

business through use of facts and fact-based systems" (p. 2). Wixom and Watson (2010)

defined BI as "a broad category of technologies, applications, and processes that

cooperate in gathering, storing, accessing, and analyzing data to aid users in making

informed decisions" (p. 14). Jourdan, Rainer, and Marshall (2008) described BI as both a

process and a product. These authors described the process as the methods that

organizations use to develop useful information, whereas the product is the information that allows organizational leaders to forecast and predict with higher certainty. March and Hevner (2007) emphasized the importance of differentiating between the terms *intelligence* and *business intelligence*. March and Hevner asserted:

> We use the term intelligence in its general sense of information—information acquired to aid the purposeful execution of business processes. We use the term business intelligence to refer to inferences and knowledge discovered by applying algorithmic analysis to acquired information. A data warehouse is a repository of intelligence from which business intelligence can be derived. (p. 1032)

For the purposes of this study, BI is defined operationally as a confederation of analysis, reporting technologies, applications, and processes that cooperate to gather, store, access, and analyze data to provide executives and managers with relevant business information to enable effective decision-making at the tactical, operational, and strategic levels of the organization (Elbashir et al., 2013; Wixom & Watson, 2010). Given the relationships between DW and BI, the researcher purposefully unified these concepts to reflect evolution and convergence. Therefore, the theoretical concepts and literature on DW and BI are addressed collectively within the context of DW/BI maturity.

DW/BI Maturity

Many organizations have implemented successful DW/BI projects; however, some do not achieve positive outcomes or are unclear about the practical benefits brought about by introducing their new DW/BI capabilities (Isik et al., 2013). DW/BI projects are known for being large, expensive, and high-risk initiatives prone to high failure rates (Goeke & Faley, 2007; Lupu, Bologa, Lungu, & Bara, 2007; Watson, 2002). Goeke and

Faley (2007) indicated the median cost to implement a DW/BI is more than $1 million and can potentially exceed $50 million, excluding annual operating costs. However, nearly 80% of DW/BI projects fail to deliver expected results (Chenoweth, Corral, & Demirkan, 2006; Chuah & Wong, 2011; Elbashir et al., 2013; Goeke & Faley, 2007; Lupu et al., 2007).

Lahrmann et al. (2011) asserted the achievement of maturity requires an evolutionary path that progresses through multiple, archetypal levels of growth or development from an initial stage to a target stage. Dooley, Subra, and Anderson (2001) described maturity as being process-oriented where a process is defined, managed, measured, and enriched through continuous improvement. The definition presented by Dooley et al. can be appropriately applied in the context of DW/BI. Therefore, DW/BI maturity is defined operationally as the extent that organizational and technological DW/BI capabilities and processes have been defined, managed, measured, and enriched through continuous improvement and are assimilated fully into the organization.

DW/BI maturity represents an extension of DW/BI success premised on the notion that DW/BI capabilities must evolve as the organization evolves to meet the changing and growing needs of the business (March & Hevner, 2007; Popovic et al., 2012; Wixom et al., 2008). DW/BI success is the benefits that organizations obtain as a direct consequence of using their DW/BI capabilities (Isik, 2009; Isik et al., 2013). Yeoh and Koronios (2010) extended this definition by describing DW/BI as an environment that evolves through a continuous cycle of evaluations, modifications, optimizations, and improvements. These authors asserted exemplars of this evolution can be found in organizations with mature DW/BI capabilities that have yielded extraordinary results.

Companies, such as 1-800-Contacts Retail (Howson, 2006), Allstate Insurance (Howson, 2006), Continental Airlines (Wixom & Watson, 2010; Wixom et al., 2008), and Harrah's Entertainment (Williams & Williams, 2007; Wixom & Watson, 2010) used DW/BI to improve customer relations, increase profits, and create competitive advantage across their respective business domains (Howson, 2006; Williams & Williams, 2007; Wixom & Watson, 2010; Wixom et al., 2008). The commonality among these examples is that all the organizations deployed DW/BI capabilities that required refinement and were further developed to ensure alignment with their respective business goals and objectives (Williams, 2011).

Critical Success Factors

Several researchers have conducted critical success factor (CSF) studies to help organizations achieve success from their DW/BI projects (Chenoweth et al., 2006; Hawking & Sellitto, 2010; Mukherjee & D'Souza, 2003; Sammon & Finnegan, 2000; Yeoh & Koronios, 2010; Wixom & Watson, 2001). A review of these studies indicated the CSFs that dominate within the literature include (a) executive sponsorship and championship, (b) adequate resources, (c) skilled project team, (d) business-driven approach that aligns DW/BI with the strategic goals and objectives of the organization, (e) training, (f) change management, (g) governance, (h) data integration, (i) data quality, and (j) availability of analytical applications.

Hawking and Sellitto (2010) conducted a qualitative study of critical success factors related to implementing a DW/BI system as an extension of an enterprise resource planning (ERP) system. The authors used a content analysis approach to examine vendor presentations and transcripts from user group conferences. A total of 9,868 presentations

were sourced from more than 69 SAP-related industry events of which 142 (1.4%) of the

presentations met the criteria for content analysis. Hawking and Sellitto found factors

with the highest frequency of occurrences were management support, user participation,

and team skills. Other factors the authors highlighted were training, change management,

data quality, governance, and business content.

Yeoh and Koronios (2010) employed a two-stage qualitative approach to

investigate critical success factors. In Stage 1, the researchers used the Delphi method to

support the construction and validation of a critical success factor framework. In Stage 2,

the researchers used the results of the Delphi to support five distinct case studies across

five large and complex organizations. The findings from the study were categorized as

organization, process, and technological. The authors described the CSFs related to the

organization as committed management support, a clear vision, and a well-established

business case. The CSFs related to process were characterized as business-centric

championship and a balanced team, business-driven and iterative approach, and user-

oriented change management. Last, the technological CSFs were distinguished as

business-driven, scalable, and flexible technology framework, sustainable data quality

and integrity (Yeoh & Koronios, 2010).

Chenoweth et al. (2006) explored DW implementation success using a case-study

approach premised on the tenets of adaptive structuration theory, which entails analyzing

interactions of the technological and the social contexts. Through the case study, the

researchers focused on a large organization that had implemented a DW. These

researchers found the organization's DW implementation had been deemed successful in

some functional units and unsuccessful in others. These researchers found opportunities

that they referred to as points of intervention for DW implementation success, which included obtaining management support and championship during the project initiation phase; determining DW architecture during the design phase; and assessing organizational fit, user acceptance, and super user roles during the training and support phases.

Mukherjee and D'Souza (2003) examined factors that caused DW implementations to fail and factors that positively influenced implementation success. The researchers identified critical implementation factors across six broad categories defined as (a) technical, (b) management sponsorship, (c) goals and objectives of the organization, (d) user-related issues, (e) organizational factors, and (f) managing system evolution and growth. These authors then aligned the critical implementation factors along the trajectory of the three-phased evolution pattern, illustrating how the factors take on different forms during each phase of evolution.

Wixom and Watson (2001) conducted a quantitative investigation of factors affecting DW success. These authors constructed a three-dimensional research model on organizational implementation success, project implementation success, and technical implementation success. Wixom and Watson created a survey instrument to collect data through responses from data suppliers of 111 large organizations. The researchers found that among implementation factors, the most common reasons for DW project failures were weak sponsorship and management support, insufficient funding, inadequate user involvement, and organizational politics.

Sammon and Finnegan (2000) used a multiple case study approach to determine how and why certain factors affect DW implementation. The researchers identified 10

organizational prerequisites for DW implementation success. The prerequisites included a business-driven approach, executive sponsorship and commitment, adequate funding, skilled project team, data quality, flexible enterprise data model, data stewardship, long-term strategy for automated data extraction, integration of DW and operational data sources, and hardware/software proof of concept.

Efficacy of DW/BI Maturity Models

Researchers addressed maturity in the DW/BI literature primarily through the construction and application of maturity models. However, the maturity model landscape is dense with models proposed by both academia and industry. Since the 1970s, more than 100 maturity models have been published in the information systems field in general, and more than a dozen within the DW/BI domain specifically (Becker, Knackstedt, & Poppelbub, 2009; Lahrmann, Marx, Winter, & Wortmann, 2010). Although the use of maturity models is an established approach to assessing the posture of an organization's DW/BI capabilities (Cosic, Shanks, & Maynard, 2012; Lahrmann et al., 2011; Raber et al., 2012), the quantity of DW/BI maturity models suggests an absence of standardization and consensus regarding the dimensions and sub-factors subject to measurement (Becker et al., 2009).

The ambiguity and lack of standardization among DW/BI maturity models have inspired researchers to understand the similarities and differences. Ong et al. (2011) reviewed five DW/BI-related maturity models commonly used in academia and in practice. The authors found the models differed in the number of stages, scope, structures, dimensions, and characteristics. The authors observed a common limitation among the models was a lack of specificity regarding the assessment and validation

methodologies. Ong et al. also noted coverage areas were not comprehensive and inconsistent in the inclusion of impact dimensions, such as outcome and performance, or organizational dimensions, such as management support, executive sponsorship, and strategic alignment. Other limitations included the absence of data issues, such as master data management, metadata management, data governance, change management, and BI awareness and training.

Rajteric (2010) analyzed six DW/BI-related maturity models and found that although the models were effective, each seemed to target a specific interest area. However, neither of the maturity models reviewed were all-encompassing. Rajteric suggested given the limited focus offered by the individual maturity models, multiple models should be used to obtain meaningful and accurate results in assessing the level of maturity. Rajteric posited the multi-model approach allows for expanding the key focus or process areas to effectively determine the current state of maturity and to identify challenges that must be mitigated to achieve a higher maturity level. Chuah and Wong (2011) reviewed the same six models that Rajteric identified, but considered three additional maturity models in their analysis. The authors found documentation for the models were either inadequate or absent. The authors also found the models did not offer questionnaires to in aid self-assessments. Chuah and Wong re-emphasized the plausibility of using multiple models as discussed in Rajteric (2010), but cautioned that doing so would be time consuming and may yield incompatible results across the different models.

Lahrmann et al. (2010) conducted a literature analysis to examine the content of 10 DW/BI-related maturity models across their respective dimensions. An artifact

originating from this examination was a catalog of 13 dimensions that covered all aspects of the maturity models under investigation. Lahrmann et al. found many of the proposed models focused extensively on IT, addressing such topics as applications, data, and infrastructure, with limited focus on organizational efficiency, structures, staff, and strategies. Lahrmann et al. concluded that among the maturity models analyzed, the stages of growth for data warehousing (Watson, Ariyachandra, & Matyska, 2001) was the only model based explicitly on an accepted design theory. The authors contended a sound theoretical foundation in maturity model development aids in explicating how the dimensions of a maturity model influence one another.

Although most of the DW/BI maturity models are promulgated by practitioners, maturity model developments within academia are gaining traction (Chuah & Wong, 2011; Dinter, 2012; Ong et al., 2011; Raber et al., 2012; Sen et al., 2012; Sen, Sinha, & Ramamurthy, 2006; Watson et al., 2001). Watson et al. (2001) introduced the data warehousing stages of growth maturity model based on the stages of growth theory (Gibson & Nolan, 1974). The data warehousing stages of growth model proposed three evolutionary stages: initiation, growth, and maturity. The model consists of nine dimensions that align with the three stages. The dimensions include data, architecture, stability of the production environment, DW staff, users, impact on users' skills and job, applications, costs and benefits, and organizational impact. Although the authors highlighted business need, executive support, and availability of resources are influential in assessing maturity, these dimensions were less explicit in description and denoted only as factors to consider (Watson et al., 2001).

Sen et al. (2006) identified factors that influence DW process maturity using concepts derived from the Capability Maturity Model, a process maturity model developed by researchers at Carnegie Mellon University and widely used in software engineering. The authors conducted a field study to examine nine dimensions that address user perceptions of data warehousing process maturity. The dimensions included the type of DW architecture, DW size, alignment of architecture to business strategy, organizational readiness, analytic decision culture, organizational slack, data quality, project management, and change management. The authors mailed questionnaires to 2,498 companies located in the Midwest and the southern part of the United States. Sen et al. targeted two senior executives from each company, the chief information officer or DW manager to provide a technical perspective and the other from a functional business area (e.g., marketing, operations, finance, or human resources). The outcome of the study revealed both managerial and technological factors, which included data quality, alignment of architecture, change management, organizational readiness, and DW size.

Ong et al. (2011) developed and tested a maturity model based on dimensions and limitations observed within existing maturity models. These researchers organized the model along four dimensions: organizational, process, technology, and outcome. The authors conducted a preliminary study to test the maturity model using a structured questionnaire approach. Study participants belonged to four organizations representing different industries: one organization from the banking industry, two organizations from the health care industry, and one organization from the tourism and hospitality industry. The results of the preliminary study yielded organizational and outcome dimensions were at opposite ends of the mean scoring (e.g., organizational with the highest mean score of

3.08 and outcome with the lowest mean score of 2.63; Ong et al., 2011). Given the limited number of participating organizations, the authors posited more studies were necessary to establish the model's comprehensiveness and validity.

In the response to calls for an objective assessment instrument, Sen et al. (2012) created the data warehousing process maturity model. These researchers enlisted more than 20 DW executives from 13 different companies to participate in the development and evaluation of the model. The resulting validated model consists of five maturity levels: initial, repeatable, defined, managed, and optimizing. The authors organized the data warehousing process maturity model around developmental and operational tasks. The development tasks focus on the design, development, and implementation of the DW, while the operations tasks help to ensure the DW continues to function as designed. This extensive model covers a total of 41 key process areas and 219 activities.

Raber et al. (2012) proposed the capability maturity model for business intelligence (CMMBI) premised on theoretical foundations from sociotechnical theory, information systems success, and business or IT alignment. The CMMBI consists of five dimensions that emphasize strategy, organization, IT, quality, and use or impact. These dimensions are assessed along the trajectory of five maturity levels described progressively from Maturity Level 1 to Maturity Level 5 as Initiate, Harmonize, Integrate, Optimize, and Perpetuate. Table 2 provides descriptions for the CMMBI maturity levels.

Table 2

Capability Maturity Model for Business Intelligence Maturity Levels

Maturity Level	Description
Level 1 – Initiate	Early, immature state of maturity; high degree of decentralization with limited to no standardization within the DW/BI environment.
Level 2 – Harmonize	Centralized management of the DW/BI environment; demonstrates transition towards the establishment of governance and organizational DW/BI alignment.
Level 3 – Integrate	Organization achieving a higher degree of centralization and demonstrates an intermediate transition towards optimizing the DW/BI environment.
Level 4 – Optimize	Organization reaping the rewards of the DW/BI initiative, while realizing well-defined governance and portfolio management and developing plausible DW/BI business cases.
Level 5 – Perpetuate	The pinnacle of the maturity level hierarchy with characteristics that necessitate establishing a sustainable and continuously managed DW/BI environment.

Note. Adapted from "Using Quantitative Analysis to Construct a Capability Maturity Model," by D. Raber, R. Winter, and F. Wortmann, 2012, *Proceedings of the 45th Hawaii International Conference on System Sciences (HICSS)*, 4219–4228.

Maturity models are intended to be effective instruments that chart a path to achieving mature DW/BI capabilities and to underscore critical areas that may require attention (Rajteric, 2010). However, DW/BI maturity models receive criticism for failing to explain the process of moving from one stage of maturity to the next stage (Wixom et al., 2008). The constructs and dimensions presented in DW/BI maturity models are vast and suggest the need for theory formulation to help develop effective maturity assessment instruments that can aid in assessing an organization's DW/BI maturity posture

(Lahrmann et al., 2010). Moreover, limited empirical data indicate many of the proposed DW/BI maturity models have been applied in practice (Dinter, 2012; Raber et al., 2012).

DW/BI Success and DW/BI Maturity

The diffusion of DW/BI can have transformative implications on organizations (Elbashir, Collier, & Sutton, 2011; Ramamurthy et al., 2008b). Wixom and Watson (2010) indicated the extent of these implications depends on the organization's motivation for implementing DW/BI. The researchers explained some organizations implement DW/BI to (a) facilitate the efforts of a single department in carrying out a specific project, such as a marketing campaign; (b) leverage DW/BI as an IT infrastructure to facilitate data aggregation from source systems into a centralized DW; and (c) vector corporate transformation efforts as an endeavor to establish DW/BI as an enabling capability aimed to support enterprise business operations at the strategic, operational, and tactical levels. Wixom and Watson further explained that although DW/BI as a technology infrastructure calls for a highly scalable IT platform, robust IT capabilities, and senior level IT championship, a DW/BI initiative that targets organizational transformation can significantly influence changes in jobs, work processes, and organizational cultures. Williams and Thomann (2003) argued obstacles that organizations face with DW/BI initiatives are less about the technology and more about the unwillingness of organizations to make the kind of changes necessary to reap the rewards of DW/BI. These researchers emphasized DW/BI is more than a refreshment of technologies to enhance current work practices, but a new paradigm in the definition and use of information in business operations.

Lahrmann et al. (2011) stated regardless of the sophistication of the DW/BI environment, organizations cannot realize improvements in business performance without usage. Bijker and Hart (2013) employed an exploratory approach to investigate factors that influence DW/BI use within five organizations that had maintained mature DW/BI capabilities for nine to 15 years. The researchers employed the Technical-Organizational-Environment framework to highlight emerging themes. The emerging themes included a lack of senior executive buy-in and involvement; a lack of managerial involvement or ownership; the need for support and training on using the data derived from DW/BI; the importance of a phased implementation approach to deliver incremental business value; and issues regarding the integration, timeliness, and accuracy of data. Bijker and Hart concluded that among the Technical-Organizational-Environment factors, the organizational factor had the strongest influence on DW/BI pervasiveness. Additionally, the authors found that, for some organizations, the role of regulatory compliance influenced DW/BI use.

Vesset and McDonough (2009) also explored DW/BI use. These researchers outlined five key factors as influential and controllable in the delivery of pervasive DW/BI capabilities. The factors included the degree and quality of training that users receive on using the available data, tools, and analytic techniques; the design quality of the DW/BI environment; the existence of data governance in terms of policy and oversight; the presence of nonexecutive-level managerial involvement in promoting the design and use of DW/BI; and the existence of formal performance management considerations across the organization.

Information Systems Success and DW/BI

The literature suggests high correlation between information systems success and the maturity of DW/BI technological capabilities (Lahrmann et al., 2011; Popovic et al., 2012). Information systems success is a measure of the degree to which a system provides benefits to an individual and to the overall organization by explicating the moderating drivers that influence positive outcomes (Petter, DeLone, & Mclean, 2008; Raber et al., 2012; Seddon, 1997). DW/BI maturity is a measure of quality that emphasizes the evolution of the DW/BI environment through continuous improvement in capabilities and processes (March & Hevner, 2007; Popovic et al., 2012; Watson et al., 2002; Wixom et al., 2008; Wrembel, 2009).

The DeLone and McLean (1992, 2003) information systems success model is frequently cited in the literature (Popovic et al., 2012). DeLone and McLean (1992) outlined a taxonomy of six interdependent factors for measuring information systems success. These factors include measurements for system quality, information quality, use, user satisfaction, individual impact, and organizational impact. Despite its prominence, DeLone and McLean's model has received criticism across the information systems research community. Seddon (1997) criticized the information systems success model (DeLone & McLean, 1992) for its ambitious endeavors to combine process and casual explanations for measuring information systems success. Seddon was concerned with the assessment of *use* as a measure of information systems success. Seddon argued that *use* was a consequence of information systems impact, not a dimension for construct measurement. Seddon underscored the potential risks of misunderstanding the

measurements and offered a re-specification and extension to the model to disambiguate the use construct as it related to measuring net benefits for individuals and organizations.

Pitt, Watson, and Kavan (1995) argued the information systems success model (DeLone & McLean, 1992) is product-oriented and does not account for the service provider role of the information systems department. The researchers warned an absence of a service quality measurement could lead researchers to incorrectly measure information systems effectiveness. Pitt et al. proposed modifications to the information systems success model that incorporate a service quality construct to reflect the effect of service quality on use and user satisfaction.

In response to criticisms, DeLone and McLean (2003) introduced a revision to the original information systems success model (DeLone & McLean, 1992). The revised model (DeLone & McLean, 2003) retained the six constructs, but was recalibrated to (a) introduce a "service quality" dimension; (b) provide clarification of the *use* dimension by addressing user intent; and (c) amalgamate the individual and organizational impact dimensions to form a single impact-oriented construct referred to as *net benefits*. As a result, DeLone and McLean included the constructs of system quality, information quality, and service quality as the factors that lead to or cause information systems success in concert with an end-state that defines information systems success through the constructs of intent to use, user satisfaction, and net benefits (Wieder et al., 2012). Table 3 presents these constructs more descriptively.

Table 3

Constructs and Characteristics of Information Systems Success

Construct	Description
System Quality	Refers to the desirable characteristics of the system. These characteristics include ease of use, ease of learning, accessibility, reliability, flexibility, response time, and integration (Petter et al., 2008).
Information Quality	Refers to the desirable characteristics of system outputs. Examples are accuracy, completeness, timeliness, and relevancy (Petter et al., 2008).
Service Quality	Refers to the quality of support that system users receive from the IT staff. Examples include responsiveness, reliability, competence, and empathy of the IT staff (Petter et al., 2008).
Intent to use/use	Refers to the degree and manner that users utilize the capabilities of the system. Examples include amount of use, frequency of use, nature of use, extent of use, appropriateness of use, and purpose of use (Petter et al., 2008).
User Satisfaction	Refers to individual user satisfaction with the products and services derived from the system (Petter et al., 2008).
Net Benefits	The extent to which the information system is contributing to the success of individuals and organizations. Improved decision-making and improved productivity are examples of net benefits (Petter et al., 2008).

DW/BI researchers have found the measures of information systems success beneficial in evaluating the quality of DW/BI systems, the information derived from these systems, and services provided by the DW/BI staff (Popovic et al., 2012; Raber et al., 2012; Wieder et al., 2012; Wixom & Watson, 2001). Popovic et al. (2012) used the DeLone and McLean (1992, 2003) model to examine the relationships between DW/BI maturity, information quality, analytical decision-making culture, and the use of information for decision-making. Raber et al. (2012) used the DeLone and McLean

(2003) model as a theoretical basis for constructing a DW/BI maturity model. Schieder and Gluchowski (2011) and Wixom and Watson (2001) used the information systems success model (DeLone & McLean, 1992, 2003) in their respective studies to construct consolidated research models aimed to measure DW/BI success. Yeoh and Koronios (2010) researched critical success factors and found the information systems success variables—system quality, information quality, and system use—were beneficial in measuring system infrastructure performance within the DW/BI environment. Wixom and Watson's (2001) investigation of factors affecting DW success pertained to the DeLone and McLean (1992) model. The researchers found system quality and data quality had high correlation with perceived net benefits.

Governance and Strategic Alignment

The literature suggests DW/BI can produce the highest return on investment when organizations establish a DW/BI strategy that supports and enables corporate strategies (Isik et al., 2013; Watson et al., 2001; Williams, 2004; Williams & Williams, 2007). According to Pant (2009), the goals of DW/BI strategies are to ensure alignment of organizational objectives, business strategies, investments, and DW/BI capabilities. These goals should also unify the people, processes, and technologies that facilitate the collection, integration, access, and analysis of information that support and enable better decision-making at all organizational levels (Pant, 2009).

The objective of DW/BI strategy is to ensure the respective strategies of business and IT are in alignment to support and advance enterprise goals (Isik et al., 2013; Pant, 2009; Watson et al., 2001; Williams & Williams, 2007). The alignment of IT and business is a perennial business concern that has eluded organizations for more than three

decades (Luftman & Ben-Zvi, 2010; Luftman & Brier, 1999). Business-IT alignment is a relationship between the IT function and other business functions working to build cohesive strategies that advance organizational goals and objectives (Anderson-Lehman, Watson, Wixom, & Hoffer, 2004; Elbashir et al., 2013; Luftman, 2004).

Henderson and Venkatraman (1993) conceptualized the strategic alignment model premised on the strategic fit between strategy and infrastructure in concert with the functional integration between business and IT. Specifically, the strategic alignment model emphasizes the interrelationships between business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes. As a result of their five-year longitudinal investigation, Luftman and Brier (1999) extended the strategic alignment model (Henderson & Venkatraman, 1993) to incorporate 12 components comprising six enablers and six inhibitors to the strategic alignment of business and IT. The researchers found senior executive support, IT understanding of business, business-IT relationships, and leadership were represented characteristics among both the enablers and inhibitors. Other enablers and inhibitors to business-IT alignment were identified respectively as engagement of IT in the development of strategy and a lack of commitment from IT.

Governance is recognized as an effective mechanism for facilitating alignment between business and IT (Sledgianowski, Luftman, & Reilly, 2006). DW/BI governance is an organizational practice that helps decision makers rationalize resources, provide direction through the promulgation of policies and guidelines, and coordinate organizational decisions related to investment in IT initiatives and the alignment of those

investments to the strategic and operational priorities of the business (Fernandez-Gonzalez, 2008; Gutierrez, 2006; Huang, Zmud, & Price, 2010; Matney & Larson, 2004).

Fernandez-Gonzalez (2008) described DW/BI governance as an outgrowth of corporate governance, which establishes the foundation of governance practices, such as strategic management, risk management, and performance management. Fernandez-Gonzalez described DW/BI governance as a convergence of corporate governance, which places emphasis on controlling the organization, and IT governance, which places emphasis on controlling information systems. Moreover, Fernandez-Gonzalez recognized four basic values of DW/BI governance required to support organizational decision-making. These values include ongoing adaptability to support dynamic organizational decisional processes, teamwork between business and IT, flexible hierarchies that encourage information exchange across functional business areas, and emphasis on the provision of appropriate information to decision makers—with less emphasis on defining mechanistic decisional processes.

Researchers have suggested that a key component for establishing and administering an organization's governance policies is the steering committee (Huang et al., 2010; Wixom & Watson, 2010). The steering committee is a formal decision-making body comprised of executive-level stakeholders who oversee and coordinate related activities integral to ensuring alignment with an organization's strategic and operational priorities (Huang et al., 2010). Wixom and Watson (2010) described the DW/BI governance approach at Blue Cross and Blue Shield of North Carolina as one that established a senior-level steering committee and a mid-level project-oriented committee. The senior-level committee provided strategic guidance, corporate-level resource

management, set project priorities, and ensured alignment between DW/BI and

communicated corporate direction. The mid-level committee allocated resources,

oversaw projects, and addressed issues such as data quality.

Organizations are recognizing that centralization of the day-to-day operations of

DW/BI under a single structure called the Business Intelligence Competency Center

(BICC) is advantageous to both the success and the evolution of their initiatives. Gartner

Research introduced the BICC in 2002 as a dedicated organizational structure to facilitate

DW/BI stewardship, service delivery, program management, and user engagement

relationships (Hostmann, 2007; Turban et al., 2011; Viaene, 2008).   Referring to a

Gartner report that surveyed 350 DW/BI end-users, Hostmann (2007) revealed 33% of

respondents reported their organizations had established a BICC. According to the

Gartner report, 28% of organizations rated at low to moderate maturity levels had

established a BICC. Hostmann also pointed out that all respondent organizations that

ranked at least the penultimate maturity level of the Gartner BI Maturity Curve had a

BICC in place.

Research Model and Hypotheses

Some researchers have investigated DW/BI maturity solely through the lens of

technological capabilities (Popovic & Jaklic, 2010; Popovic et al., 2012; Wieder et al.,

2012).   Other researchers contended IT is an enabling capability of the BI infrastructure

and cannot be examined in isolation; therefore, DW/BI research that emphasizes maturity

should consider the skills and capabilities of people alongside the structure and practices

of the organization (Isik et al., 2013; Lahrmann et al., 2011; Raber et al., 2012; Watson &

Wixom, 2007b; Wixom & Watson, 2001).

The research model used for this study (see Figure 1) is an adaptation of models by Lahrmann et al. (2011) and Raber et al. (2012). The research model draws on discoveries found in the DW/BI literature, which underscore the organizational context of DW/BI (Lahrmann et al., 2011; Raber et al., 2012; Ramamurthy et al., 2008a; Ramamurthy et al., 2008b; Wixom & Watson, 2001). The research model is also based on theoretical foundations from information systems success literature (DeLone & McLean, 1992, 2003; Seddon, 1997) and strategic alignment literature (Henderson & Venkatraman, 1993; Luftman & Brier, 1999).

The DW/BI maturity concept is operationalized using the constructs of organizational support, DW/BI information technology, DW/BI practices, and DW/BI use to determine the influence on organizational performance. This research was predicated on the argument that a mature DW/BI environment determined by the interactions of organizational support, technological capabilities, and DW/BI practices that encourage and support pervasive organizational use will lead to higher levels of organizational performance. Figure 1 presents the conceptual research model used for this study.
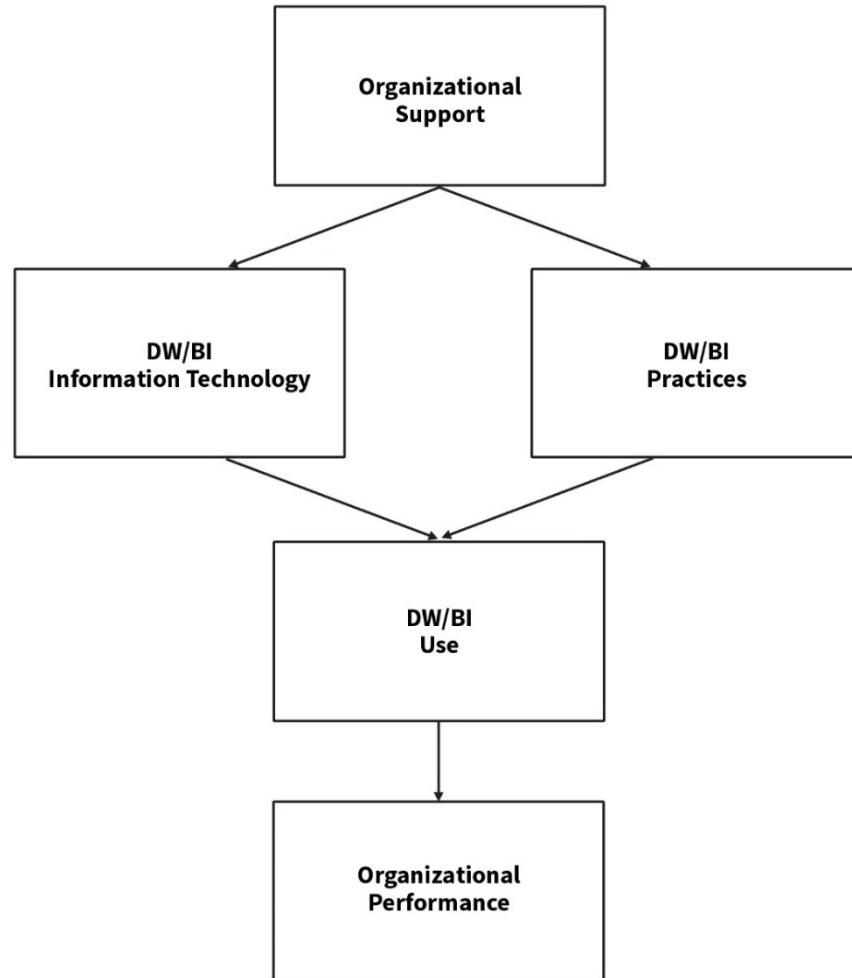
Figure 1. Research model.

Organizational Performance

   The purpose of this study was to investigate the perceived influence of DW/BI

maturity on organizational performance. A fundamental goal that inspires organizational

investments in DW/BI is to realize business value through effective decision processes

that yield increased performance (Elbashir et al., 2013).   However, some of the

challenges that arise in achieving this business goal stem from how organizational

performance is defined, operationalized, and measured. Although researchers have

endeavored to measure the influence of DW/BI on organizational performance (Elbashir

et al., 2008; Lonnqvist & Pirttimaki, 2006), some have discussed the difficulty in measuring the business value of DW/BI because of the variability in how organizations apply the capability in practice (Lonnqvist & Pirttimaki, 2006; Popovic et al., 2009). Lonnqvist and Pirttimaki (2006) suggested different applications of DW/BI may call for different measurement approaches depending on the perspectives from which performance is examined; DeLone and McLean (1992) also made this point in the information systems success literature.

Several researchers have attempted to measure the influence of DW/BI on organizational performance using return on investment, but researchers found that cost in isolation is insufficient to measure the value of information (Lonnqvist & Pirttimaki, 2006). Elbashir et al. (2008) indicated the effects of DW/BI on business performance can be viewed from two perspectives: internally through improvement in the efficiency and effectiveness of organizational management and business processes, and competitively where emphasis is placed on outperforming competing organizations within the industry.

Popovic et al. (2009) contended DW/BI initiatives are long-term, evolutionary projects that are envisioned to yield performance benefits and return on investment over time; however, many of the performance benefits are either not realized immediately or are considered intangibles that are challenging to measure. Two tangible non-financially motivated benefits that prevail in the literature for measuring the influence of DW/BI on organizational performance are time savings and better quality of the information needed to support decision-making (Lonnqvist & Pirttimaki, 2006; Popovic et al., 2009; Watson et al., 2002). In the context of this study on DW/BI maturity, organizational performance was operationalized as the extent to which DW/BI has promoted improvement in the

efficiency and effectiveness of individuals and organizational processes through increased time savings, assimilation, and use (Elbashir et al., 2008; Gable et al., 2008; Popovic et al., 2009).

Organizational Support

The organizational support construct is characterized by the properties of championship, managerial support, and availability of resources from senior executives that are necessary to advance the organization's DW/BI initiative. These attributes are well-established in the literature (Davenport, 2006; Lahrmann et al., 2011; Ramamurthy et al., 2008a; Ramamurthy et al., 2008b; Wixom & Watson, 2001; Yeoh & Koronios, 2010). Researchers suggested that a measure of championship and managerial support is the extent that executives and managers are active and engaged advocates in exhibiting and communicating the strategic importance of DW/BI to the organization (Wixom & Watson, 2001; Yeoh & Koronios, 2010). Gonzales et al. (2011) indicated four measurements for examining DW/BI sponsorship: (a) the existence of an executive sponsor for DW/BI; (b) the executive sponsor's perception of DW/BI; (c) the level of commitment of the sponsor; and (d) whether the sponsor is held accountable for DW/BI. Moreover, the availability of funding reflects senior executive sponsorship and commitment to the organization's DW/BI initiative (Wixom & Watson, 2001). Yeoh and Koronios (2010) explained DW/BI initiatives require consistent funding and resource allocation obtained directly from senior executives to support the evolution and continuous improvements of DW/BI capabilities that extend beyond implementation.

DW/BI Information Technology Capabilities

The DW/BI information technology capabilities construct is a multidimensional examination of DW/BI technological capabilities and provides the basis for understanding how IT influences the use of DW/BI and increases organizational performance. The literature indicated factors associated with the technological aspect of DW/BI align with the system quality, information quality, and service quality dimensions of the information systems success model (DeLone & McLean, 1992, 2003). The alignment between the DW/BI information technology capabilities construct and the information systems success dimensions were system quality to address data integration and analytical applications and tools, information quality to address the quality of data, and service quality to address the competency of the DW/BI staff.

Researchers described the DW as the core technological architecture of the BI infrastructure (Gonzales et al., 2011; Ranjan, 2008; Sabherwal & Becera-Fernandez, 2011; Schieder & Gluchowski, 2011). The DW is responsible for the integration functions and processes that prepare, ingest, and store data originating from enterprise data sources into a central repository that makes data available and accessible from a single location; thereby providing a holistic view of the enterprise and enabling executive and managerial decision-making (Bennett & Bayrak, 2011; Kavanagh, 2005; Sabherwal & Becera-Fernandez, 2011; Watson & Wixom, 2007a).

Data integration refers to the extent the underlying DW/BI system facilitates combining data from disparate data sources to provide a unified or consolidated view of the enterprise data to enable or support decision-making (Bennett & Bayrak, 2011; Popovic et al., 2009). The extent that data integration facilitates the assimilation of data

originating from the transactional systems that support functional business areas is an indicator of the business scope of DW/BI (Dayal et al., 2009; Inmon et al., 2008; Kimball et al., 2008). Ramamurthy et al. (2008a, 2008b) claimed organizations with DW/BI systems that integrate with corporate data sources have the highest probability for achieving tangible operational and strategic benefits.

The type of analytical applications available for use is a system quality consideration within the DW/BI information technology construct. DW/BI involve online analytical processing to expose multidimensional views of underlying data and works collaboratively with the DW to support operations, such as filtering, aggregation, drill-down, and pivoting (Chaudhuri et al., 2011). Other commonly used analytical applications include ad-hoc reporting, dashboards, key performance indicators, and decision support tools (Popovic et al., 2012). Lahrmann et al. (2011) suggested there must be a determination of whether an extensive or limited set of analytical capabilities exists within the DW/BI environment and whether the available applications are homogeneous or heterogeneous.

Researchers contended data quality is one of the most important factors that contributes to organizations achieving DW/BI success and maturity (Sabherwal & Becera-Fernandez, 2011; Sen et al., 2012; Yeoh & Koronios, 2010). A mature DW/BI environment relies on high data quality to enable users to perform analytics on vital data resources and enhance organizational decision-making (Isik et al., 2013; Sen et al., 2012). Data quality is characterized by its accuracy, consistency, existence, integrity, relevance, and validity (Sabherwal & Becera-Fernandez, 2011). Gonzales (2011) suggested data quality is a significant measure of DW/BI maturity as a method of examining the user's

trust in the data originating from the DW/BI environment and the frequency that DW/BI

data are updated and synchronized. This consideration of data quality as a dimension of

DW/BI information technology is supported by the information quality construct

articulated by DeLone and McLean (1992, 2003).

Lahrmann et al. (2011) suggested the ability of the DW/BI staff to deliver

capabilities and services is a critical requirement for delivering business value (Lahrmann

et al., 2011; Watson et al., 2001; Williams, 2004; Wixom & Watson, 2001). Watson et

al. (2001) contended that although internal organizational IT personnel may have

experience with databases, it is a false to assume such experience translates into DW or

BI experience. The researchers also explained it is common for organizations to

commission consultants to help establish or advance DW/BI capabilities and facilitate

knowledge transfer to organizational personnel. Furthermore, Watson et al. posited

progressive movement of DW/BI through the stages of maturity should result in

increased skills and competencies among in-house staff and less reliance on consultants.

Wixom and Watson (2001) found poor team skills contributed to the technical challenges

within DW/BI. Moreover, they observed team skills extend beyond technical abilities,

but incorporate the need for interpersonal skills to interact and communicate effectively

with the users.

DW/BI Practices

The DW/BI practices construct is characterized as the existence of an

organizational DW/BI governance structure and strategy that advances corporate goals

through the advocacy and facilitation of business and IT alignment and the assurance of

business processes alignment. Watson and Wixom (2007a) found organizations were

more likely to be successful in their DW/BI initiatives when alignment existed between

business and BI strategies and when effective governance was in place. The literature

indicated it is essential for organizations to ensure alignment between the business, the

business organization and its associated processes, the organization's IT strategy, IT

infrastructure, and the IT organization and its processes (Watson, 2013; Williams, 2004).

The alignment of an organization's business and IT strategies is an indicator of whether

the business is on a trajectory towards achieving higher levels of DW/BI maturity

(Matney & Larson, 2004; Williams & Williams, 2007). Luftman (2004) found

organizations with low alignment between business and IT demonstrated lower

organizational performance. Researchers indicated that a measurement of business-IT

alignment is the extent of partnership between the IT organization and the business

functions of the enterprise (Raber et al., 2013; Reich & Benbasat, 1996).

Watson et al. (2002) suggested that organizations experience significant benefits

when DW/BI is used to facilitate business processes aligned to strategic business

objectives. Ramamurthy et al. (2008b) stated DW/BI is often viewed in the context of

business process reengineering because an increased potential exists for creating radical

changes to data ownership, access and distribution, and business processes. Dayal et al.

(2009) stated, "there is a growing realization that BI [business intelligence] must be

integrated into business operations of the enterprise to enable the many knowledge

workers engaged in business processes to make better and timelier decisions" (p.1).

Bucher, Gericke, and Sigg (2009) contended that organizational business processes

provide the context for data analysis, interpretation, and action; otherwise, organizations

may harvest data that either go unused or risk interpretation outside the intended context.

Elbashir and Williams (2007) argued the alignment of DW/BI with core business processes must be the central focus of leadership and management for organizations to realize positive effects of DW/BI. Given the preceding discussions on organizational support, DW/BI information technology capabilities, and DW/BI practices, the researcher formulated the following hypotheses.

> *H1.* High levels of organizational support will have a positive influence on
>
> DW/BI information technology.
>
> *H2.* High levels of organizational support will have a positive influence DW/BI
>
> practices.

DW/BI Use

The literature suggests increased business performance is realized as a consequence of use (Howson, 2006; Lahrmann et al., 2011). The DeLone and McLean (2003) information systems success model explains system use as a facilitating condition to achieving net benefits. The dimensions of individual use, organizational use, and analytic decision culture characterize the DW/BI use construct.

Individual use is characterized by the users' perceptions of DW/BI being easy to use, efficient, effective, and helpful (Lahrmann et al., 2011). Davis (1989) contended users are more likely to accept and use new IT when such technology is perceived as being useful in enhancing job performance and is easy to use. Davis defined perceived usefulness as the degree to which users are convinced that their use of the system enhances their productivity and job performance. Grubljesic, Coelho, and Jaklic (2014) argued considerable differences exist between organizational users accepting IT and actually using IT when compared to the routine use of information derived through

DW/BI to support organizational management and business processes. Grubljesic and Jaklic (2014) contended that successful integration of DW/BI into the organization where the capability is embedded into the routines of the workforce creates synergies that increase organizational performance. According to researchers, a significant predictor of DW/BI use is the extent to which individuals use DW/BI in strategic and operational decision-making (Eckerson, 2008; Lahrmann et al., 2011; Ramamurthy et al., 2008b; Vesset & McDonough, 2009; Watson & Wixom, 2007b).

Organizational culture plays a significant role in achieving DW/BI success and higher levels of maturity (Ramamurthy et al., 2008b; Sabherwal & Becera-Fernandez, 2011). Sabherwal and Becera-Fernandez (2011) defined organizational culture as "the norms and beliefs that guide the behavior of the organization's members" (p. 245). In the context of DW/BI, significant emphasis is placed in the development of an analytical or fact-based decision-making culture. Researchers indicated cultivating an analytical decision culture that leverages DW/BI to inform decision-making at the strategic, operational, and tactical levels of the organization is paramount for facts-based decision-making (Davenport, 2010; Isik et al., 2013; Popovic et al., 2010).

Kimball et al. (2008) stated diffusion of DW/BI in an environment where fact-based or analytic decision-making is encouraged and rewarded increases the likelihood of DW/BI assimilation across the organization. Popovic et al. (2012) posited that for organizations to be successful in the use of information provided by DW/BI, the organization must develop a culture that combines technology and information management practices with a proactive use of an information environment where decision-making is based on comprehensive analysis of information. Sabherwal and

Becera-Fernandez (2011) suggested realizing an organizational culture of analytical

decision-making is more likely when senior executives set the example in their calls for

facts and analyses to support decisions. Ramamurthy et al. (2008b) suggested an

indicator of a strong analytic decision culture is the extent to which an organization relies

on the DW/BI environment to support decision-making. Given the preceding

discussions, the researcher formulated the following hypotheses.

H3. High levels of DW/BI information technology will have a positive influence

on DW/BI use.

H4. High levels of DW/BI practices will have a positive influence on DW/BI use.

H5. High levels of DW/BI use will have a positive influence on organizational

performance.

Figure 2 illustrates the conceptual research model with the dimensions and the

hypotheses formulated for testing.
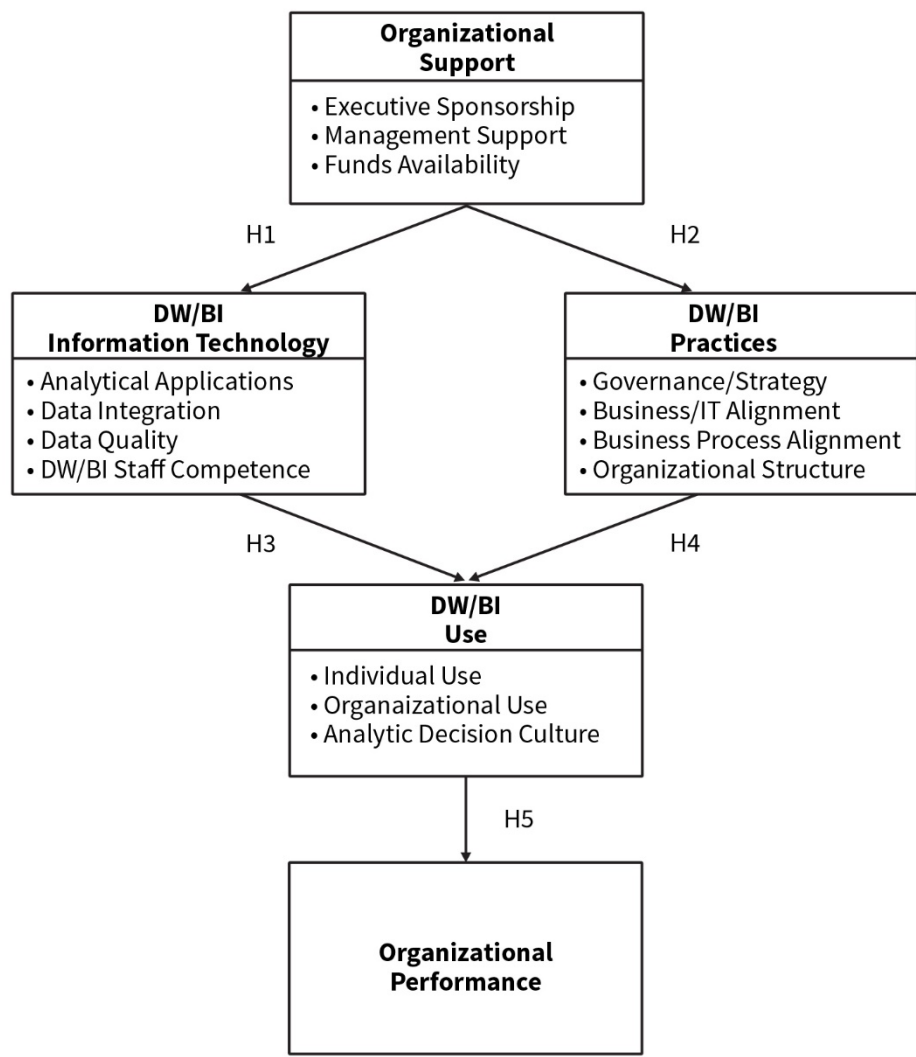
Figure 2. Research model and hypotheses.

Summary

This chapter presented a review of extant literature on DW/BI beginning with discussions on the foundations of the DW and BI. The researcher introduced studies related to DW/BI maturity models and critical success factors. Generally, DW/BI research that has pertained to maturity seemed to manifest as studies with an emphasis on the construction of maturity models. A synthesis of the literature suggested critical success factors found to be important for DW/BI success enrich the understanding of

factors that influence DW/BI maturity. The factors described in DW/BI maturity models and critical success factors are situated within the organizational or technological context. Additionally, the researcher discussed literature that related DW/BI to the theoretical concepts of information systems success and strategic alignment. While this chapter presented concepts and findings from prior research, the next chapter presents the research methodology employed for this study.

Chapter 3

Research Methodology

Overview

This chapter includes a description of the research design and methods employed to investigate the perceived influence of DW/BI maturity on organizational performance. The chapter is segregated into eight major sections in which the researcher describes the research method employed and rationale for its use, instrument development and measures, research population and sampling, data collection procedures, and data analysis procedures. The chapter concludes with a discussion regarding the format for presenting results, the study's resource requirements, ethical considerations, and a summary.

Research Methods Employed

This researcher employed the mixed methods exploratory sequential research design. Johnson and Onwuegbuzie (2004) defined mixed methods research as "a class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study" (p.17). The three major methodological paradigms that prevail in scholarly research are quantitative methods, qualitative methods, and mixed methods (Creswell, 2009; Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004; Peng, Nunes, & Annansingh, 2011; Terrell, 2012; Venkatesh, Brown, & Bala, 2013). Quantitative and qualitative methods are well-

established research paradigms in social and behavioral sciences and recognized for their effectiveness in addressing research problems (Venkatesh et al., 2013). The mixed methods paradigm is new among its methodological counterparts and therefore is still in its adolescence (Venkatesh et al., 2013). Quantitative, qualitative, and mixed methods have different characterizations and research aims. Quantitative research includes the use of numbers to measure or test for statistical significance; qualitative research involves words, narratives, and pictures rather than numbers to present novel ideas through the experiences and attitudes of subjects (Bowen, 2005; Johnson & Onwuegbuzie, 2004). Mixed methods combine quantitative and qualitative methods to address research problems in rich detail (Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004).

Mixed methods research is recognized broadly in the research community as a methodologically pluralist alternative design, but mixed method designs are not without limitations (Johnson & Onwuegbuzie, 2004). The data collection and analysis processes are time consuming, resource intensive, and expensive (Driscoll, Appiah-Yeboah, Salib, & Rupert, 2007; Johnson & Onwuegbuzie, 2004). Study designs that follow mixed methods require researchers to be adept in both quantitative and qualitative research methods, which includes knowing how to integrate the two methods into a single cohesive study (Driscoll et al., 2007; Johnson & Onwuegbuzie, 2004). Moreover, Driscoll et al. (2007) described problems with collinearity and reduced sample size as two statistical measurement-related limitations of mixed method studies; more descriptively, these researchers explained that problems with collinearity can occur during the process of recasting qualitative data in quantitative terms. The authors also

stated researchers may be motivated to use a smaller sample size when faced with the time consuming and resource intensive tasks of collecting and analyzing qualitative data.

Several types of mixed methods research designs exist. Table 4 presents six design options researchers often use. Although established characteristics and guidelines differentiate the mixed methods design options, Driscoll et al. (2007) suggested these designs are not inflexible or absolute. The researchers advised, "researchers should plan to develop a design that answers their own research questions within the constraints and boundaries of the study context" (Driscoll et al., 2007, p.20). Among the mixed methods design options, this researcher employed a modified exploratory design.

Table 4

Mixed Methods Design Options

Mixed Method Design	Priority (QUAN/QUAL)	Integration	Timing
Convergent Design	Equal	Data analysis or interpretation	Concurrent
Explanatory Design	Quantitative	Data collection	Sequential - quantitative first
Exploratory Design	Qualitative	Data collection	Sequential - qualitative first
Embedded Design	Quantitative or qualitative	Design level	Concurrent or sequential
Transformative Design	Equal	Design level	Concurrent or sequential
Multiphase Design	Equal	Design level	Multiphase combination

Note. Adapted from *Designing and Conducting Mixed Methods Research* (2nd ed.), by J. W. Creswell and V. L. Plano Clark, 2011. Thousand Oaks, CA: Sage.

Rationale for Mixed Methods Exploratory Sequential Design

The objective of this study was to understand the influences of DW/BI maturity on organizational performance using a public-sector organization with an established DW/BI environment. In exploring the universe of the target organization's DW/BI initiative, the researcher relied on the cooperation of several stakeholders in varied roles across the organization. These stakeholders were the executives that champion or sponsor the DW/BI initiative, the workforce that performs as users of the DW/BI capabilities, and the IT entity that delivers and maintains the DW/BI technological capabilities. Given the potential for differing perceptions about DW/BI across stakeholder groups, particularly between users and their senior leaders, a mixed methods design was best suited to aid the researcher in gaining a complete understanding of the DW/BI maturity phenomenon and its influence on organizational performance from different and multiple perspectives.

The adoption of the mixed methods exploratory sequential design was based on the need to triangulate multiple data sources to aid in achieving richer findings that provide a more complete accounting of the phenomena under investigation. Data source triangulation is a relevant and common protocol employed in mixed methods research, premised on leveraging multiple data sources to provide different perspectives and points of view that lead to a more comprehensive understanding of the phenomenon under study (Benbasat, Goldstein, & Mead, 1987; Eisenhardt, 1989; Maxwell, 2005; Yin, 2003). Bowen (2005) recommended using multiple data collection methods to aid in the convergence of evidence from two or more sources to support the research findings. Yin (2003) stated examples of plausible sources include the use of archival records,

documents, interviews and surveys, focused interviews, and open-ended interviews.   In this study, the researcher's triangulation approach included reviewing archival documents made available by the target organization, conducting semi-structured interviews with organizational senior leaders, and administering a web-based survey to the organization's DW/BI user population.

Research Approach

The researcher implemented this study in two phases. Figure 3 illustrates the approach the researcher employed in the design and conduct of this study. As a precursor to Phase 1, the researcher reviewed extant literature to ascertain factors related to DW/BI maturity. The researcher's discoveries from the literature review facilitated the formulation of the research questions (see Chapter 1), which served as the basis for the conceptual research model and constructs presented in Chapter 2, and contributed to the development of the survey instrument. Upon determining the content and measures for the survey instrument, the researcher conducted a pilot test to validate the instrument. Respondent feedback regarding the survey questions informed the necessary adjustments made to the survey instrument. Appendix D presents the final survey instrument.

Pre - Phase 1

Phase 1
Data Collection and Analysis
(QUAN)

Phase 2
Data Collection and Analysis
(QUAL)

Post - Phase 2
Integration

Review Literature

Construct Survey Instrument

Pilot Test Survey Instrument

Administer Survey

Analyze Quantitative Data/Results

Conduct Interviews

Analyze Qualitative Data/ Findings

Interpret/ Integrate
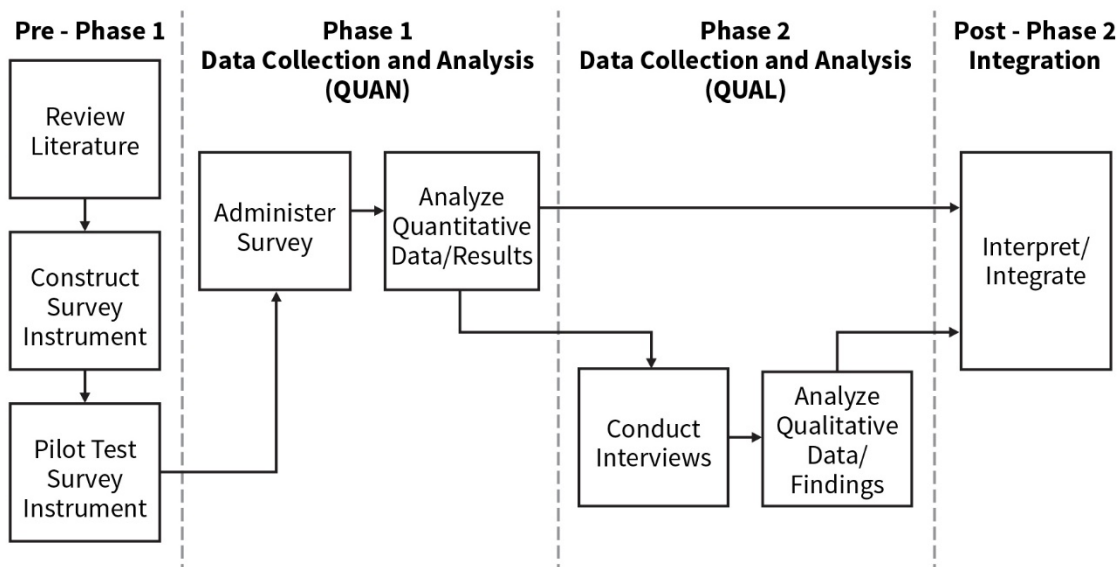
Figure 3. Phased approach to research and analysis.

In Phase 1, the researcher focused on the quantitative investigation of this study. The researcher sent email invitations to 750 people inviting their participation in this study by completing an online survey regarding their perceptions of DW/BI. Phase 2 of the researcher's approach emphasized the qualitative investigation of this study where the researcher conducted semi-structured interviews with six executives who were willing to participate in the study. These executives represented the functional business areas identified in the unit of analysis. The sequential design of this mixed methods study allowed conclusions from quantitative results in Phase 1 to guide the interview process in Phase 2, where the researcher examined the results of quantitative analyses with more specificity and detail. The data analysis in Phase 2 provided thematic insights based on the researcher's coding of informant responses to interview questions. Post-Phase 2 represented the point of integration where the researcher coalesced quantitative results and qualitative findings into a cohesive interpretation that aided in reaching conclusions and answering the study's research questions.

Survey Instrument Development and Measures

The survey instrument used in support of the quantitative phase of this study was adapted from Raber et al. (2013). The instrument consisted of previously validated items to aid in measuring the influences DW/BI maturity on organizational performance. However, the researcher adjusted and validated the scales to align with the constructs of this study. As introduced in Chapter 2, the DW/BI maturity concept is operationalized using the constructs of organizational support, IT capabilities, practices, and use to explore the perceived influences on organizational performance. These aspects of maturity lead to the construction of four measurement scales measured through four specific groups of questions on the survey instrument.

The researcher developed the survey instrument through a web-based environment hosted by SurveyMonkey, an online survey, evaluation, and analysis platform used by industry and academia (Gordon, 2002). The survey instrument consisted of 46 questions segregated into three parts. Part 1 of the web-based survey instrument consisted of one question aimed to obtain informed consent. This section of the survey established that participation in this study was voluntary, explained the purpose of the study, and assured participants that responses were anonymous. The researcher constrained Part 1 of the web-enabled survey to disallow participants to continue the survey without providing consent. Part 2 of the survey instrument consisted of nine questions that focused on obtaining demographic data. Questions regarding demographics aided the researcher in describing the sample presented in the quantitative component of this study. Part 3 of the survey consisted of 36 questions that placed emphasis on obtaining perception data regarding DW/BI. This section was organized

into five subsections and was designed to obtain responses to questions regarding

perceptions of organizational support, IT capabilities, DW/BI practices, DW/BI use, and

organizational performance. The researcher presented questions regarding perceptions in

the form of a 5-point Likert-type scale that consisted of ordinal values ranging from 1

(*strongly disagree*) to 5 (*strongly agree*).

Pilot Study

The researcher conducted a pilot study as a precursor to administering the main

study survey. The goal of the pilot study was to assess the value of the survey questions

and to ensure the design of the measurement scales could aid in achieving the objectives

of the study. The pilot study also served as an opportunity to ensure the SurveyMonkey

website functioned as expected.

For the pilot study, the researcher targeted a sample of 30 participants. Stevens

(2009) explained most statistical analyses with a minimum of 30 observations are robust

and can be assumed to have normally distributed data, which is a commonly required

parametric analyses for multiple linear regression. The researcher adopted the sample

minimum of 30 to preclude calling upon too many participants for the pilot and risk

substantially reducing the number of candidates available for the main study.

The researcher emailed invitations to a total of 50 (6.25%) randomly selected

registered users of the DIA's EDW out of the 800 reconciled email addresses provided by

the organization. In the emailed invitation, the researcher conveyed to recipients that

participation in the pilot study was voluntary, explained the purpose of the study,

provided instructions regarding the pilot, and assured anonymity of survey responses and

comments. Additionally, the invitation included a hyperlink to the online pilot survey

hosted on the SurveyMonkey website. The piloted survey consisted of demographic data, perception data with 29 questions, and a section reserved for participants to provide comments about the questions. The pilot study was carried out between February 1, 2016 and February 22, 2016. The pilot study yielded a sample of 28 respondents, a response rate of 56%.

Reliability and Internal Consistency

The researcher designed four subscales for the piloted survey instrument. Cronbach's alpha tests of reliability and internal consistency were conducted on each of the survey subscales. The Cronbach's alpha provides the mean correlation between each pair of items and the number of items in a scale (Brace, Kemp, & Snelgar, 2006). The researcher evaluated Cronbach's alpha coefficients using the guidelines suggested by George and Mallery (2010) where a coefficient value of .7 or higher is acceptable. The organizational support (OS) scale was originally drawn from one item on the survey and internal consistency was not relevant to this scale. The DW/BI information technology capabilities (IT) scale was calculated as the mean of 19 items, the DW/BI practices (PRAC) scale was calculated as the mean of 5 items, and the use (USE) scale was calculated as the mean of 4 items. The Cronbach's alpha scores did not fall below .77 for any of the subscales, indicating reliability was no lower than "acceptable" among these scales. The PRAC subscale had "good" reliability and IT had an "excellent" level of reliability. Table 5 presents the average scores for each scale as represented among the pilot sample of 28 participants.

Table 5

Subscale Reliability for Pilot Study

Scale	Cronbach's α	No. of items	*M*	*SD*
OS	-	1	3.16	1.14
IT	.97	19	3.28	0.75
PRAC	.88	5	3.11	0.86
USE	.77	4	3.53	0.67

The researcher improved and revised the survey instrument based on feedback from pilot study participants. The researcher changed the wording of subscales to provide clarity and to ensure that each subscale corresponded to the respective construct subject to measurement. The pilot study indicated each subscale had a degree of internal consistency above acceptable; therefore, no changes were made for internal consistency. However, during the review of the pilot study results, the researcher observed the absence of a construct for measuring organizational performance; therefore, the researcher added two items to measure this scale. Additionally, the researcher added three items to the organizational support scale so that internal consistency could be assessed and added two items to the use scale. Appendix D includes the final version of the survey.

Research Population and Sample

Site Selection and Unit of Analysis

The organization of interest for this study was the DIA. The DIA is a combat support agency of the U.S. Department of Defense and a component of the U.S. intelligence community. The DIA employs more than 16,000 men and women worldwide and headquartered in Washington, DC (DIA, n.d.). Although the DIA is

chartered with a global defense intelligence mission to provide military intelligence to warfighters, defense policymakers, and force planners in the Department of Defense and the intelligence community, at its headquarters, the organization has a supporting back-office business infrastructure dedicated to running the daily business operations of the agency. It was at the DIA Washington, DC headquarters, within this back-office business environment, that the researcher analyzed DW/BI maturity and its influence on organizational performance.

The unit of analysis for this study was employees of DIA's back-office business operations. The back-office refers collectively to the people, processes, and systems that focus exclusively on running the business (McGee & Fritsky, 2014; Tatum & Harris, 2014). Conversely, the front-office includes the client or customer facing business functions (Ellis & Harris, 2014; McGee & Fritsky, 2014). The back-office includes business functions, such as administrative support activities, production, or services that sustain the daily operations of the business. Examples of common back-office operations are accounting, human resources, and IT (Tatum & Harris, 2014). Collectively, the departments, operations, and enabling systems of the back-office are foundational to ensuring the well-being of the organization; therefore, the functions of the back-office represent a major contribution to an organization's business performance.

Within the DIA, the back-office business operations are acquisition, facilities, finance, human resources, information systems, logistics, and training and education (DIA, n.d.). These business areas are functionally independent and treated as separate business units. These units are aligned operationally under the leadership of either the directorate for mission services or the special office of the CFO (see Table 6).

Table 6

DIA Back-Office Organizational Alignment

Directorate for Mission Services	Special Office of the CFO
• Office of Facilities and Services	• Acquisition/Contracting/Procurement
• Office of Human Capital	• Office of the Comptroller (Finance)
• Office of the Chief Information Officer	
• Office of Logistics & Global Readiness	
• Academy for Defense Intelligence (e.g., Training and Education)	

Sample Size Determination

This mixed methods study called for using two distinct samples, DW/BI users and their organizational leaders. Determining the sample sizes from these two populations were based on the most stringent needs for probability sampling (quantitative analyses) and the optimal needs for the nonprobability sampling (qualitative analysis).

Linear regression and mediation analyses were the two methods adopted for testing the hypotheses presented in this study. The sample size for probability sampling was determined by comparing requirements for these methods. The comparison revealed mediation analysis called for a larger sample size than the linear regression analysis. Therefore, the requirements for mediation analysis prevailed as the determined sample size for the quantitative analyses. According to Frazier, Tix, and Barron (2004), the required sample size for mediation depends strongly on the correlation strength between the independent variable and the mediator. Conducting a mediation analysis reduces the

effective sample size to $E = N * (1 - r^2)$, where N is the original sample size, E is the effective sample size, and r is the correlation coefficient between the independent variable and the mediator.

Using G*Power statistical software (Faul, Erdfelder, Buchner, & Lang, 2014) the researcher determined the required sample size for a regression with two predictors is 68. Using a medium correlational coefficient (0.30) for the required sample size to have an effective sample size of 68 is $68 / (1 - 0.302) = 75$. During the preliminary planning of this study, the researcher estimated there were approximately 1,200 registered users of the DIA's EDW. The researcher planned to invite 90% of the DIA's EDW registered user population to participate in the main portion study, which was 1,080. Based on this number, the statistical analyses could reach the desired power with a 7% response rate. However, the actual number of registered users was 800, of which the researcher identified 50 to participate in the pilot study; therefore, 750 were invited to participate in the main study. The final actualized response rate was approximately 4%, which resulted in a slight reduction to the power of the mediation analyses.

The sample size determination for the qualitative analysis was based on purposeful sampling with maximum variation sampling. Palinkas et al. (2015) described purposeful sampling as a concept employed in qualitative research to identify and select information-rich subjects with deep knowledge of the topic under investigation. Maximum variation sampling is a type of purposive sampling premised on the notion that a researcher's deliberate selection of diverse participants can yield variations in perspectives on the phenomenon under study (Creswell & Plano Clark, 2011; Palinkas et al., 2015). The objective of the qualitative investigation in this study was to achieve

depth in understanding the perceptions of select organizational leaders regarding DW/BI

and its effect on organizational performance. The identification and selection of

candidate participants were deliberate and purposeful. Using maximum variation

sampling, the researcher identified and selected occupationally diverse senior-level

candidates to participate in the semi-structured interviews based on their functional role,

knowledge, and experience with the organization's DW/BI capabilities.

Creswell and Plano Clark (2011) advised that when using purposeful sampling,

the number of participants should be relatively small (e.g., 4 to 10) and the subjects

should possess sufficient knowledge to provide deep informational insights about the

phenomenon under investigation. The sample size for the qualitative component of this

study was six. The researcher identified eight DIA senior-level candidates to participate

in the study. Although all eight were willing to participate, six were available to engage

in interviews. The six subjects participating in interviews represented the business

functions of the CFO, chief information officer, the EDW Program Management Office,

the Office of Facilities and Services, the Office of Logistics and Global Readiness, and

the Academy of Defense Intelligence (i.e., training and education).

Data Collection Procedures

To identify candidates to participate in the main study's survey and as a resource

from which to identify participants for the pilot study, data collection for this study was

initiated by sending correspondence to the chairman of DIA's Business Enterprise

Services Working Group, requesting a list of registered users of the organization's EDW.

The researcher's request was based on a planning assumption that registered users of the

EDW operate exclusively within the back-office business segment of DIA and perceived

to have knowledge and experience with the organization's DW/BI initiative, which is known operationally as the EDW.

DIA's EDW Program Management Office, on behalf of DIA's Business Enterprise Services Working Group, prepared and submitted the registered user listing to the researcher. The initial list consisted of more than 1,300 named users, but did not include email addresses or other contact information. The researcher used DIA's corporate global address listing and available data from the registered user list to identify and validate user email addresses. The reconciliation resulted in validation of 800 users, which revealed a user population fewer than presented in the original listing.

Quantitative Data Collection Procedures

Quantitative data collection represented the first phase of the mixed methods data collection strategy. The researcher administered a web-based survey to registered users of DIA's EDW to ascertain demographic information and general perception responses regarding DW/BI maturity and its influence on organizational performance. According to Bloomberg and Volpe (2012), demographic information places emphasis on the characteristics that describe survey respondents in terms that include, but are not limited to, age, gender, ethnicity, occupation, and education background, thereby facilitating the establishment of a profile of each subject. The authors described perceptual information as an endeavor to draw upon survey respondents' knowledge and experience related to the topic under investigation. Perceptual information facilitates the discovery of attitudes and perspectives through the lens of each individual respondent.

The researcher administered the survey instrument using the SurveyMonkey web-based survey tool to facilitate the collection of participant responses. The survey sample

frame was drawn from a list of users provided by the DIA Business Enterprise Services

Working Group, which comprises representatives from each of the organization's back-

office business areas. The researcher distributed invitations to 50 registered users

requesting their participation in the pilot phase of the study, the response rate was 56%,

based on 28 qualified survey responses. After completing the pilot study, the researcher

invited 750 users to participate in the main study, which 29 participants provided

informed consent and responded to the survey, yielding a response rate of 3.87%. The

timeframe established to collect data to support this study was approximately one month.

Qualitative Data Collection Procedures

Qualitative data collection represented the second phase of the mixed methods

data collection strategy. The qualitative data collection strategy involved the collection

of data in the form of semi-structured interviews. The researcher conducted interviews

with senior-level stakeholders using questions defined in the researcher's interview guide

(see Appendix E) to inform the central research question and supporting research

questions. Semi-structured interviews were fundamental to the objectives of this study.

Yin (2003) described the interview as a principal component of obtaining evidence to

support qualitative studies. Stake (1995) described qualitative data as being interpretive,

experimental, situational, and personalistic. Stake explained that qualitative data are

interpretive because findings are subjective and researchers endeavor to present multiple

perspectives. Qualitative data are also experimental because such data are empirical and

thereby developed and formulated through the experiences of others. Qualitative data are

situational because characteristics, such as place and time, can influence or yield different

experiences. Last, qualitative data are personalistic because such inquiry seeks to

understand varying perceptions while examining the commonalities and diversities of

situational experiences. Bloomberg and Volpe (2012) contended the four areas of

information required in most qualitative studies are categorized as contextual, perceptual,

demographic, and theoretical. Table 7 highlights the types of information required in

qualitative studies and the method by which the researcher derived the information.

Table 7

Types of Information Used

Information Type	Information Required	Method
Contextual	Organizational background, history, and structure; mission; vision; values; organizational culture; leadership; staff and site description.	Document Review
Perceptual	Participants' descriptions and explanation of their experiences relating to the phenomenon under study.	Interview, Survey
Demographic	Descriptive information regarding participants, (e.g., age, gender, ethnicity, and discipline).	Survey
Theoretical	Review and assessment of extant literature to understand what is already known about the topic.	Literature Review

Note. Adapted from *Completing Your Dissertation: A Roadmap From Beginning to End* (2nd ed.), by L. D. Bloomberg and M. Volpe, 2012. Thousand Oaks, CA: Sage.

The researcher interviewed six executives to obtain the perspectives of leadership

regarding the organization's established DW/BI initiative. The researcher scheduled

interviews at the convenience of the executives. Gaining access to these senior leaders

was subject to long scheduling lead time and required advance coordination and

planning. The interviews took place within the offices of each informant, except the

interview with the chief overseer of the agency's EDW, which took place in the researcher's office. The researcher scheduled all interviews for one hour. The interviews were structured around predefined questions (see Appendix E). In each case, the informant seemed willing to participate in the interview process and relatively open in providing responses to the interview questions.

In support of this qualitative inquiry, the organization made available intra-agency documents for the researcher's review. Documents helpful in this endeavor were the DIA 2012–2017 strategic plan, the charters of Business Enterprise Services Steering Committee and subordinate Working Group, the EDW architecture framework, and the EDW interface strategy document. Additionally, the EDW Program Management Office granted the researcher access to a shared document repository to access relevant, permissible organizational documents to include official memoranda, minutes, audio-visual material, and archival material (Creswell, 2009).

Data Analysis Procedures

The central research question of this study was, "What are the influences of DW/BI maturity on organizational performance as perceived by primary constituencies directly involved in the DW/BI process at the DIA?" The conceptual research model for the study comprised constructs described as organizational support, DW/BI information technology capabilities, DW/BI practices, DW/BI use, and organizational performance. The sources of data used to address these constructs represented a combination of qualitative and quantitative data derived from interviews, surveys, and organizational documents/archival records. Table 8 presents the supporting research questions, hypotheses, and type of analysis used in this study.

Table 8

Research Questions and Hypotheses

Research Question	Hypothesis	Analysis
RQ1. What is the influence of organizational support on DW/BI Information technology?	H1. High levels of organizational support will have a positive influence on DW/BI information technology.	• Qualitative • Quantitative (Linear regression)
RQ2. To what extent does organizational support influence DW/BI practices?	H2. High levels of organizational support will have a positive influence DW/BI practices.	
RQ3. How does DW/BI information technology inspire constituents to use DW/BI in organizational decision-making?	H3. High levels of DW/BI information technology will have a positive influence on DW/BI use.	
RQ4. To what extent do DW/BI practices inspire or influence DW/BI use?	H4. High levels of DW/BI practices will have a positive influence on DW/BI use	
RQ5. To what extent does DW/BI use influence organizational performance?	H5. High levels of DW/BI use will have a positive influence on organizational performance	
RQ6. What is the influence of perceived DW/BI information technology in mediating the relationship between organizational support and DW/BI use?	H6. Perceptions of DW/BI information technology mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.	• Quantitative (Mediation analysis)
RQ7. What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?	H7. Perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.	

Research Question	Hypothesis	Analysis
RQ8. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI information technology and organizational performance?	H8. Perceptions of DW/BI use mediate the relationship between perceptions of DW/BI information technology and perceptions of organizational performance.	
RQ9. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?	H9. Perceptions of DW/BI use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance.	

Quantitative Data Analysis

The researcher conducted the quantitative data analysis in Phase 1 of this study and included hypotheses testing for RQ1 through RQ9. The researcher employed SPSS Version 22.0 for Windows (IBM Corp, 2013) to support quantitative data analysis. Prior to conducting data analysis, the researcher screened data for accuracy, missing data, outliers, and extreme cases. The researcher performed descriptive statistics and frequency distributions to determine whether responses were within the possible range of values and that data were undistorted by outliers. The presence of outliers was evaluated by examining standardized values and nonrandom patterns in cases with missing data. The researcher rendered responses that did not answer major sections of the survey unusable for analysis.

The researcher used a simple linear regression for RQ1 through RQ5 to test the hypotheses and to assess the correlations among the variables that constitute DW/BI maturity and their effect on organizational performance. Linear regression is an appropriate analysis when the goal of the researcher is to assess the extent of a

relationship of a dichotomous or interval/ratio predictor variable and an interval/ratio

criterion variable. A linear regression involves the following regression equation: $y = b1*x + c$; where Y = estimated dependent, c = constant, b = regression coefficients, and x = independent variable (Tabachnick & Fidell, 2012). The researcher employed mediation

analysis for RQ6 through RQ9 to determine the effects of perceptions of DW/BI

information technology capabilities, DW/BI practices, and DW/BI use on mediating the

relationships between organizational support and organizational performance. Mediators

describe how or why perceptions may be linked. The mediator is considered an

intervening variable, which accounts for the relationship between a predictor variable and

an outcome variable (Baron & Kenny, 1986).

Qualitative Data Analysis

The researcher conducted the qualitative data analysis in Phase 2 of this study.

Qualitative data collection garnered significant amounts of non-numeric data from

interviews that required interpretation and analysis. Data collection and analysis

followed an inductive approach and analytic procedures were reassessed as new insights

emerged from qualitative data sources, as recommended by Maxwell (2005). To aid the

researcher's coding, qualitative data analysis for this study was augmented using NVivo

Version 11 by QSR International. NVivo is utilitarian computer software that supports

qualitative data analysis. The software does not self-generate codes, categories, or

themes and relies on the qualitative researcher to guide the analysis (Tracy, 2013). In

lieu of hand coding, the NVivo software aided the researcher in managing and organizing

collected qualitative data; facilitated the coding of key conceptual data attributes; and

assisted the researcher in recognizing, labeling, and exposing a cohesive series of overarching themes and subthemes.

Creswell (2009) described an inductive approach for analyzing qualitative data where the procedures included the organization and preparation of data for analysis, followed by reading all collected data to determine usefulness and appropriateness. After preparing and getting familiar with the data, the researcher coded the data to assign meaning, categorized emerging themes and descriptions, and then interpreted the meaning of the interrelated themes and descriptions. In this study, the researcher conducted the qualitative data analysis consistent with the procedures described by Creswell (2009):

1. Organized and prepared data for analysis. The researcher imported the Microsoft Word formatted transcripts from each of the six semi-structured interviews into NVivo to prepare for coding.

2. Read all collected data. The researcher read each of the transcripts multiple times to gain increased familiarity with the data, to determine the usefulness and appropriateness for analysis, and to explore the data for emerging patterns and themes.

3. Coded data to assign meaning. The researcher traversed the data using line-by-line coding to highlight relevant phrases and sentences within NVivo. The researcher coded the phrases and sentences verbatim and placed codes into the corresponding nodes within the NVivo software.

4. Categorized emerging interrelating themes and descriptions. A review of the constructed nodes in NVivo yielded common occurrences of words, phrases,

and sentences that aided in assembling a list of emerging topics that were similar. The researcher examined the list and determined which codes were interrelated and discerned which codes were unusable. Subsequently, the researcher classified relevant codes into categories. These categories formed the relational linkage used to surmise themes and subthemes (Bazeley & Jackson, 2013).

5. Interpreted meaning of interrelating themes and descriptions. The researcher examined the codes to observe where relationships existed between codes and across categories, while watching for emerging themes that offered coherent and accurate representation of the data.

Validity, Reliability, and Trustworthiness

This study consisted of qualitative and quantitative methods that supported the mixed methods design. Yin (2003) outlined four concepts that assess the quality of research designs. These assessment concepts include construct validity, internal validity, external validity, and reliability. Construct validity refers to an assessment of whether the operational measures selected are valid for the concept under study. Internal validity refers to the establishment of cause-effect relationships among conditions. External validity refers to whether the research finding can be generalized. Last, reliability refers to whether methods and procedures of a study can be repeated and yield the same results (Yin, 2003). Although Yin highlighted these four assessments are common in quantitative research and generally relevant to case study research, not all the assessment concepts are applicable to all types of qualitative studies.

Alternatively, Bloomberg and Volpe (2012) cited the seminal work of Guba and Lincoln (1998) who endeavored to deal with a competing paradigm between qualitative and quantitative research designs by establishing trustworthiness in qualitative research to address traditional validity issues that are seemingly germane to quantitative research. Researchers highlighted credibility, dependability, confirmability, and transferability as four factors necessary in establishing the trustworthiness within qualitative research (Bloomberg & Volpe; Bowen, 2005).

Credibility in qualitative research is aligned with its internal validity counterpart in quantitative research. The goal of credibility is for qualitative researchers to ensure findings are accurate and credible (Bloomberg & Volpe, 2012; Bowen, 2005). In this study, the researcher addressed credibility from the methodological and interpretive perspectives. The triangulation of data sources as part of the data collection approach is an appropriate and effective means to enhancing methodological validity. The researcher addressed interpretive validity by inviting key respondents from the interview sessions to participate in the review of the draft study report through the process of member checking (Bloomberg & Volpe; Maxwell, 2005).

Dependability in qualitative research is analogous to the concept of reliability in quantitative research and can be described as the reliability or repeatability of the study findings (Bowen, 2005). Bloomberg and Volpe (2012) proposed maintaining an audit trail that captures the evolution of thinking and records the rationale for all the choices and decisions made throughout the research study process. Confirmability in qualitative research parallels the concept of objectivity in quantitative research and involves discounting researcher subjectivity and biases by providing an audit trail throughout the

data collection and analysis processes that establishes the basis findings, interpretations, and recommendations (Bloomberg & Volpe; Bowen, 2005). In this study, the researcher addressed both dependability and confirmability by maintaining a journal to chronicle general insights and decisions relating to the study, documenting the researcher's perspective on how data were analyzed, and capturing the basis of interpretations used to derive the research findings.

Transferability in qualitative research is equivalent to external validity in quantitative research. Transferability refers to the extent the phenomenon within a context is transferrable to another context (Bloomberg & Volpe, 2012). In the context of qualitative research, the extent of transferability or generalizability resides with the reader. However, the researcher addressed transferability by providing rich, deep descriptions of the research context and the main assumptions to the investigation, as suggested by researchers (Bloomberg & Volpe, 2012; Bowen, 2005; Maxwell, 2005).

Format for Presenting Results

The researcher presents the results of this study in Chapter 4 and discusses the results in Chapter 5. Chapter 4 is the segment of this dissertation that facilitates the presentation of results and findings as derived from collected quantitative and qualitative data and uses a combination of narratives, tables, and figures to support the analyses. The analyses performed in this study and the related results and findings are segregated to reflect the distinct but complementary quantitative and qualitative examinations. The quantitative analysis section consists of statistical data to describe the population sample using frequency distribution and percentages to illuminate demographic characteristics. Additionally, survey participant responses contribute to the computation of means and

standard deviations. The qualitative segment identifies themes extracted from semi-structured interviews. The researcher discusses the emerging themes and associated linkages within the context of the research questions and the conceptual framework of the study. Chapter 5 is the segment of the dissertation that offers discussions related to the results and includes conclusions and implications of the study.

Resource Requirements

The researcher conducted this study at the DIA. Executive stakeholders granted permission to the researcher for data collection. This data collection included access to managers and employees assigned to the agency's back office organizations, which is the unit of analysis in this study. Additionally, the permission for data collection included access to relevant, permissible organizational documents, such as official memoranda, meeting minutes, audio-visual material, and archival documents and records. This study did not require funding from Nova Southeastern University (NSU), the DIA, or any source.

This research required extensive content analysis of key data sources. The key data collection mechanisms included a survey of peer-reviewed technical and journal articles, unclassified organizational planning documents and directives, books, conference proceedings, theses, dissertations, and questionnaires and interviews that target business and technology-centric subject matter experts. To obtain and review appropriate literature related to the phenomenon under investigation, the researcher used web-enabled information retrieval systems, such as Google Scholar and digital libraries of the Association of Computing Machinery digital library, IEEE Computer Society digital library, and other digital resources made available by the Alvin Sherman Library.

Ethical Considerations

Researchers who conduct studies that involve human subjects have a

responsibility to inform and protect participants (Bloomberg & Volpe, 2012). In

conducting this study, the researcher adhered to the ethical and moral guidelines

prescribed by federal regulations and the Institution Review Boards (IRB) of NSU and

the National Intelligence University (NIU) on behalf of DIA. The researcher interacted

with human subjects during this study. The researcher's data collection approach

entailed conducting interviews, administering a survey instrument, and reviewing

organizational documents or archival records. The researcher used email correspondence

to invite candidate participants.

Institution Review Board Approval

The IRB of NSU and the IRB of DIA/NIU reviewed and approved this study.

This investigation required DIA's approval prior to engaging in data collection. The

entire process for obtaining approvals from both IRBs occurred during a 4-month period.

The researcher submitted the IRB application sequentially to the NSU IRB and the

DIA/NIU IRB for approval. The submissions included separate application packages to

the respective IRBs. The application packages included the dissertation proposal, the

proposed survey instrument, the proposed interview questions, the informed consent

letter, and draft memoranda proposed for use by the researcher in communicating with

study subjects.

The NSU IRB reviewed the researcher's application and supporting documents

and granted preliminary approval predicated on obtaining approval from the DIA/NIU

IRB (see Appendix B) prior to commencing data collection activities. Consequently, the

DIA/NIU IRB approval was predicated on obtaining the required permissions from the

DIA data owners. Because this research was bound to the back-office environment of the

DIA, the researcher met with the organization's senior officials who have authority of the

targeted business areas to discuss the study and to obtain approval for data collection.

Initial contact between the researcher and the senior officials was facilitated through

formal memoranda (see Appendix D). The researcher follow-up occurred through

separate face-to-face meetings with the CFO and the deputy director for mission services

to provide an overview of the study, the types of data being collected, and the candidate

subjects targeted to complete the survey instrument or to participate in interviews.

The signed approval letters for data collection within DIA were submitted to the

DIA/NIU IRB (see Appendix B). Subsequently, the researcher was invited to present the

original research proposal to the DIA/NIU IRB panel and to answer questions regarding

the study. Appendix B also includes the DIA/NIU IRB approval letter.

Informed Consent

The researcher used the predefined NSU informed consent document as the

discussion framework for obtaining verbal and written consent from study subjects. In

establishing the relationship with the study subjects, the researcher introduced the study

by explaining the purpose of the study, describing the procedures, disclosing the risks and

benefits, establishing the role of the subject, and estimating the time involved. The

researcher informed all subjects that participation was voluntary. Subjects were informed

that no identifiable data would be used in the study and that they could drop out of the

study at any time. Additionally, the researcher advised subjects of their right to review

all information, including the transcript. The subjects participating in this study were

provided a copy of the informed consent document. This document included contact information for the researcher, the dissertation advisor, and the NSU IRB. The subjects were not allowed to participate in the study without consent.

Data Storage, Retention, and Destruction to Protect Confidentiality

The survey instrument, interviews, and associated protocols for this study were designed to minimize the need to collect identifiable data. In accord with NSU IRB and federal guidelines all data and information were and continue to be safeguarded by the researcher to protect confidentiality. The safeguard measure for data storage is a locked file in the researcher's residence where the data will be retained securely for a period of 3 years after completion of the research. Upon expiration of the 3-year retention period, the researcher will use commercial incineration to permanently destroy all research-related data and information pertaining to this study.

Summary

This chapter included the research design, methods, and procedures used in conducting this study. The mixed methods exploratory sequential design was defined and rationalized as an appropriate approach and strategy for achieving the research objectives of this study. Additionally, the researcher discussed the development, testing, and administration of the survey instrument and measures. Procedures for data collection and analysis were presented in relation to the quantitative and qualitative components of this study. Finally, the researcher addressed ethical considerations applied while preparing and conducting research involving human subjects. In the next chapter, the researcher presents the quantitative results and qualitative findings from the mixed methods data analyses.

Chapter 4

Results

This chapter presents the quantitative and qualitative data analyses of this mixed methods exploratory sequential study and is segregated into its constituent components. The chapter begins with the quantitative data analysis and results. In this section, the researcher discusses the survey response rate, presents demographic information and descriptive statistics, describes the preliminary analysis data treatment, and presents detailed analysis to address supporting research questions as presented in Chapter 1. The second part of this chapter presents the qualitative data analysis. This section represents qualitative analysis and findings that highlight the emergence of themes resulting from a series of semi-structured interviews with senior leaders. The researcher used purposeful sampling to identify and select participants based on their functional role, knowledge, and experience with established DW/BI capabilities. The chapter concludes with a summary of the quantitative results and qualitative findings.

Quantitative Data Analysis and Results

In conducting this study, the researcher used a questionnaire to obtain information from users of DW/BI regarding their perceptions of the current state of DW/BI within their organization and their perceptions regarding the influence of DW/BI on organizational performance. Using a list of DW/BI registered users made available by DIA, the researcher emailed invitations to 750 users requesting their participation in the

study. Participation involved navigating to the SurveyMonkey website using the

included hyperlink and completing the online survey. Upon closing quantitative data

collection, statistics from the SurveyMonkey website indicated a total of 57 participants

accessed the survey and provided consent to use their responses in the study. Among

these participants, 29 completed the survey in its entirety; the data indicate 28 did not

proceed beyond providing demographic information. The results of the completed

surveys yielded a response rate of 3.87%.

Demographic Information and Descriptive Statistics

The final sample resulting from survey responses consisted of 29 participants.

The demographic data revealed participants were mostly men ($n = 22$, 75.90%), age 51 or

more years old ($n = 15$, 51.70%), and a large proportion of the population had completed

a Baccalaureate degree ($n = 11$, 37.90%).   Additionally, the demographic data revealed

participants' employment at DIA was an average of 10.50 years ($SD = 7.02$), and have 1–

5 years of experience with the agency's EDW. The largest portion of respondents

worked in logistics or supply chain management ($n = 7$, 24.10%), were considered

functional management ($n = 12$, 41.40%), and had less than 100 employees in their

business area ($n = 21$, 72.40%). Table 9 presents the frequencies and percentages of

categorical data, and Table 10 presents the means and standard deviations of continuous

data.

Table 9

Frequencies and Percentages for Demographic Characteristics

Variable	n	%
Age		
23–30	3	10.30
31–40	5	17.20
41–50	6	20.70
51+	15	51.70
Gender		
Male	22	75.90
Female	7	24.10
Education		
Some College	3	10.30
Associate Degree	2	6.90
Baccalaureate Degree	11	37.90
Graduate Degree	9	31.00
Post-Graduate Degree	4	13.80
Functional Business Area		
Other	4	13.80
Acquisition and Procurement	5	17.20
Facilities	1	3.40
Finance	6	20.70
Human Resources	1	3.40
Information Systems/Technology	5	17.20
Logistics/Supply Chain	7	24.10
Management Level		
Other	4	13.80
Executive Management	2	6.90
Middle Management	7	24.10
Functional Management	12	41.40
Chose Not to Answer	4	13.80
Approximate Number of Employees		
< 100	21	72.40
100–499	4	13.80
500–999	1	3.40
> 1000	1	3.40
Chose Not to Answer	2	6.90

Variable	*n*	%
Experience with EDW/BI (Years)		
< 1	1	3.40
1–5	21	72.40
6–10	4	13.80
> 10	1	3.40
"I have never used my agency's EDW/BI"	2	6.90

Table 10

Means and Standard Deviations for Time Employed

Variable	Min.	Max.	*M*	*SD*
Time Employed at DIA (Years)	2.00	30.00	10.50	7.03

Pre-Analysis Data Treatment

The researcher initiated the pre-analysis data treatment by checking for outliers. Upon downloading survey response data from SurveyMonkey, the researcher examined data for the existence of anomalous data points and incorrect entries. The survey presented closed-ended questions only and yielded closed-ended responses, there were no instances of incorrect entries. The examination of outliers followed the procedure described by Tabachnick and Fidell (2012) where the researcher created standardized scores for each of the study variables and then examined for cases falling beyond ±3.29 standard deviations. No outliers identified. All variable scores were within 3.29 standard deviations of the mean based on the response sample size of 29.

The researcher created composite scores for the variables defined as organizational support, DW/BI information technology capabilities, DW/BI practices, DW/BI use, and organizational performance. These variables and the 36 questions

presented in the survey instrument are derivatives of the five constructs outlined in the

conceptual research model presented in Chapter 2. The following paragraphs present the

relationship between the survey questions, constructs, and variables employed for the

quantitative analysis.

The organizational support (OS) construct consisted of four survey questions and

represented in the analysis as items OS1 through OS4. The researcher created the

resulting organizational support scale from the mean of items OS1, OS2, OS3, and OS4.

The DW/BI practices (PRAC) construct consisted of five survey questions and

represented in the analysis as items PRAC1 through PRAC5. The researcher created the

DW/BI practices scale using the mean of items PRAC1, PRAC2, PRAC3, PRAC4, and

PRAC5. The DW/BI information technology (IT) capabilities construct consisted of 19

survey questions and represented in the analysis as items IT1 through IT19. The

researcher created the IT capabilities scale from the mean of items IT1 through IT19.

The DW/BI use (USE) construct consisted of six survey questions and represented in the

analysis as items USE1 through USE6. The researcher created the use scale from the

mean of items USE1 through USE6. Finally, the organizational performance (OP)

construct consisted of two survey questions and represented in the analysis as items OP1

and OP2. Using these items, the researcher created the organization performance scale.

The researcher used Cronbach's alpha to assess the reliability of composite

scores. Cronbach's alpha coefficients were interpreted using guidelines as prescribed by

George and Mallery (2010), where $> .9$ = Excellent, $> .8$ = Good, $> .7$ = Acceptable, $> .6$

= Questionable, $> .5$ = Poor, and $< .5$ = Unacceptable. The reliability for each composite

score was above excellent, where $\alpha = .90–.95$, with an exception being the composite

score that corresponded to DW/BI practices, which had an acceptable reliability of $\alpha =$

.73. Based on these findings, the researcher deemed each scale useful for analysis. Table

11 presents the results of the reliability analysis.

Table 11

Cronbach's Alpha Coefficients for Composite Scores

Composite Score	α	No. of Items
OS	.92	4
PRAC	.73	5
IT	.95	19
USE	.90	6
OP	.97	2

Quantitative Detailed Analysis

Research Question 1

The researcher performed a linear regression to address research question one

(RQ1), "What is the perceived influence of organizational support on DW/BI information

technology?" The predictor variable corresponded to OS and the criterion variable

corresponded to IT. Prior to analysis, the researcher assessed the assumptions of the

linear regression for linearity, homoscedasticity, and the absence of multicollinearity.

Examination of a scatter plot allowed for determination of linearity and homoscedasticity.

In accord with Stevens (2009), linearity assumes a straight-line relationship between the

predictor variables and the criterion variable, and homoscedasticity assumes normal

distribution of scores about the regression line. In the assessment for linearity and

homoscedasticity, the prevailing assumptions were met for RQ1 (see Figure 4). The

absence of multicollinearity assumes that predictor variables are not too related; which

the researcher assessed using Variance Inflation Factors (VIFs). Stevens indicated VIF

values higher than 10 will suggest the presence of multicollinearity. In assessing for the

absence of multicollinearity, all VIFs were well under the value of 10 (VIF = 1.00),
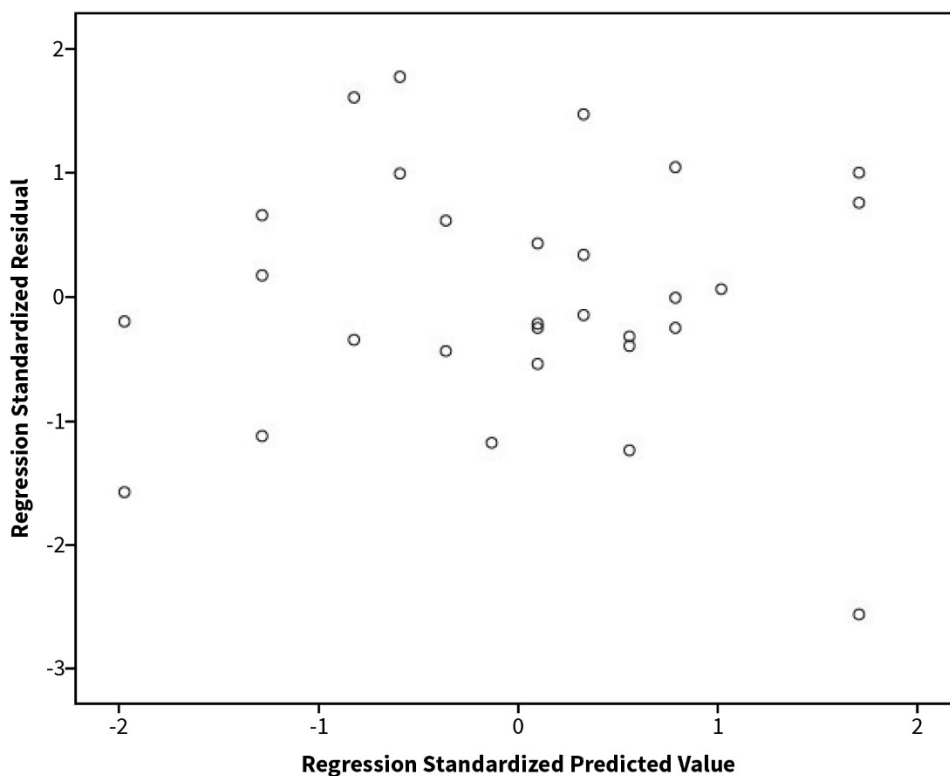
which indicated this assumption was met.

Figure 4. Scatterplot for regression with OS predicting IT.

Derived from RQ1, hypothesis one (H1) predicted that high levels of

organizational support will have a positive influence on DW/BI information technology

capabilities. The results of the linear regression indicated organizational support is a

significant predictor of DW/BI information technology capabilities, $F(1, 27) = 15.81$, p <

.001, $R^2 = .37$. The coefficient of determination—R^2— indicated OS accounts for up to

37% of the variability in IT. Examination of the coefficients ($B = 0.45$, $t = 4.00$, $p <$ .001) revealed that for every 1-unit increase in OS, IT increases by 0.45 units. As such, the null hypothesis can be rejected in favor of the alternate, H1. Table 12 presents the results of the analysis for H1.

Table 12

Coefficients: Regression with OS Predicting IT

Variable	B	SE	β	t	p
Organizational Support	0.45	0.11	.61	4.00	<.001

Note. $F(1, 27) = 15.81$, $p < .001$, $R^2 = .37$. (B) unstandardized beta, (SE) standard error, (β) standardized beta, (t) t test value, (p) t test associated p value.

Research Question 2

The researcher performed a linear regression to address research question two (RQ2), "To what extent does organizational support influence DW/BI practices?" The predictor variable corresponded to OS and the criterion variable corresponded to PRAC. Prior to analysis, the researcher assessed the assumptions of the linear regression using criteria as described previously in RQ1. In the assessment of linearity and homoscedasticity in this linear regression, examination of the scatter plot (see Figure 5) indicated the assumptions of linearity and homoscedasticity were met for RQ2. The absence of multicollinearity was met for RQ2, as the VIF = 1.00.
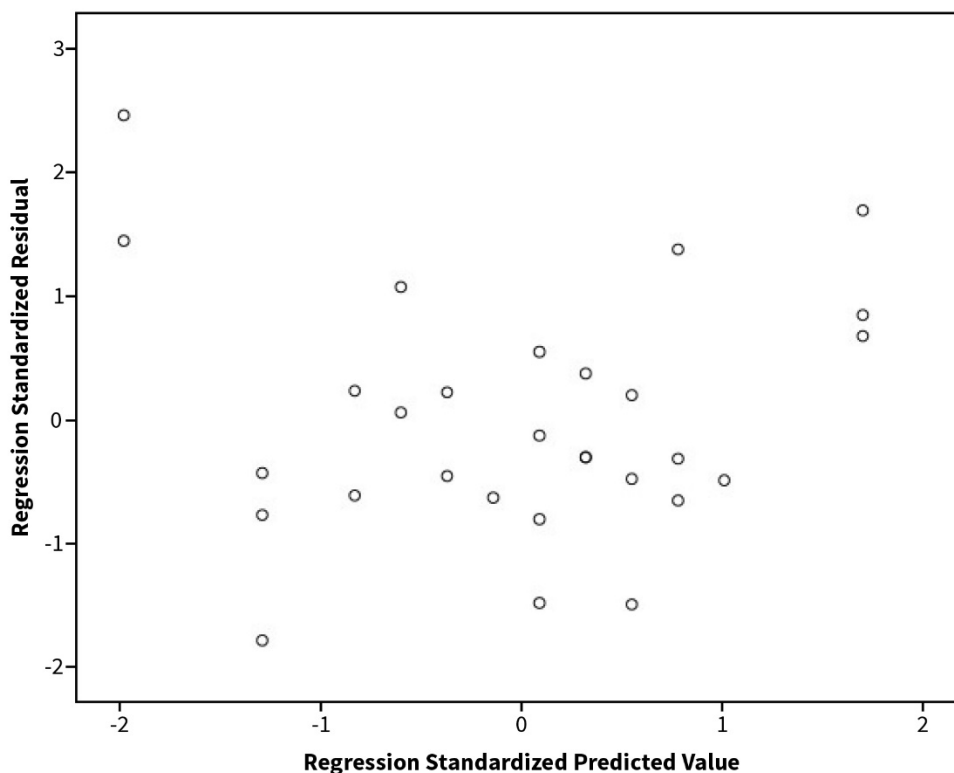
Figure 5. Scatterplot for regression with OS predicting PRAC.

Derived from RQ2, hypothesis two (H2) predicted that high levels of organizational support will have a positive influence on DW/BI practices. The results of the linear regression indicated organizational support is a significant predictor of DW/BI practices, $F(1, 27) = 16.17$, $p < .001$, $R^2 = .38$. This result indicated OS accounts for up to 38% of the variability in PRAC. Examination of the coefficients ($B = 0.41$, $t = 4.02$, $p < .001$) revealed that for every 1-unit increase in OS, PRAC increased by 0.41 units. The null hypothesis can be rejected in favor of the alternate, H2. Table 13 presents the results of the analysis for H2.

Table 13

Coefficients: Regression with OS Predicting PRAC

Variable	*B*	*SE*	*β*	*t*	*p*
Organizational Support	0.41	0.10	.61	4.02	<.001

Note. $F(1, 27) = 16.17$, $p < .001$, $R^2 = .38$. (*B*) unstandardized beta, (*SE*) standard error, (*β*) standardized beta, (*t*) t test value, (*p*) t test associated *p* value.

Research Question 3

The researcher performed a linear regression to address research question three (RQ3), "How does DW/BI information technology motivate constituents to use DW/BI in organizational decision-making?" The predictor variable corresponded to IT and the criterion variable corresponded to USE. Prior to analysis, the researcher assessed assumptions of the linear regression using criteria as described previously. In the assessment of linearity and homoscedasticity in this linear regression, examination of the scatter plot (see Figure 6) indicated the assumptions of linearity and homoscedasticity were met. The absence of multicollinearity was met for RQ3, as the VIF = 1.00.
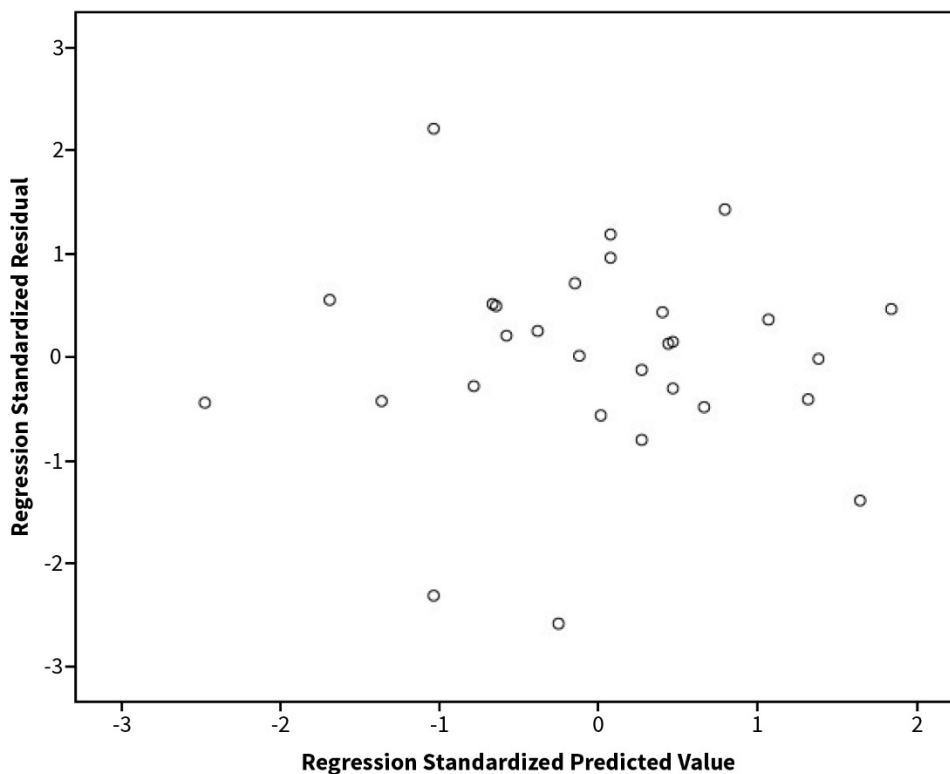
Figure 6. Scatterplot for regression with IT predicting USE.

Derived from RQ3, hypothesis three (H3) predicted that high levels of DW/BI information technology capabilities will have a positive influence on DW/BI use. The results of the linear regression indicated DW/BI information technology capabilities are a significant predictor of DW/BI use, $F(1, 27) = 23.61$, $p < .001$, $R^2 = .47$. This result indicated IT accounts for up to 47% of the variability in USE. Examination of the coefficients ($B = 0.84$, $t = 4.86$, $p < .001$) revealed that for every 1-unit increase in IT, USE increases by 0.84 units. As such, the null hypothesis can be rejected in favor of the alternate, H3. Table 14 presents the full results of the analysis for H3.

Table 14

Coefficients: Regression with IT Predicting USE

Variable	*B*	*SE*	*β*	*t*	**p**
IT Capabilities	0.84	0.17	.68	4.86	$< .001$

Note. $F(1, 27) = 23.61$, $p < .001$, $R^2 = .47$. (*B*) unstandardized beta, (*SE*) standard error, (*β*) standardized beta, (*t*) t test value, (*p*) t test associated *p* value.

Research Question 4

The researcher performed a linear regression to address research question four (RQ4), "To what extent do DW/BI practices inspire or influence pervasive DW/BI use across the organization?" The predictor variable corresponded to PRAC and the criterion variable corresponded to USE. Prior to analysis, the researcher assessed the assumptions of the linear regression using criteria as described previously. In the assessment of linearity and homoscedasticity, examination of the scatter plot (see Figure 7) indicated the assumptions of linearity and homoscedasticity were met. The absence of multicollinearity was also met for RQ4, where the VIF = 1.00.
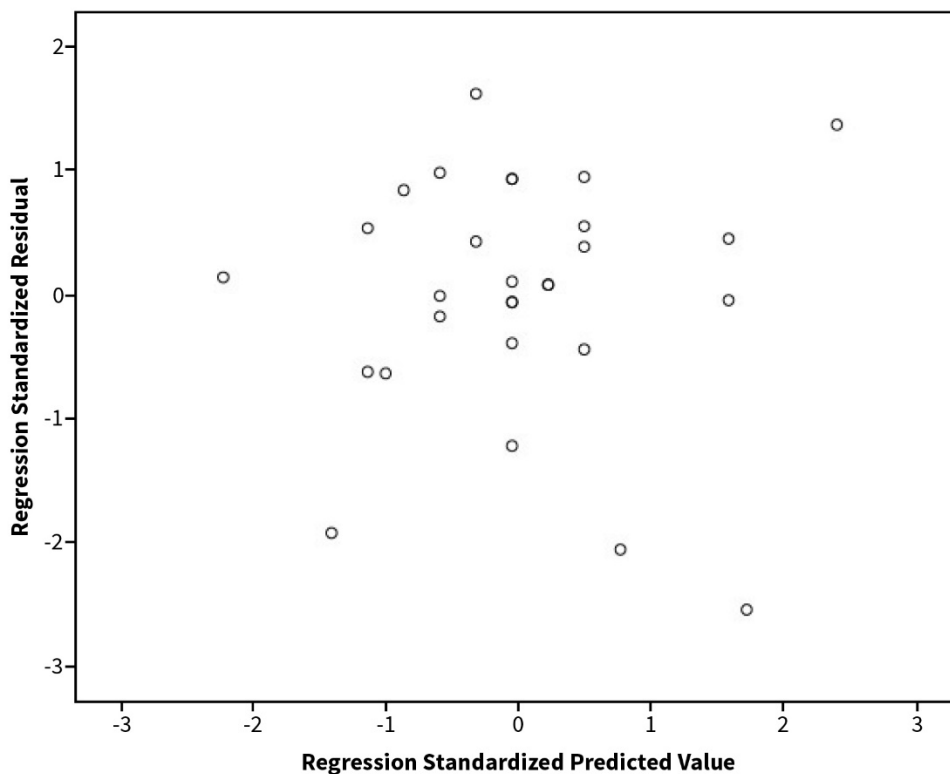
Figure 7. Scatterplot for regression with PRAC predicting USE.

Derived from RQ4, hypothesis four (H4) predicted that high levels of DW/BI practices will have a positive influence on DW/BI use. The results of this linear regression were not significant, $F(1, 27) = 0.24$, $p = .631$, $R^2 = .01$. This result indicated PRAC does not significantly predict USE. As such, the coefficients were not examined further and the null hypothesis cannot be rejected. The alternate hypothesis, H4, could not be supported.

Research Question 5

The researcher performed a linear regression to address research question five (RQ5), "To what extent does DW/BI use influence organizational performance?" The predictor variable corresponded to USE and the criterion variable corresponded to OP.

Prior to analysis, the researcher assessed the assumptions of the linear regression using criteria as described previously. In the assessment of linearity and homoscedasticity, examination of the scatter plot (see Figure 8) indicated the assumptions of linearity and homoscedasticity were met. The absence of multicollinearity was also met for RQ5, where the VIF = 1.00.
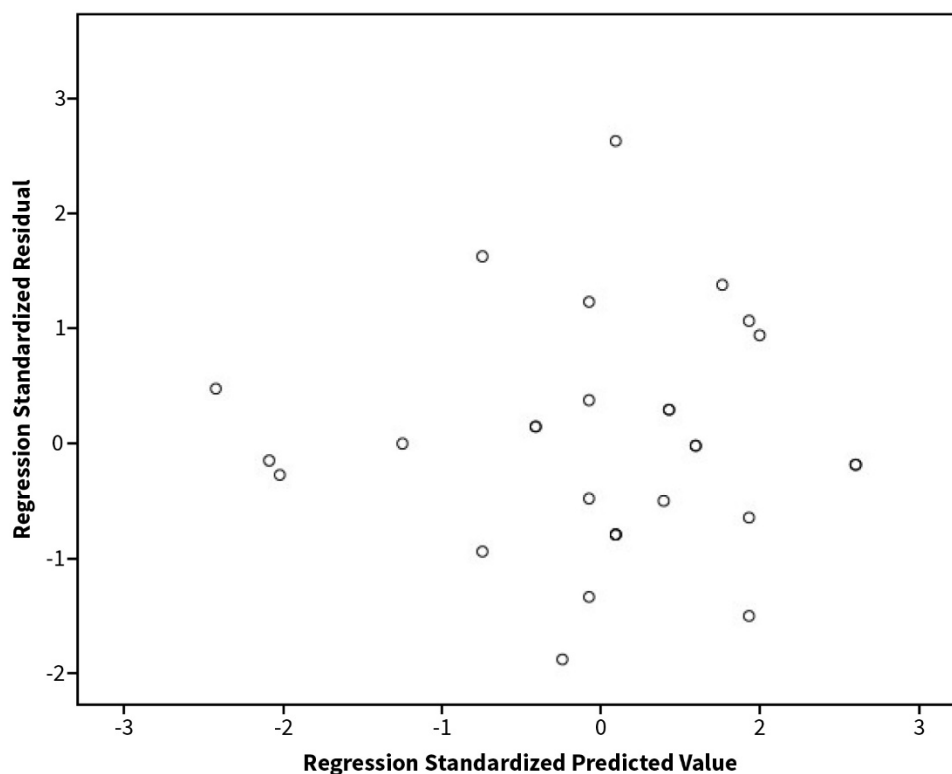
Figure 8. Scatterplot for regression with USE predicting OP.

Derived from RQ5, hypothesis five (H5) predicted that high levels of DW/BI use will have a positive influence on organizational performance. The results of this analysis were significant, $F(1, 27) = 97.40$, $p < .001$, $R^2 = .78$, indicating DW/BI use significantly predicts organizational performance. The coefficient of determination suggested USE accounts for up to 78% of the variability in OP. Examination of the coefficients ($B = 1.10$, $t = 9.87$, $p < .001$) revealed that as USE increases by 1.00 unit, OP increases by 1.10 units.

The results of a one sample *t* test on the standardized beta co-efficient, found USE was a significant predictor of OP within the overall regression. As such, the null hypothesis can be rejected in favor of the alternate H5. Table 15 presents the analysis results for H5.

Table 15

Coefficients: Regression with USE Predicting OP

Variable	B	SE	β	t	p
DW/BI Use	1.10	0.11	.89	9.87	< .001

Note. $F(1, 27) = 97.40$, $p < .001$, $R^2 = .78$. (*B*) unstandardized beta, (*SE*) standard error, (*β*) standardized beta, (*t*) t test value, (*p*) t test associated *p* value.

Research Question 6

The researcher formulated research question six (RQ6) as a supplemental examination regarding the perceptions of mediating relationships among variables; a mediation analysis was performed to address RQ6, "What is the influence of perceived DW/BI information technology in mediating the relationship between organizational support and DW/BI use?" The researcher performed a Baron and Kenny (1986) mediation analysis to assess if DW/BI information technology capabilities mediated the relationship between organizational support and DW/BI use. In this analysis, the independent variable was OS, the mediator was IT, and the dependent variable was USE. Prior to analysis, the researcher assessed the assumptions of linearity and homoscedasticity through examination of scatterplots (see Figure 9); both assumptions were met. The absence of multicollinearity was met as well (VIF = 1.00). Baron and Kenny emphasized that three conditions must be met for mediation to be supported: (a) the independent variable must significantly predict the dependent variable in the first regression, (b) the independent variable must significantly predict the mediating variable

in the second regression, and (c) the mediator must significantly predict the dependent variable in the third regression, where both the independent variable and mediator are entered as predictor variables. Baron and Kenny further advised if in the third regression the independent variable is no longer significant in predicting the dependent variable, then full mediation is supported.

Figure 9. Scatterplot for regression with IT as mediator between OS and USE.

Derived from RQ6, hypothesis six (H6) predicted that perceptions of DW/BI information technology capabilities mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. To assess for mediation, the researcher conducted three regressions. The first regression used OS as the independent variable and USE as the dependent variable. The results of the first regression were not

significant, $F(1, 27) = 3.29$, $p = .081$, $R^2 = .11$. Given the results of the first regression where Condition 1 of the Baron and Kenny method was not supported, then mediation cannot be supported. Because insufficient evidence supported a relationship between the independent and dependent variables, further analysis was not continued and the null hypothesis could not be rejected.

Research Question 7

The researcher formulated research question seven (RQ7) as a supplemental examination regarding the perceptions of mediating relationships among variables. RQ7 asked, "What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?" To address RQ7, the researcher performed a Baron and Kenny (1986) mediation analysis to assess if DW/BI practices mediate the relationship between organizational support and DW/BI use. In this analysis, the independent variable was OS, the mediator was PRAC, and the dependent variable was USE. Prior to analysis, the researcher assessed the assumptions of linearity and homoscedasticity through examination of scatterplots (see Figure 10); both assumptions were met. The absence of multicollinearity was met as well (VIF = 1.60).
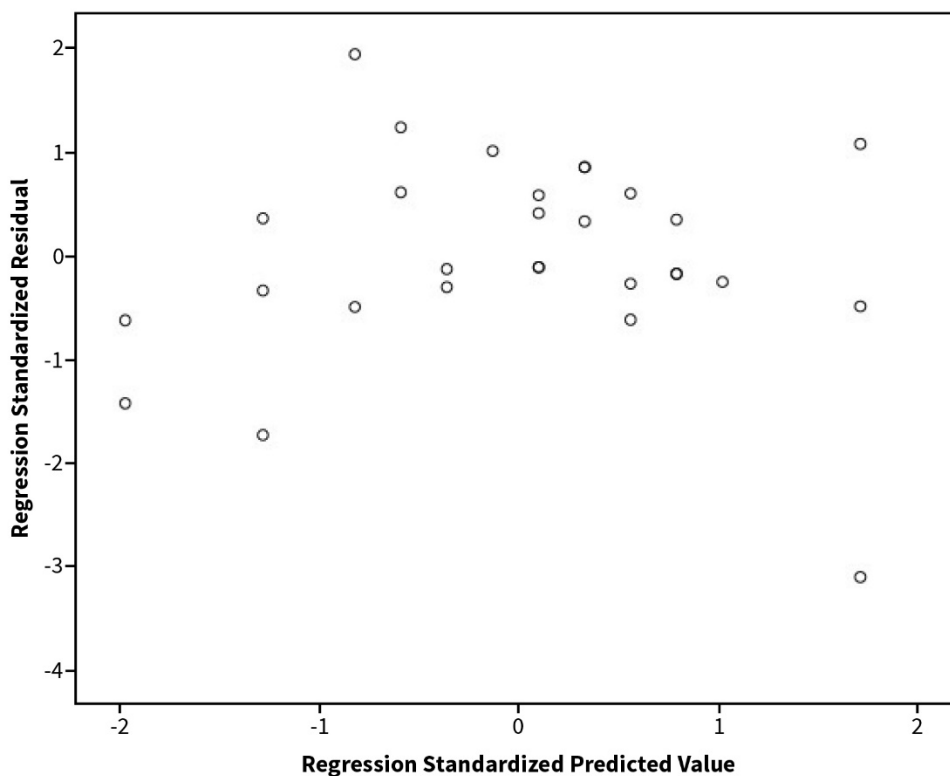
Figure 10. Scatterplot for regression with PRAC as mediator between OS and USE.

Derived from RQ7, hypothesis seven (H7) predicted that perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. To assess for mediation, the researcher conducted three regressions. The first regression included OS as the independent variable and USE as the dependent variable. The results of this first regression were not significant, $F(1, 27) = 3.29$, $p = .081$, $R^2 = .11$. As the results were not significant, Condition 1 of the Baron and Kenny method was not supported; mediation cannot be supported. The researcher did not continue further analysis and the null hypothesis could not be rejected.

Research Question 8

The researcher formulated research question eight (RQ8) as a supplemental examination regarding the perceptions of mediating relationships among variables. RQ8

asked, "What is the influence of perceived DW/BI use in mediating the relationship between DW/BI information technology and organizational performance?" To address RQ8, the researcher performed a Baron and Kenny (1986) mediation analysis to assess if DW/BI use mediated the relationship between DW/BI information technology capabilities and organizational performance. In this analysis, the independent variable was IT, the mediator was USE, and the dependent variable was OP. Prior to analysis, the researcher assessed the assumptions of linearity and homoscedasticity through examination of scatterplots (see Figure 11); both assumptions were met. The absence of multicollinearity was met as well (VIF = 1.87).
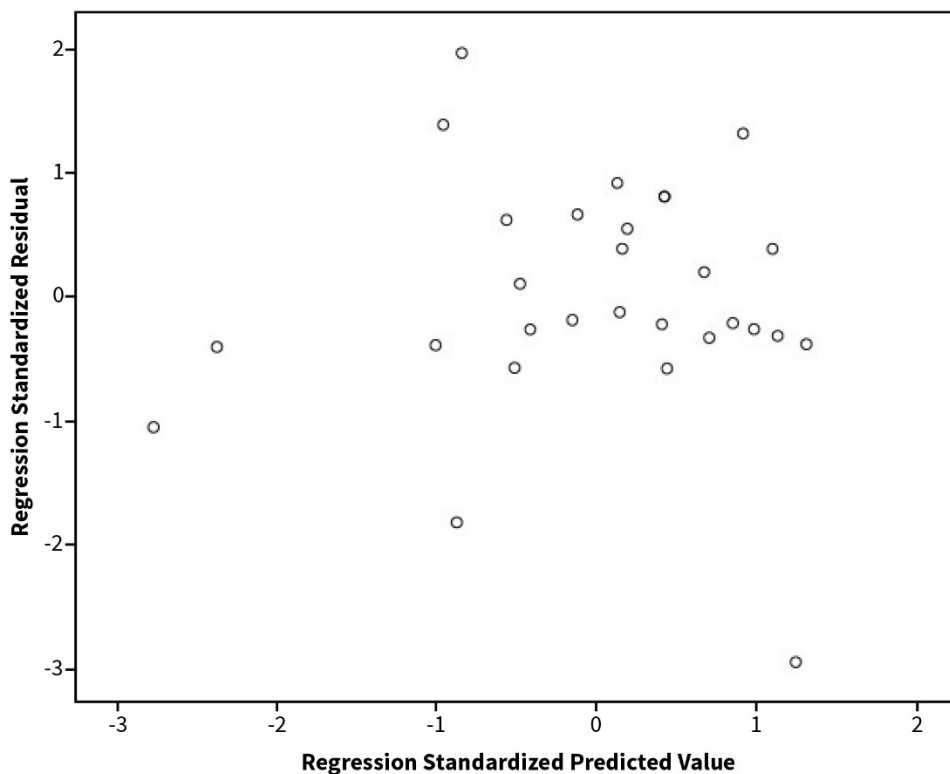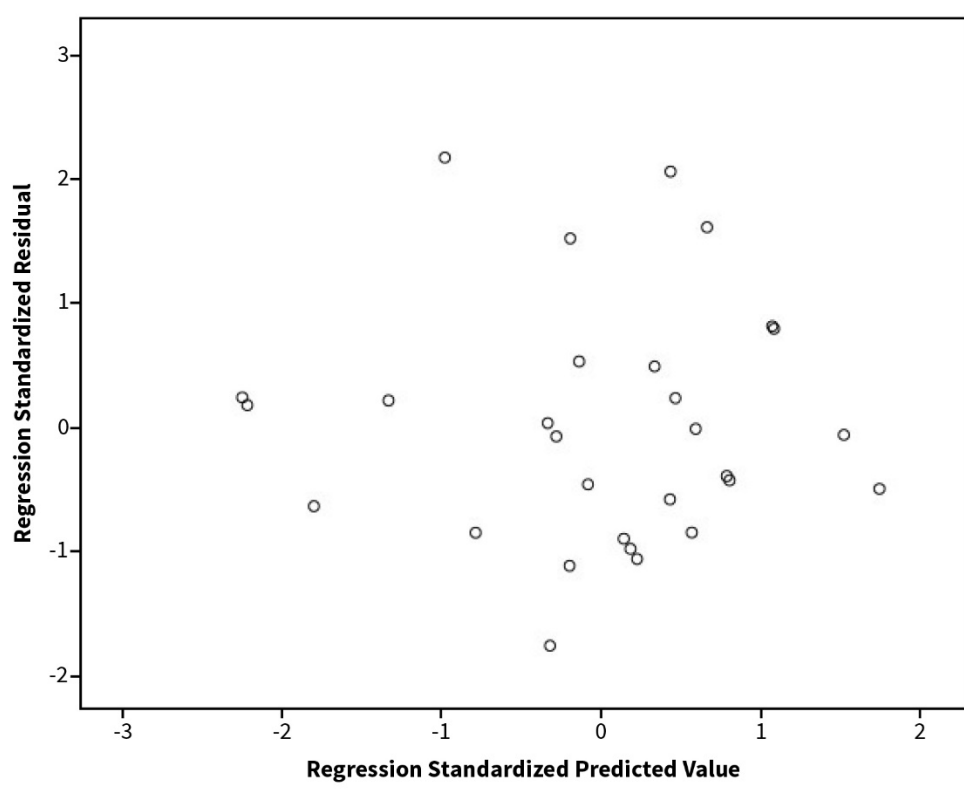

Figure 11. Scatterplot for regression with USE as mediator between IT and OP.

Derived from RQ8, hypothesis eight (H8) predicted that perceptions of DW/BI use mediate the relationship between perceptions of information technology capabilities and perceptions of organizational performance. First, the researcher conducted a regression with IT predicting OP. This was found to be significant, $F(1, 27) = 26.87$, $p < .001$, $R^2 = 0.59$. This finding suggests that IT predicts OP and satisfies Condition 1 of the Baron and Kenny method of mediation analysis. Next, the regression from RQ3 with IT predicting USE was reassessed, and based on the significant findings for this research question, $F(1, 27) = 23.61$, $p < .001$, $R^2 = 0.47$. The results indicated IT predicts USE, thus satisfying Condition 2 of the Baron and Kenny mediation analysis. Finally, the researcher performed a regression with IT and USE predicting OP. The results of this final regression were significant as well, $F(2, 26) = 52.80$, $p < .001$, $R^2 = .80$. This finding suggests that collectively, DW/BI information technology capabilities and DW/BI use predict organizational performance. DW/BI use was an individually significant predictor of organizational performance, $B = 0.94$, $t = 6.32$, $p < .001$; as such, Condition 3 of the Baron and Kenny method was met. Because the independent variable, IT, was not a significant predictor in the presence of the mediator, $B = 0.29$, $t = 1.60$, $p = .122$, full mediation is supported. The null hypothesis can be rejected. The results suggest DW/BI use fully mediates the relationship between DW/BI information technology capabilities and organizational performance. This finding indicates that although there appeared to be a relationship between IT and OP, this relationship is carried through the variable of USE. Table 16 presents the full results of this analysis.

Table 16

Regression Results with USE Mediating Relationship Between IT and OP

Dependent Variable	Independent	*B*	*SE*	β	*t*	*p*
Regression 1:						
Organizational Performance	IT Capabilities	1.08	0.21	.71	6	<.001
Regression 2:						
DW/BI Use	IT Capabilities	0.84	0.17	.68	4.86	<.001
Regression 3:						
Organizational Performance	IT Capabilities	0.29	0.18	.19	1.60	.122
	DW/BI Use	0.94	0.15	.75	6.32	<.001

Note. First regression: $F(1, 27) = 26.87, p < .001, R^2 = 0.59$
Second regression: $F(1, 27) = 23.61, p < .001, R^2 = 0.47$
Third regression: $F(2, 26) = 52.80, p < .001, R^2 = .80$
(*B*) unstandardized beta, (*SE*) standard error, (*β*) standardized beta, (*t*) t test value, (*p*) t test associated *p* value.

Research Question 9

The researcher formulated research question nine (RQ9) as a supplemental examination regarding the perceptions of mediating relationships among variables. RQ9 asked, "What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?" To address RQ9, the researcher performed a Baron and Kenny (1986) mediation analysis to assess if DW/BI use mediated the relationship between DW/BI practices and organizational performance. In this analysis, the independent variable was PRAC, the mediator was USE, and the dependent variable was OP. Prior to analysis, the researcher assessed the assumptions of linearity and homoscedasticity through examination of scatterplots (see Figure 12); both assumptions were met. The absence of multicollinearity was met as well (VIF = 1.01).
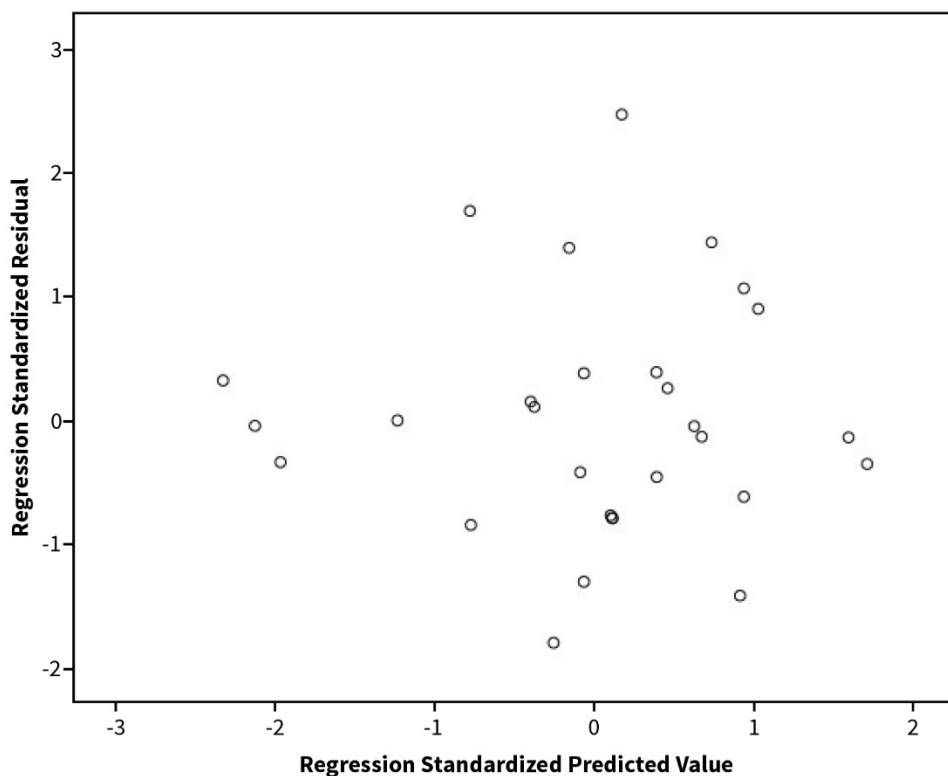
Figure 12. Scatterplot for regression with USE as mediator between PRAC and OP.

Derived from RQ9, hypothesis nine (H9) predicted that perceptions of organizational use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance. Three regressions were planned for this final mediation analysis. In the first regression, the independent variable corresponded to PRAC and the dependent variable was OP. This regression was not significant, $F(1, 27) = 0.39$, $p = .535$, $R^2 = .01$; thus, Condition 1 of the Baron and Kenny method was not supported. As such, the researcher did not complete further analysis. The null hypothesis for H9 cannot be rejected.

Table 17

Summary of Hypotheses Testing

Research Question	Alternate Hypotheses	Result
RQ1. What is the influence of organizational support on DW/BI Information technology?	H1. High levels of organizational support will have a positive influence on DW/BI information technology.	Supported
RQ2. To what extent does organizational support influence DW/BI practices?	H2. High levels of organizational support will have a positive influence DW/BI practices.	Supported
RQ3. How does DW/BI information technology inspire constituents to use DW/BI in organizational decision-making?	H3. High levels of DW/BI information technology will have a positive influence on DW/BI use.	Supported
RQ4. To what extent do DW/BI practices inspire or influence DW/BI use?	H4. High levels of DW/BI practices will have a positive influence on DW/BI use.	Not Supported
RQ5. To what extent does DW/BI use influence organizational performance?	H5. High levels of DW/BI use will have a positive influence on organizational performance.	Supported
RQ6. What is the influence of perceived DW/BI information technology in mediating the relationship between organizational support and DW/BI use?	H6. Perceptions of DW/BI information technology mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.	Not Supported
RQ7. What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?	H7. Perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use.	Not Supported
RQ8. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI	H8. Perceptions of DW/BI use mediate the relationship between perceptions of DW/BI information technology and	Supported

Research Question	Alternate Hypotheses	Result
information technology and organizational performance?	perceptions of organizational performance.	
RQ9. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?	H9. Perceptions of DW/BI use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance.	Not Supported

Qualitative Data Analysis and Findings

The qualitative data analysis focused on RQ1 through RQ5. Although the quantitative findings drawn from the use of regression and mediation analyses were insightful, specific details and rich descriptions of these findings were sought through qualitative analysis, resulting in a more comprehensive examination of the research questions. The use of qualitative analysis represented the second stage of analysis in this mixed methods study. Data collection consisted of a series of interview questions developed based on quantitative findings (see Appendix E). The researcher posed interview questions to a sample of six participants identified as executives who were knowledgeable of the phenomenon under investigation and consented to taking part in this study. Pertaining to this data analysis, the term EDW was the project name used for DIA's DW/BI initiative. Therefore, in the context of this qualitative data analysis, the terms EDW and DW/BI were synonymous.

The researcher performed the analysis for this study using NVivo by QSR International to aid in managing and organizing transcription data, to facilitate coding and tagging of key attributes, and to support theme development. The use of NVivo offered

an efficient and effective approach to qualitative data analysis without consuming the time required to hand code large amounts of data.

The researcher initiated the preliminary phase of data analysis by populating the NVivo database with transcripts from each of the six semi-structured interviews. In parallel with reading the transcripts and exploring the data, the researcher highlighted within NVivo relevant phrases and sentences from participant responses with the aim of coding the exact words into their respective nodes. Using line-by-line coding and subsequently assessing data attributes as presented in the nodes yielded common occurrences of words, phrases, and sentences that aided the researcher in assembling a list of emerging topics. After line-by-line coding was complete, the researcher constructed a list of the resultant codes to assess the relationships that existed among them. The researcher then classified relevant codes into categories. The researcher examined the list of resultant codes and determined which codes were related to one another and discerned which codes were irrelevant to the central and supporting research questions. These categories formed the relational linkage used to infer themes and subthemes.

After the relationships were established between the codes and across categories, the researcher looked for emerging themes and subthemes to compile a coherent and accurate representation of the data (see Figure 13). The researcher examined the relationships that existed between subthemes to ascertain whether participants' responses were persistent in supporting an overarching theme. After recognizing the emergence of an overarching theme, the researcher transitioned to the descriptive aspect of this qualitative data analysis to provide support that aided in defining and describing each

subtheme. Six themes emerged as an overarching theme and five subthemes. The

overarching theme was Understanding the EDW. The five subthemes that emerged were

categorized as championship, business value, organizational performance, support, and

pervasive use. These subthemes illuminated the data in a concise and meaningful manner
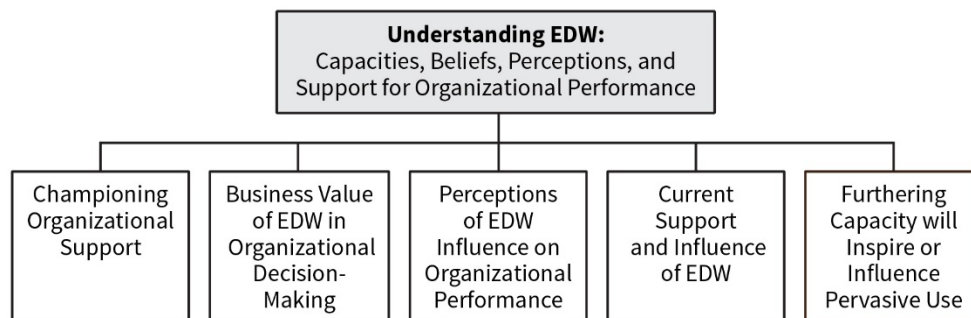
to support the overarching theme.

Figure 13. Diagram of overarching theme and subthemes.

Understanding EDW: Capacities, Beliefs, Perceptions, and Support for Organizational

Performance

The researcher examined the perceptions, beliefs, and experiences of six

executives who were identified and selected purposefully to participate in this study. An

overarching theme that manifested as the researcher analyzed the qualitative data

pertained to the organization's senior leaders' understanding and appreciation for DW/BI.

Among these executives, all acknowledged championship for the current and continued

use and development of the organization's DW/BI capabilities. A common sentiment

existed that DIA's DW/BI initiative offers untapped potential regarding its capabilities

and capacities and is perceived as being instrumental in capturing, organizing, and

mining integrated data that originate from transactional business systems across the

organization. Interview participants cited scenarios in which the use of DW/BI for data

analyses and reporting informed decision-making within their respective business areas when making financial and performance-based decisions.

Although all participants conveyed their knowledge and recognition that the organization's DW/BI capabilities were more mature in generating reports and presenting dashboards within the financial domain, three senior executives (Participant 1, Participant 2, and Participant 3) articulated a strong desire and support in further developing the DW/BI capabilities to facilitate the seamless integration of cross-functional business systems to provide a unified view of organizational data. The following paragraphs provide a detailed description of the five subthemes that informed the development of the overarching theme.

Championing Organizational Support

As illustrated in Figure 14, the subtheme championing organizational support was comprised of the categories belief, commitment, and organizational support and championing for EDW.
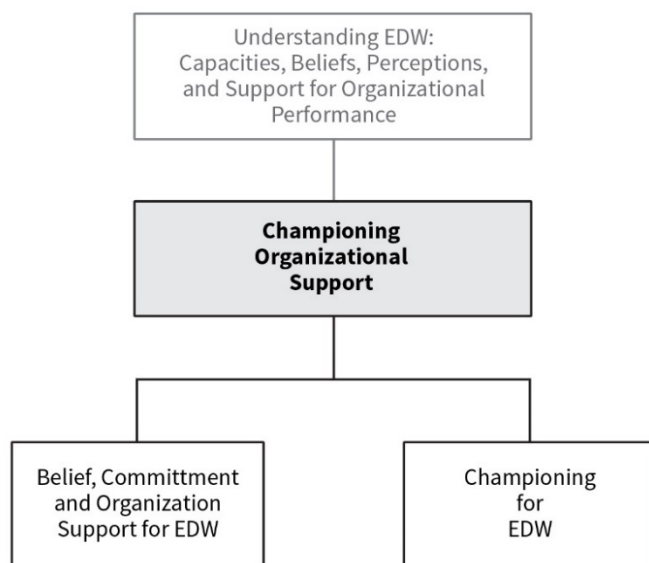

Figure 14. Subtheme championing organizational support.

This subtheme of championship was informed by participant responses to interview questions regarding the influence of organization support on the maturation of DIA's DW/BI initiative. In coding participant responses, key words and related statements spanned multiple nodes. All participants discussed their beliefs about the DIA's EDW within their respective business areas and explained the importance of the governance board in advocating for the expansion of EDW capabilities to address the business and data needs of the enterprise. All six participants were executives who identified themselves as champions for EDW and believed unanimously that furthering the capabilities and capacity of the EDW will yield increased performance benefits for the organization.

Participants' experiences with the EDW were varied. Each participant represented a different discipline and functional business area within DIA. Each conveyed an understanding of the importance, value, and use of the EDW, except Participant 4 who admitted to not using EDW capabilities to its fullest. Participant 2 used EDW to support decision-making and as a central repository to support the organization's financial statement audits. Participant 3 self-identified as "absolutely a full champion" of EDW, particularly in "driving change that drives behavior." Participant 3 explained that "EDW is critical to us coming up with decision or decision points" in order "to illustrate to our managers how we arrive at decisions." Participant 1 noted the DIA's governance board advocated for expanding EDW capabilities:

> I'm convinced that with the increased awareness and emphasis on data analytics
> that we're seeing outside of the financial world, and how we're starting to use it in

mission kinds of work, it's going to make data warehouse requirements or make

the use of data warehouse ubiquitous [to other fields].

Participant 2 stated, "EDW has helped us in various areas." Participant 2

highlighted one of the most important aspects of EDW is that when "we have contract

data and finance data, that in a sense collides into the system, we can use the data to

inform that the two systems are staying aligned." Participant 4 was the only interviewee

out of six who acknowledged EDW is utilized minimally within the participant's business

domain. Participant 4 shared, "you don't appreciate the importance of what it [EDW]

does to tie together all the [business] systems." Participant 4 also described the current

state of EDW use as "a leadership challenge" because without context leaders may not

"appreciate all the caveats that go with the data."

Business Value of EDW in Organizational Decision-Making

The business value of EDW in organizational decision-making comprised the

categories business value and information technology influences the use of EDW (see

Figure 15). This subtheme of business value manifested from participant responses to

interview questions aimed to assess whether DW/BI (or EDW) information technology

capabilities motivated employees to use the EDW when faced with making

organizational decisions. Although this topic was mentioned in the subtheme of

Championing of Organizational Support, the researcher focused on the influence of

DW/BI information technology capabilities on the use of EDW in organizational
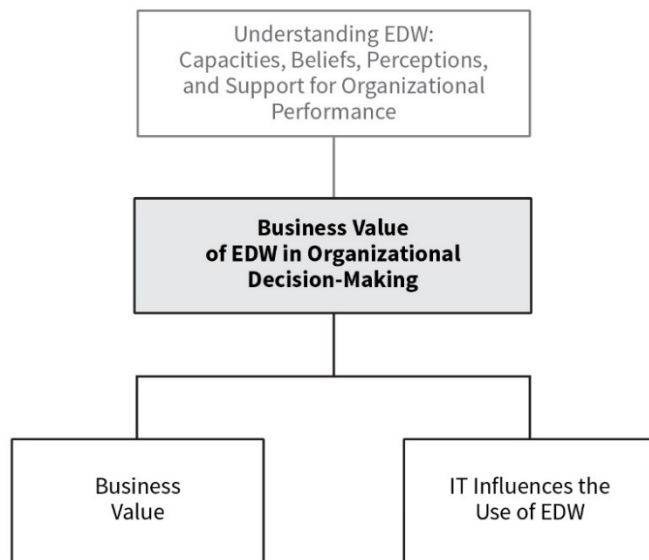
decision-making.

Figure 15. Subtheme business value of EDW in organizational decision-making.

Participant 1 and Participant 5 explained the DIA's EDW Program Management
Office is the office of primary responsibility for deploying and maintaining the agency's
DW/BI capabilities. However, according to Participant 1, the EDW Program
Management Office cannot force employees to use the capabilities, especially because
functional users "have their individual business systems that they can dive into and get
information." Still, according to Participant 1, the Program Management Office is
obligated to illuminate "the elements that EDW can bring together to be used to make
better business decisions across the agency instead of being stove-pipped." Participant 2
highlighted business managers and directorates "use it [EDW] to monitor day-to-day but
they don't know how they can pull and use the data for management decisions, so that is
something that needs to be communicated across the agency." Participant 4 mentioned,
"It's essential to teaming up the data so you can make a good decision. Again, to me, it's

the importance of someone who understands the data, pulling it out, interpreting it

correctly, and analyzing it."

Participant 3 stated it is important to "create the systems that can talk to each

other across the board and to generate reports that make sense across the board to come

up with decisions." Although the participants expressed using the EDW to inform

decision-making, two participants (Participant 1 and Participant 6) shared aspirations for

the DIA EDW initiative to incorporate newer technology. Participant 1 stated, "the

technology is a bit dated and it's difficult to use." Participant 6 asserted, "in this day and

age you need about two or three clicks of the mouse; otherwise, [if navigation and use are

cumbersome] people are just going to move on [and abandon the system]."

Perceptions of EDW Influence on Organizational Performance

Perceptions of EDW influences on organizational performance comprised the

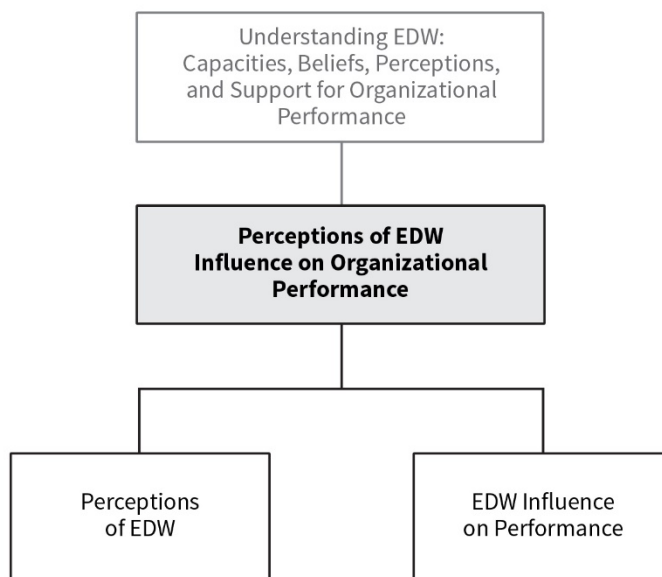categories Perceptions of EDW and EDW's Influence on Performance (see Figure 16).

Figure 16. Subtheme perceptions of EDW influence on organizational performance.

This subtheme emerged from coding of participant responses to interview questions regarding the extent that EDW influences organizational performance and was informed by participant perceptions regarding how DW/BI (or EDW) use could influence organizational performance. Participants discussed the positive influence of EDW on organizational performance. Some participants (Participant 1, Participant 2, Participant 3, and Participant 5) were optimistic that EDW will have even more significant influence as more people across the organization use the capabilities.

Participant 2 shared EDW is used to assimilate data derived from "different [business] feeder systems into one" to support "recurring reporting or ad hoc reporting [for] day-to-day work and for managers to develop reports for management information and decisions." Participant 2 continued by describing EDW as "a powerful tool that's underutilized to make business decisions here [at DIA]." Participant 3 stated,

> EDW is influencing performance in a positive way. We've still got some things to work through, but we will only get better. I think our only anchor is the fear of it and not knowing how to properly use it. A year from now we will be even better in leveraging the EDW.

Participant 3 mentioned that "we haven't scratched the surface" of the full capabilities of the EDW. Several participants recognized the value of EDW. Participant 4 mentioned, "EDW does tie together [information and data] just for its systems." Participant 5 described the EDW as, "as a critical tool within the enterprise currently, [especially] for the financial side." Participant 6 acknowledged that EDW is "a very good tool for us to be able to access information and share it [across the organization]."

Although consensus existed among interview participants that expanding the

scope of the EDW to include more functional business areas is a necessity, overall

participants' perceptions of EDW demonstrated the "clear value" (Participant 4) the

capability brings to DIA. Generally, interview participants described the DIA EDW

initiative as a critical apparatus that aids and informs decision-making for senior leaders

and managers across back-office operations.

Current Support and Influence of EDW

The subtheme Current Support and Influence of EDW was compiled from the

categories of Influence of EDW and Support for EDW (see Figure 17), which emerged

during the coding process. Attributes of these categories were compiled and aligned to

the resulting subtheme. This subtheme is premised on discussions regarding how the

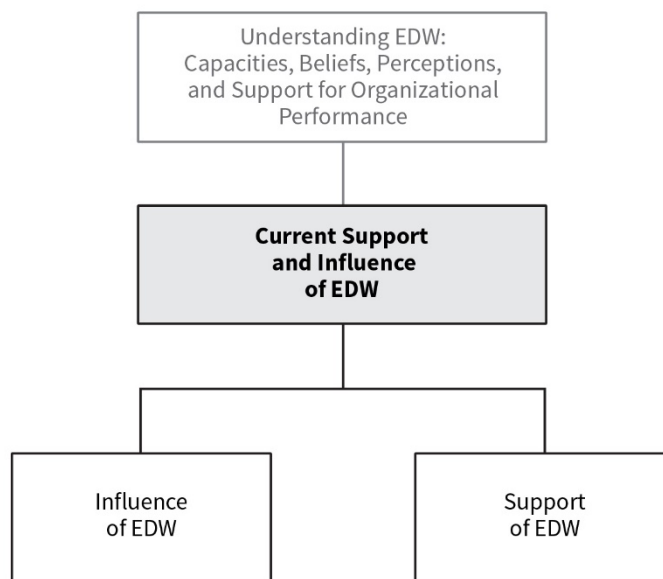current support for the EDW has influenced DW/BI practices.

Figure 17. Subtheme current support and influence.

This subtheme of support and influence was informed by participant responses to interview questions related to this topic. When discussing individual support of the EDW initiative and its influence on organizational performance, participants acknowledged opportunities for growth. Each participant, except Participant 6, shared at least one perceived opportunity for expanding capabilities across the enterprise. Participant 3 asserted,

> We've got to pivot away from what we've always known or what we've always done [or] what we've done in the past, and understand the full capability of information technology [if we are] to do business more accurately [and] more efficiently.

Participant 3 discussed concepts of what the organization could do "to carry us to the next level" with "an innovative mind" in IT. Participant 3 spoke about growth outside of finance. Participant 3 stated,

> It's [EDW] a financial tool more so than an enterprise tool, which we're going to have to address. We're going to have to address that across the board for all the entities within the enterprise.

Participant 1 explained EDW enabled cross-functional business areas to "utilize one system that pulls together all the relevant data and generates reports." Additionally, Participant 1 contended organizational support for EDW among senior leaders and functional managers influenced the way business and data analytics were implemented across DIA. Participant 1 stated the ubiquity of EDW is important for DIA because,

> It [EDW] becomes a source of ground truth. It becomes a system of record for management reporting, not a system of record for processing the underlying

transactions. Believe me that has performance impacts, because you get people to

stop arguing about whether their number's right versus this number. You got one

number. It comes out of one source, and everybody's agreed that source is

accurate.

Organizational support for EDW among senior leaders and functional managers

has made EDW practices congruent throughout the organization. Although opportunities

for growth and improvement exist, EDW "very much impacts the back-office… [and it] .

. . impacts the mission as well" (Participant 5).

Furthering Capacity Will Inspire or Influence Pervasive Use

Furthering Capacity of EDW Will Inspire or Influence Pervasive Use was

compiled from the categories capacity and uses of EDW and reliance and pervasive use
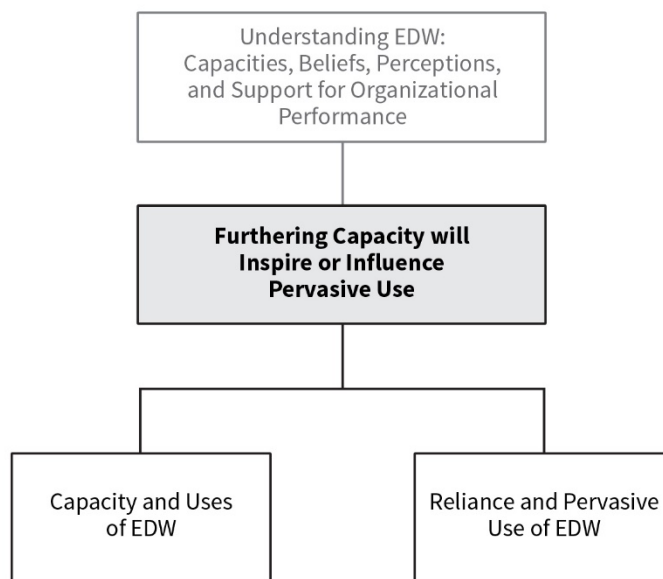
of EDW (see Figure 18).

Figure 18. Subtheme furthering capacity will inspire or influence pervasive use.

This subtheme emerged from participant responses to interview questions regarding the extent that DW/BI (or EDW) practices influence or inspire the pervasive use of EDW across the organization. Participants discussed current practices that inspire the use of EDW along with anticipated changes aimed to further the capacity of EDW and to influence use across the organization. Participants discussed how the current use of EDW was important for the DIA. The following excerpts were drawn from those who provided their perceptions.

Participant 1 stated that from inception of the EDW, one of its key outputs "is our budget execution reports, which basically sets the standard across the agency so we have one source of reporting to say to everybody… [here's] how much you have spent and how much you have available to spend [in the current fiscal year]." Participant 1 expounded,

> EDW cuts down dramatically on the number of interfaces that I've got to develop but more importantly operate. It [EDW] makes [for] a much more efficient environment both for exchanging data internally and externally with our external service providers.

Several participants recognized that EDW has made DIA an efficient and effective environment to manage resources and finances. Participant 2 acknowledged that the "biggest area where they use the data is obligation rates" in conjunction with "keeping our feeder systems and our accounting system reconciled." Participant 5 suggested this was not always the case:

> When it first started, yes, EDW was a standalone CPU that dealt with just archiving or collecting the financial data... It's become the central hub of the

spoke and wheel type design for communicating between the various business systems, it's the central clearinghouse and the report-providing tool that lets the individual user query and get reports accordingly.

Although growth has occurred regarding the capabilities of EDW, Participant 3 indicated a desire to see EDW expand "to conduct inventories, to support our inventory and property accountability programs." Participant 3 indicated the organization is embarking on initiatives to further inculcate EDW capabilities into the business domain.

Summary

This chapter began with a description of the pre-analysis data treatment and a description of the participant sample. During the screening process, data were absent of outliers and each scale constructed from the set of responses had at least acceptable reliability, with most found to be above excellent. The description of these procedures was followed with a detailed quantitative analysis of the results.

The quantitative data analysis revealed the following results for H1 through H5 through linear regression. The results for H1 indicated organizational support significantly predicts DW/BI information technology capabilities. The results for H2 indicated organizational support significantly predicts DW/BI practices. The results for H3 indicated DW/BI information technology capabilities significantly predict DW/BI use. The results for H4 indicated DW/BI practices do not significantly predict DW/BI use. The results for H5 indicated DW/BI use is a significant predictor of organizational performance.

Additionally, the quantitative data analysis provided insights regarding the mediating relationships among constructs. The results for H6 indicated DW/BI

information technology capabilities do not significantly mediate the relationship between organizational support and DW/BI use. The results for H7 indicated DW/BI practices do not significantly mediate the relationship between organizational support and DW/BI use. The results for H8 suggested DW/BI use does significantly mediate the relationship between DW/BI information technology capabilities and organizational performance. Finally, the results for H9 indicated DW/BI use does not significantly mediate the relationship between DW/BI practices and organizational performance.

In the qualitative analysis, the use of semi-structured interviews provided more depth to the thoughts, perceptions, and experiences of executives who represent the IT and business segments of the DIA. The goal of the interviews was to build on the quantitative findings to better understand linkages between the organization, DW/BI technology, DW/BI usage, and performance. The qualitative findings highlighted the benefit of the organization's EDW initiative and capabilities, particularly the EDW's value in aiding senior leaders and managers in making financial decisions related to their respective business areas. Senior level participants detailed opportunities where EDW can be further developed to support enterprise integration and offered support toward new directions where EDW can be utilized to improve organizational performance. Generally, the researcher observed broad enthusiasm for EDW among interviewees. In the next chapter, Chapter 5, the researcher will discuss the quantitative results and qualitative findings in relation to the existing literature, highlight limitations of the study, and suggest directions for future research.

Chapter 5

Conclusions, Implications, Recommendations, and Summary

This chapter includes conclusions, implications, recommendations, and a summary based on study findings. The researcher designed the study to examine the influence of data warehousing/business intelligence (DW/BI) maturity on organizational performance using a mixed methods exploratory design that relied on quantitative and qualitative methods. The chapter begins with the researcher's summary and interpretation of the study results that integrates the quantitative results and qualitative findings as a cohesive discussion in response to the research questions. The chapter proceeds with a discussion regarding the study's potential implications for research and practice, highlights the study's limitations, and provides recommendations for future research. The chapter concludes with a summary of this dissertation.

Conclusions

This researcher studied the influence of DW/BI maturity on organizational performance with the purpose of examining the linkages between organizational support, the underlying technological capabilities, practices, and the extent to which the Defense Intelligence Agency (DIA) uses DW/BI in enabling decision support. The researcher employed quantitative and qualitative research methods cooperatively in a mixed methods exploratory sequential research design to accomplish this goal. The data analysis for the quantitative phase of this study was based on 29 responses to an online

survey distributed to users of existing DW/BI capabilities within the DIA, which had a 3.87% response rate. Conversely, the data analysis for the qualitative phase of the study was based on results of semi-structured interviews with six executives whom the researcher identified and selected using purposeful sampling to achieve maximum variation among senior leaders who represented the business segment of DIA.

The central research question for this study was, "What are the influences of DW/BI maturity on organizational performance as perceived by constituents directly involved in DW/BI at the DIA?" In answering the central research question, the researcher relied on nine supporting research questions that guided both quantitative and qualitative inquiry. The researcher designed the supporting research questions to obtain stakeholder perceptions related to organizational support, DW/BI information technology capabilities, DW/BI practices, DW/BI use, and organizational performance. The conclusions from this study are organized by the supporting research questions. The researcher's summary and interpretations combine the quantitative results and qualitative findings from Chapter 4 to present a cohesive discussion of these data analyses.

The researcher answered research question one (RQ1) and research question two (RQ2) by examining the influence of organizational support on DW/BI information technology capabilities and DW/BI practices, respectively. RQ1 asked, "What is the perceived influence of organizational support on DW/BI information technology?" and RQ2 asked, "To what extent does organizational support influence DW/BI practices?" In answering these research questions quantitatively, the researcher formulated two hypotheses to examine the perceptions of organizational support and its influence on DW/BI information technology capabilities and DW/BI practices. Hypothesis one (H1)

predicted that high levels of organizational support would have a positive influence on

DW/BI information technology capabilities and hypothesis two (H2) predicted that high

levels of organizational support would have a positive influence on DW/BI practices.

The results of the linear regression analysis for H1 indicated organizational support, $B =$

0.45, $t = 4.00$, $p < .001$, is a significant predictor of DW/BI information technology

capabilities. The researcher accepted H1. The analysis indicated perceptions of

organizational support accounts for up to 37% of the variability in DW/BI information

technology capabilities. The results of the linear regression analysis for H2 indicated

organizational support, $B = 0.41$, $t = 4.02$, $p < .001$, is a significant and positive predictor

of DW/BI practices. The researcher accepted H2. This analysis indicated organizational

support accounts for up to 38% of the variability in DW/BI practices. The results take

into account that approximately half of the survey responses indicated DW/BI was led by

influential senior leaders who are committed to ensuring financial resources are available

to support the development and maturation of DW/BI capabilities.

Comparatively, the qualitative findings revealed that although the senior leaders

recognized the importance of executive-level sponsorship, all admitted organizational

support was relatively low to moderate in practice, particularly in their efforts to promote

and encourage broader integration of data sources that effectively represent the business

enterprise. Although all the senior leaders indicated willingness for their departments to

provide funding to support the continued development of DW/BI, only the departments

of two of the senior executives (Participant 1 and Participant 2) indicated actually

committing funds to the initiative. However, the qualitative findings revealed no

mechanism is in place that clarifies shared funding responsibilities among stakeholders.

The quantitative results and qualitative findings are supported by critical success factor discoveries found in prior research where championship and financial support (e.g., sponsorship) from organizational senior leaders were critical in ensuring that DW/BI evolves to keep pace with organizational needs (Bijker & Hart, 2013; Davenport, 2006; Lahrmann et al., 2011; Ramamurthy et al., 2008a; Ramamurthy et al., 2008b; Wixom & Watson, 2001; Yeoh & Koronios, 2010). Lahrmann et al. (2011) stated, "organizational support in the form of sponsorship and championship are preconditions to establishing successful BI capabilities" (p. 5). Ong and Siew (2013) found executive sponsorship and championship were critical to sustained funding that aided in building a mature DW/BI environment. Gonzales (2011) confirmed sponsorship from strong senior leadership had a positive influence on DW/BI information technology capabilities to include the skills of the DW/BI staff and the robustness of the infrastructure. Yeoh and Koronios (2010) argued active support of senior executives is paramount for demonstrating and communicating the strategic and operational importance of DW/BI and breaking down barriers from cross-functional integration and organizational politics.

Research question three (RQ3) asked, "How does DW/BI information technology motivate constituents to use DW/BI in organizational decision-making?" The researcher formulated hypothesis three (H3) to examine the perceptions of DW/BI information technology capabilities on DW/BI use and predicted that high levels of DW/BI information technology capabilities would have a positive influence on DW/BI use. The results of the linear regression analysis indicated DW/BI information technology capabilities, $B = 0.84$, $t = 4.86$, $p < .001$, are a significant and positive predictor of DW/BI use. Therefore, the researcher accepted H3. High levels of DW/BI information

technology capabilities positively influence DW/BI use. The results of this analysis also indicated DW/BI information technology capabilities account for up to 47% of the variability in DW/BI use. The quantitative results take into account that 51.7% of the survey responses indicated DW/BI provides analytical tools and other software to support advanced and proactive business analysis. Approximately 60% of survey responses indicated DW/BI provides a unified view of data originating from different business systems and enables seamless access to information. In addition, 35% of responses indicated data quality is measured continuously and proactively to ensure delivery of high quality data.

The quantitative results were clarified through qualitative findings that indicated DW/BI use in decision-making processes is inspired by the quality of DW/BI information technology capabilities. Through unanimous recognition and cognizance, the senior executives pinpointed data integration and data quality as being common determinants of whether constituents could rely on DW/BI in organizational decision-making. Although some senior executives (Participant 1, Participant 2, and Participant 5) described the organization's DW/BI capabilities as providing sufficient analytical tools and applications to support financial performance through reports and dashboards, all informants were aspirational about expanding the scope of DW/BI information technology capabilities to incorporate more business areas as contributors to achieving a holistic representation of the enterprise. However, two senior executives (Participant 1 and Participant 6) indicated current DW/BI information technology capabilities are outdated and require too many mouse clicks to navigate the user interface. The quantitative results and qualitative findings suggest constituents are motivated to use

DW/BI in organizational decision-making when DW/BI information technology capabilities are available to meet their needs, particularly, in an environment where access to analytical applications and tools that are current, relevant, and intuitive can inform decision-making processes.

These results and findings are supported by findings in prior research in which the use or intended use of DW/BI information technology capabilities was inspired by system quality, information quality, and service quality (DeLone & McLean, 1992, 2003; Popovic et al., 2012; Raber et al., 2012; Schieder & Gluchowski, 2011; Wieder et al., 2012; Wixom & Watson, 2001). Wixom and Watson (2001) contended users must have confidence and trust in the quality of data from which they make decisions and the DW/BI staff must possess the technical and interpersonal skills necessary to support the needs of the user community. Popovic et al. (2012) examined the relationships between maturity, information quality, analytical decision-making culture, and the use of information in decision-making. The authors found data integration and analytical capabilities were two dimensions that had a significant influence on DW/BI maturity. Although the results of their analysis revealed analytical capabilities exhibited higher significance, Popovic et al. recommended organizations make resolving data integration challenges a priority if any chance exists of achieving a mature DW/BI environment that yields business performance benefits.

Research question four (RQ4) asked, "To what extent do DW/BI practices inspire or influence pervasive DW/BI use across the organization?" The researcher formulated hypothesis four (H4) to examine the perceptions of DW/BI practices on DW/BI use and predicted high levels of DW/BI practices would have a positive influence on DW/BI use.

The results of the linear regression analysis were not significant and did not warrant

further examination. Therefore, the researcher rejected H4. However, this analysis does

take into account that approximately 42% of survey responses indicated DW/BI decisions

are made by a steering committee. In addition, approximately 20% of the survey

responses indicated a partnership exists between business and IT. Although statistically

DW/BI practices were perceived not to have significant influence on DW/BI use, the

survey responses were interesting when compared to the qualitative findings, which

revealed senior leaders do rely somewhat on an established executive steering committee

to oversee and approve IT investments across the business enterprise. However, this

executive body is not a dedicated DW/BI committee that advocates for the strategic

alignment, business process alignment, or the pervasive use of DW/BI.

Alternatively, the qualitative findings revealed an organizational relationship does

exist between the functional business areas and the IT department. According to three

senior executives interviewed (Participant 1, Participant 2, and Participant 5), the

relationship between business and IT is defined by segregated responsibilities for

delivering DW/BI services whereby the IT department is responsible for maintaining the

DW/BI infrastructure and a dedicated project office, aligned under the CFO, is

responsible for managing the daily operations of the DW/BI environment and governing

operational DW/BI activities, such as facilitating data stewardship, data integration, and

decision rights in support of the user community. One senior executive (Participant 5)

acknowledged that although the business and IT departments have independent strategy

documents that support corporate strategy, business and IT have not worked

cooperatively to construct a common DW/BI strategy. These results and findings imply

that placing emphasis on elevating DW/BI as a strategic priority may be beneficial. Although DW/BI is operational with a well-established project office, consideration may be given to the significance of an executive steering committee in providing governance and oversite in advancing the strategic goals of the organization.

The quantitative results indicating that DW/BI practices were not significant in predicting DW/BI use are contrary to prior research. However, the qualitative findings are supported by prior studies on DW/BI practices, such as governance and strategic alignment, business and IT alignment, business process alignment, and organizational structure (Anderson-Lehman et al., 2004; Bucher et al., 2009; Cosic et al., 2012; Elbashir et al., 2013; Elbashir & Williams, 2007; Fernandez-Gonzalez, 2008; Gutierrez, 2006; Hawking & Sellitto, 2010; Hostmann, 2007; Huang et al., 2010; Lahrmann et al., 2010; Luftman, 2004; Popovic et al., 2010; Raber et al., 2013; Sammon & Finnegan, 2000; Shanks, Bekmamedova, & Willcocks, 2013; Turban et al., 2011; Vesset & McDonough, 2009; Viaene, 2008; Watson & Wixom, 2007a; Watson et al., 2001; Williams & Williams, 2007; Wixom & Watson, 2010, 2001).

Shanks et al. (2013) stated effective governance enables broad deployment and pervasive use of DW/BI across the organization. Several researchers have found a steering committee that includes the chief information officer, the chief financial officer, and executive stakeholders representing the organization's business functions can ensure alignment with the organization's strategic and operational priorities by overseeing and managing DW/BI resources, assigning decision rights, coordinating DW/BI activities, and organizing and facilitating the development of a DW/BI strategy (Cosic et al., 2012; Gutierrez, 2006; Huang et al., 2010; Pant, 2009; Shanks et al., 2013). Hostmann (2007)

stated organizations that have achieved successful, strategic-level DW/BI capabilities

have established a dedicated project office (e.g., Business Intelligence Competency

Center [BICC]) that is uniquely postured to define and advance the organization's DW/BI

strategies and requirements. The composition of the DW/BI project office or BICC

should include cross-functional representatives from key organizational business areas

(Hostmann, 2007).

Research question five (RQ5) asked, "To what extent does DW/BI use influence

organizational performance?" The researcher formulated hypothesis five (H5) to

examine the perceptions of DW/BI use on organizational performance and predicted high

levels of DW/BI use will have a positive influence on organizational performance. The

results of the linear regression analysis indicated DW/BI use, $B = 1.10$, $t = 9.87$, $p < .001$,

is a significant and positive predictor of organizational performance. Therefore, the

researcher accepted H5.   The results of the quantitative data analysis indicated DW/BI

use accounts for up to 78% of the variability in organizational performance. These

results take into account survey responses that indicated DW/BI is used by top

management (41.4%), middle management (65.5%), business analysts (51.7%), and

functional users (65.5%). Nearly 45% of survey respondents indicated experiencing

improved organizational efficiency using DW/BI and 52% indicated improved

organizational performance. Moreover, the demographic characteristics (see Table 9)

show DW/BI use is prominent in the business areas of logistics/supply chain (24.1%),

finance (20.7%), and acquisition and procurement (17.2%). These quantitative results

imply increased use of DW/BI capabilities increases the likelihood for improved

organizational performance. Lahrmann et al. (2011) suggested DW/BI is a reflection of

the breadth of business topics or subject areas covered within the DW/BI environment, along with the proliferation and pervasive use of DW/BI across the entire organization. The survey response data indicate moderate use of DW/BI exists at all organizational levels.

The qualitative findings revealed that among the executives interviewed, the general perceptions of DW/BI capabilities were favorable and optimistic in furthering the capacity of DW/BI to inspire pervasive use at all organizational levels. However, the qualitative findings suggested prevailing challenges have constrained proliferation and pervasive use of DW/BI. One senior executive (Participant 6) indicated the user interface for DW/BI information technology capabilities is not intuitive and is challenging to use. Another senior executive (Participant 2) suggested pervasive use is constrained because business managers are either not aware of the capabilities or not trained on the retrieval and use of the data. Two executives (Participant 3 and Participant 4) expressed concerns about user knowledge, skills, and abilities needed to extract, interpret, and analyze data derived from the DW/BI environment.

The quantitative results and qualitative findings imply awareness and training may help to increase the use of DW/BI, which is consistent with the overarching theme from the qualitative data analysis pertaining to the need for enhanced understanding of DW/BI. This theme implied that experiencing improvements in organizational performance depends on users and senior leaders increasing their knowledge, understanding, and use of DW/BI capabilities. These results and findings are supported by prior research regarding the pervasive use of DW/BI (DeLone & McLean, 1992, 2003;

Eckerson, 2008; Grubljesic & Jaklic, 2014; Lahrmann et al., 2011; Ramamurthy et al.,

2008b; Vesset & McDonough, 2009; Watson & Wixom, 2007b).

Several researchers have found awareness and training are critical to the

proliferation and use of DW/BI (Bijker & Hart, 2013; Hawking & Sellitto, 2010;

Mukherjee & D'Souza, 2003; Ong et al., 2011; Vesset & McDonough, 2009). Vesset

and McDonough (2009) believed training is not limited to formal classroom or online

settings, but includes exposing users to as much DW/BI content as possible to enable

better understanding and use of the information. Eckerson (2008) stated embedding

DW/BI usage into existing business processes is the best way to increase its use.

Eckerson also found impediments to pervasive DW/BI use were user perceptions of poor

data quality, the complexity of the DW/BI tools, slow response times when executing

queries, inadequate support from organizational executives, and users' preference to

employ alternative tools or methods. Grubljesic and Jaklic (2014) emphasized pervasive

and effective use of DW/BI is premised on three organizational considerations: (a) the

intensity that DW/BI is used by individuals in their job performance, (b) the extent that

DW/BI is used as a decision support mechanism, and (c) the extent to which DW/BI is

embedded into organizational decision-making processes.

Research question six through research question nine were unique to the

quantitative phase of this study. The researcher examined these four questions using

mediation analysis to elicit insights that facilitate understanding the intervening

relationships between organizational support, DW/BI information technology

capabilities, DW/BI practices, DW/BI use, and organizational performance.

Research question six (RQ6) asked, "What is the influence of perceived DW/BI information technology capabilities in mediating the relationship between organizational support and DW/BI use?" The researcher formulated hypothesis six (H6) to examine the mediating relationship between DW/BI information technology capabilities, organizational support, and DW/BI use. H6 predicted that perceptions of DW/BI information technology capabilities mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. The results of the mediation analysis indicated no evidence of statistically significant associations with perceptions of DW/BI information technology capabilities mediating the relationship between perceptions of organizational support and perceptions of DW/BI use. Therefore, the researcher rejected H6.

Research question seven (RQ7) asked, "What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?" The researcher formulated hypothesis seven (H7) to examine the mediating relationship between DW/BI practices, organizational support, and DW/BI use. H7 predicted that perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. The results of the mediation analysis indicated no evidence of statistically significant associations with perceptions of DW/BI practices mediating the relationship between perceptions of organizational support and perceptions of DW/BI use. The researcher rejected H7.

Research question eight (RQ8) asked, "What is the influence of perceived DW/BI use in mediating the relationship between DW/BI information technology capabilities and organizational performance?" The researcher formulated hypothesis eight (H8) to

examine the mediating relationship between DW/BI use, DW/BI information technology capabilities, and organizational performance. H8 predicted that perceptions of DW/BI use mediate the relationship between perceptions of DW/BI information technology capabilities and perceptions of organizational performance. The results of the mediation analyses indicated DW/BI use fully mediated the relationship between DW/BI information technology capabilities and organizational performance. Therefore, the researcher accepted H8. The results imply DW/BI information technology capabilities that are high in quality are more likely to inspire increased DW/BI use and subsequently more likely to facilitate enhanced individual job and organizational performance. The significance of DW/BI use in predicting organizational performance is consistent with RQ5, as the quantitative results indicated high levels of DW/BI use will have a positive influence on organizational performance. The results of this mediational hypothesis imply organizations can focus on DW/BI information technology capabilities to increase use. The results are supported by prior researchers who suggested without the appropriate use of DW/BI information technology capabilities, there can be no performance benefits (DeLone & McLean, 2003; Grubljesic & Jaklic, 2014; Lahrmann et al., 2011).

Research question nine (RQ9) asked, "What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?" The researcher formulated hypothesis nine (H9) to examine the mediating relationship between DW/BI use, DW/BI practices, and organizational performance. H9 predicted that perceptions of DW/BI use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance.

The results of the mediation analysis indicated no evidence of statistically significant associations with perceptions of DW/BI use mediating the relationship between perceptions of organizational support and organizational performance. Therefore, the researcher rejected H9.

Implications

This study contributes to the existing body of knowledge as an evidentiary resource that provides empirical data to advance the scholarship of DW/BI research. The results of this study are intended to aid researchers and practitioners in understanding the factors that affect DW/BI maturity and in recognizing how these factors can facilitate improvements in decision and business performance. This study provided research, practical implications, and directions for further research.

DW/BI is well-established in the research environment; however, the challenges that plague organizational advancement within this domain remains fertile for academic exploration. DW/BI is a complex undertaking that necessitates the cooperation of people, processes, and technologies to realize the benefits of the capabilities. The conceptual research model used in this study and the mixed methods design facilitated the examination of DW/BI maturity and its influence on organizational performance through the perceptions of users and senior leaders within an established DW/BI environment. Although this study was based on an organization that has sustained DW/BI capabilities for 10 years, future research should include considerations of whether an established culture exists that inspires continuous process improvement and if a proclivity for using information and analytics exists to drive decision-making (Bijker & Hart, 2013; Williams & Williams, 2004). However, future research endeavors in this area should not assume

equivalency between longevity and maturity with either DW/BI or the decision environment. This researcher found DW/BI erudition, analytic aptitude, and technology acceptance among users and senior leaders are important considerations for further study, particularly in understanding the business value, use, and maturation of DW/BI capabilities.

In practice, DW/BI entails considerations that transcend IT capabilities in isolation (Williams & Thomann, 2003). DW/BI can yield meaningful and measurable business value when employed in an environment where stakeholders recognize that DW/BI involves the organization's people, processes, and technologies. Senior leaders and managers must resist viewing DW/BI as a traditional deployment of an IT capability intended exclusively to automate existing business processes. Instead, leaders should view DW/BI as the amalgamation of strategic decision support capabilities that advance the needs of the business. Researchers found organizations that recalibrated their focus from solely an IT project and instead placed priority on the business needs of the organization experienced higher levels of success with their DW/BI initiatives (Bijker & Hart, 2013; Williams & Thomann, 2003; Yeoh & Koronios, 2010).

Data integration, data quality, analytical capabilities, and strategic alignment are key considerations for DW/BI maturity. The findings from this research indicated the scope of data integration to be representative of only a few business areas. As a strategic enabling capability, achieving the full value proposition of DW/BI requires data integration across the entire spectrum of the business enterprise. The findings suggest user confidence in DW/BI increases when there is high quality data to support decision-making; therefore, emphasis on data quality in both the source systems and DW/BI

environment is essential. The researcher also found that a strong partnership between the business components and the IT organization based on a common strategy to increase business performance can aid organizations in realizing the full benefits of DW/BI.

As evidenced by the results of this study, senior leader involvement through championship and sponsorship is imperative to the maturity of DW/BI, but the results also indicate the need to have a single business executive who is accountable for DW/BI within the organization (Gonzales, 2011) and a mechanism to facilitate cost sharing among stakeholders. An organization's commitment to DW/BI is reflected in its practices, particularly in the areas of governance and strategic alignment, business and IT alignment, and business process alignment. The establishment of a steering committee that is chartered exclusively with governance and oversight can help cultivate and facilitate the continuous improvement culture necessary to ensure DW/BI capabilities evolve with the business needs of the organization (Huang et al., 2010; Wixom & Watson, 2010).

Limitations of the Study

Limitations of this study manifested in both the quantitative and qualitative phases. The limitation identified during the quantitative component was low survey response rate. The researcher invited 750 candidates to complete the online, web-enabled survey instrument. A total of 57 participants accessed the survey on the SurveyMonkey website. Of these respondents, 29 provided complete and qualified submissions, which yielded a 3.87% response rate. The challenge that underpins survey-based research is the reliance on the willingness of people to respond. Baruch (1999) postulated the reasons people do not respond to surveys are they either did not receive the survey (or invitation)

or they simply chose not to respond. In this study, it seemed some people aligned to the latter reason for nonresponse and were reluctant to participate even after subsequent requests. Conversely, some respondents did not progress past the demographic information, which may indicate the survey design affected the response rate. Although it is possible that a larger sample may have resulted in the detection of more significant relationships, the small sample size of this study still detected sufficiently strong relationships.

Many factors may have contributed to the low survey response rate in this study, including the closed organizational culture of the U.S. intelligence community. Although collaboration is increasingly common among industry, academia, and the intelligence community, generally, agencies operate in relatively closed environments with strict guidelines regarding employees disclosing information to the public. By the nature of the intelligence business, employees are highly sensitive to responding to unsolicited email correspondence. After emailing invitations to participates in the study, two recipients requested to be removed from the distribution list. One recipient notified the organization's security office to report the receipt of unsolicited email out of suspicion of nefarious phishing, particularly since the email contained embedded hyperlinks to a commercial website. The researcher's advanced coordination with the organization's IRB and the security office prior to the broad distribution of the invitations assuaged concerns regarding this matter. Given the intelligence community presents a unique operating environment, having senior-level organizational sponsorship may have helped in disarming suspicion and increasing survey response rate.

During the qualitative phase of the study, the six executive informants were open about their perceptions, generally, but at times seemed guarded. In some cases, the informants' responses did not align exactly to the quantitative results, even when asked questions specifically about the quantitative results. However, all responses from the interviews were helpful in providing depth and understanding to the study through perceptions and experiences of these executives.

The researcher observed other limitations were in the mixed methods research design. Mixed methods research is an advanced research design that calls for a complete understanding of quantitative and qualitative research methods. Undertaking the mixed methods research design was a learning opportunity for the researcher that yielded highly distinguished benefits in the scholarship of academic research. However, the learning process slowed the overall progress of the study and increased the complexity of the investigation. Differentiating among the characteristics of the mixed methods design options was helpful in advancing this study, particularly in determining the sequence of the quantitative and qualitative phases of the study. Additionally, Johnson and Onwuegbuzie (2004) pointed out that mixed methods research is resource intensive and challenging for one researcher to carry out. In this study, the employment of additional people to help in conducting the thematic analysis may have yielded more themes from the interview transcripts.

Recommendations for Future Research

       Through this study, the researcher endeavored to gain deeper insights into DW/BI maturity in a public-sector organization with established DW/BI capabilities that have been in place for a decade. The findings in this study that were contrary or inconsistent with prior research along with the limitations provide impetus for further research. Moreover, the results of the study are not generalizable. This mixed methods study took place within a single organization; repeating this study across multiple organizations with established DW/BI capabilities may aid in making the results more generalizable. Researchers may consider revisiting the number of items in the survey design as a possible constraint to achieving a higher response rate. Additionally, the quantitative results of this study showed DW/BI practices were not significant to the pervasive use of DW/BI; therefore, researchers may conduct further research pertaining to the effects of practices on the pervasive use of DW/BI. Research that further explores these effects may demonstrate whether the results of the linear regression conducted in this study were an anomaly or may confirm the existence of a stronger relationship between DW/BI practices and DW/BI use.

       The researcher recommends more research to understand the analytical decision culture of organizations that embrace DW/BI, particularly in the public-sector where profit-making motivations are supplanted by the fiscal exigency for prudent decision-making that lead to effective stewardship of taxpayer contributions. Although this researcher addressed the analytical decision culture as an element of this investigation, a study that focuses exclusively on the decision culture within public-sector organizations may help to understand the effects of culture on DW/BI maturity. Future explorations

may involve the extent that organizational decision-making processes integrate DW/BI at the strategic, operational, and tactical levels.

Finally, consideration should be given to investigating technology acceptance and use of DW/BI. The findings from this study suggest user perceptions of DW/BI may be more favorable when capabilities are easy to use and perceived to be useful in enhancing individual job performance. Generally, researchers have used the technology acceptance model (Davis, 1989) to examine user acceptance of information systems in organizational environments, but this research has largely focused on the general adoption and implementation of IT. Grubljesic et al.'s (2014) assertion that considerable differences exist between technology acceptance and actual use raises research curiosity within the context of DW/BI. Research on technology acceptance and use pertaining to DW/BI maturity may help in understanding the motivations and constraints related to the maturation or continuous use of DW/BI.

Summary

The central research question for this study was, "What are the influences of DW/BI maturity on organizational performance as perceived by constituents directly involved in DW/BI at the DIA?" The researcher investigated the central research question using a mixed methods research design to understand the perceptions of DW/BI maturity and its influence on organizational performance from the perspectives of users and executives of stakeholder business functions at the DIA. The study's mixed methods research design consisted of two main phases: the sequential use of quantitative and qualitative research methods, respectively.

In the quantitative phase, the researcher administered an online survey for quantitative data collection. DW/BI users received an email invitation requesting their participation in the study by completing an online survey hosted on the SurveyMonkey website. A total of 57 participants accessed the online survey. Of these respondents, 29 provided complete and qualified submissions. The results of the quantitative data analysis informed the qualitative inquiry.

In the qualitative phase, the researcher conducted semi-structured interviews with six executives that were identified and selected using purposeful sampling. The researcher used NVivo to code the transcripts from interviews with senior informants. Central to the qualitative data analysis was the process of reading and dissecting the interview transcripts to transform the raw data into meaningful patterns and themes (Creswell, 2009; Yin, 2003). The researcher determined meaningful patterns and themes during the coding process that provided insight into the perceptions of executives regarding DW/BI capabilities, the current state of maturity, and the overall goals and objectives for the organization's DW/BI initiative. The researcher's use of the mixed methods paradigm was intended to provide a complete accounting of the phenomenon under investigation. This researcher answered the central research question of this study by examining nine supporting research questions.

RQ1. What is the perceived influence of organizational support on DW/BI information technology?

RQ2. To what extent does organizational support influence DW/BI practices?

RQ3. How does DW/BI information technology motivate constituents to use DW/BI in organizational decision-making?

RQ4. To what extent do DW/BI practices inspire or influence pervasive DW/BI use across the organization?

RQ5. To what extent does DW/BI use influence organizational performance?

RQ6. What is the influence of perceived DW/BI information technology in mediating the relationship between organizational support and DW/BI use?

RQ7. What is the influence of perceived DW/BI practices in mediating the relationship between organizational support and DW/BI use?

RQ8. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI information technology and organizational performance?

RQ9. What is the influence of perceived DW/BI use in mediating the relationship between DW/BI practices and organizational performance?

Quantitative Results

The researcher formulated and tested nine hypotheses to answer RQ1 through RQ9. In testing H1 through H5, the researcher used simple linear regression. To test H6 through H9, the researcher used mediation analysis. The following list presents the results of the hypotheses tests.

- H1 predicted that high levels of organizational support will have a positive influence on DW/BI information technology capabilities. The results of the linear regression analysis indicated organizational support is a significant predictor of DW/BI information technology capabilities. H1 was supported.

- H2 predicted that high levels of organizational support will have a positive influence on DW/BI practices. The results of the linear regression analysis

indicated organizational support is a significant and positive predictor of DW/BI practices. H2 was supported.

- H3 predicted that high levels of DW/BI information technology capabilities will have a positive influence on DW/BI use. The results of the linear regression analysis indicated DW/BI information technology capabilities are a significant and positive predictor of DW/BI use. H3 was supported.

- H4 predicted that high levels of DW/BI practices will have a positive influence on DW/BI use. The results of the linear regression analysis were not significant. H4 was not supported.

- H5 predicted that high levels of DW/BI use will have a positive influence on organizational performance. The results of the linear regression analysis indicated DW/BI use is a significant and positive predictor of organizational performance. H5 was supported.

- H6 predicted that perceptions of DW/BI information technology capabilities mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. The results from the mediation analysis indicated no evidence of statistically significant associations with perceptions of DW/BI information technology capabilities mediating the relationship between perceptions of organizational support and perceptions of DW/BI use. H6 was not supported.

- H7 predicted that perceptions of DW/BI practices mediate the relationship between perceptions of organizational support and perceptions of DW/BI use. The results from the mediation analysis indicated no evidence of statistically

significant associations with perceptions of DW/BI information technology practices mediating the relationship between perceptions of organizational support and perceptions of DW/BI use. H7 was not supported.

- H8 predicted that perceptions of DW/BI use mediate the relationship between perceptions of DW/BI information technology capabilities and perceptions of organizational performance. The results from the mediation analysis indicated DW/BI use fully mediates the relationship between DW/BI information technology capabilities and organizational performance. H8 was supported.

- H9 predicted that perceptions of DW/BI use mediate the relationship between perceptions of DW/BI practices and perceptions of organizational performance. The results from the mediation analysis indicated no evidence of statistically significant associations with perceptions of DW/BI use mediating the relationship between perceptions of DW/BI practices and perceptions of DW/BI use. H9 was not supported.

Qualitative Findings

The qualitative data analysis was based on responses to questions presented to six executives during semi-structured interviews aimed to obtain leadership perceptions regarding organizational and technological considerations of the organization's established DW/BI environment. Six themes emerged from qualitative data analysis—an overarching theme and five subthemes. The overarching theme was, Understanding DW/BI: Capacities, beliefs, perceptions, and support for organizational performance. The five subthemes were:

- Championing Organizational Support

- Business Value of DW/BI in Organizational Decision-Making

- Perceptions of DW/BI Influence on Organizational Performance

- Current Support and Influence of DW/BI

- Furthering Capacity Will Inspire or Influence Pervasive Use

In conducting this study, the researcher endeavored to provide a unique perspective of DW/BI maturity through the lens of a public-sector organization with established DW/BI capabilities that have been in place for a decade. The researcher accomplished the goals of this study. In Chapter 1, the researcher explained the purpose for conducting this study by identifying the problem, stating the research goals, discussing the significance of the research, and framing the research questions. In Chapter 2, the researcher presented a review of the literature to understand what is already known about DW and BI as individual disciplines and as an integrated area of concentration. The researcher also discussed critical success factors, maturity models, information systems success, and strategic alignment, which contributed to the construction of the study's conceptual research model and hypotheses. In Chapter 3, the researcher described the research methods employed in the study and highlighted the relevance of the mixed methods research design in achieving the breadth and depth of research inquiry through the convergence of quantitative and qualitative methods. In Chapter 4, the researcher presented the quantitative results and qualitative findings. Last, in this Chapter 5, the researcher summarized the quantitative results and qualitative findings as a cohesive, integrated discussion, highlighted the implications and limitations of the study, and offered recommendations for future research.

This dissertation represents the culmination of a complete research endeavor that contributes to the existing body of knowledge by providing empirical data intended to aid in advancing the scholarship and practice of DW/BI. Although this mixed methods study pertained to a single large organization with several functional business areas, repeating this study across multiple organizations with established DW/BI capabilities may aid in making the results more generalizable and in providing deeper insights into the DW/BI maturity phenomenon.

Appendix A

Institution Review Board Approvals

NOVA SOUTHEASTERN UNIVERSITY
Office of Grants and Contracts
Institutional Review Board

MEMORANDUM

To: Charles Perkins

From: Ling Wang, Ph.D.
            Institutional Review Board

Date: Oct. 9, 2013

Re: *Investigating the Influence of Data Warehousing/Business Intelligence Maturity on Organizational Performance*

IRB Approval Number: wang09151304

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1)   CONSENT: If recruitment procedures include consent forms these must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2)   ADVERSE REACTIONS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and 954-262-2020 respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3)   AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Protocol File

NATIONAL INTELLIGENCE UNIVERSITY
Washington, D.C. 20340-5100

16 September 2016

Protocol Number: 1013.1
Protocol Title: Investigating the Influence of Data Warehousing/Business Intelligence Maturity on Organizational Performance

Type of Review: {Charles Perkins} Research Determination/Extention

Under provisions specified in Title 32 Code of Federal Regulations (CFR) part 219.102 (d), the NIU IRB has determined that your proposal constitutes a systematic investigation contributing to generalizable knowledge and is considered research. Additionally, it meets the criteria defined in 32 CFR 219.102 (f) as research involving human subjects *or* the collection of *private* identifiable information from human subjects.

An **Expedited Review** was conducted on your proposal due to interaction/intervention with human subjects. The study meets minimal risk conditions as well as requirements under 32 CFR 219.110 (b), **Category 7**, research on individual or group characteristics or behavior or research employing survey, interview, oral history, focus group, program evaluation, human factors or quality assurance methodologies.

Date of Determination: 16 September 2016

Please note the following:
- Only NIU faculty and students, who have completed human subjects training and are named on the signature page of the application, are approved as NIU Investigators in conducting this study.
- No changes may be made in the research protocol (e.g., personnel, recruitment procedures, consent forms, interview questions, etc.). If changes are needed, an addendum must be submitted to the IRB for potential changes in determination.
- Per DIA requirements, all research-related records (including signed consent forms) must be retained and available for audit for a period of at least ten years after the research has ended.
- It is the responsibility of the active interviewer/investigator to promptly report events that may represent unanticipated problems involving risks to subjects or others.

- **The NIU IRB has extended the period of approval for the protocol referenced above. Your study will expire on 15 September 2017.**

Please feel free to contact the Human Subjects Team member listed below with any further questions or concerns.

V/r,

SISLIN.JOHN.D.1386 970099 Digitally signed by SISLIN.JOHN.D.1386970099
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=SISLIN.JOHN.D.1386970099
Date: 2016.12.08 13:12:30 -05'00'

JOHN SISLIN, Ph.D.
NIU Exempt Determination Official
john.sislin@dodiis.mil
Phone: 202-231-3509

Appendix B

Permissions

October 17, 2013

Memorandum for Chief Financial Officer
            (ATTN: Mrs. Suzanne White)

Subject: Permission to Collect Data for Academic Research

        I am a doctoral student at Nova Southeastern University (NSU), Fort Lauderdale, Florida, working to complete dissertation research requirements for me to earn a Ph.D. in Information Systems. My dissertation research investigates the influence of data warehousing/business intelligence maturity on organizational performance. Pursuant to the requirements of the Defense Intelligence Agency (DIA) Institutional Review Board (IRB), this correspondence is to obtain your permission to collect data for academic research.

        Academic and industry research suggest that as public and private sector organizations continue to make considerable investment in implementing data warehousing/business intelligence technologies, some find that realizing the full value proposition is elusive. Meanwhile, there is consensus among academic researchers and practitioners that a mature data warehouse environment provides the best opportunity for organizations to realize the benefits of facts-based decision making. My research objective is to investigate this phenomenon in an endeavor to understand the linkage between the enterprise data warehouse (EDW) technology, its usage, and organizational performance.

        The unit of analysis for this study will be the DIA business enterprise services community, which comprises the business areas within the Mission Services and Chief Financial Officer organizations. Data collection for this study will consist of semi-structured interviews with organizational leaders and managers, functional subject matter experts, and the data warehousing project team; a survey to measure end-user perceptions of EDW capabilities and the ability of the technology to meet their individual business needs and the business needs of the organization; and a review of unclassified organizational literature that aids in illuminating the motivation for the organization's initial investment in data warehousing technology and the vision to align the technology with strategic goals. In advancing this study, there is no requirement to disclose any data stored within the organization's enterprise data warehouse. Participants will be assured of complete confidentiality; no individual survey responses will be published and the raw information will be accessible only to me and the NSU faculty that make up my dissertation committee. Prior to publication of the dissertation report I will ensure formal review and approval through the Office of Public Affairs and any other offices as required.

        This research study has been reviewed and approved by the IRB for Research with Human Subjects at NSU (954.262.5369) and pending approval by the IRB at DIA (202.231.3354) predicated on obtaining your permission to collect data for academic research as described in this memorandum.

                        Respectfully,

                        Charles F. Perkins, M.Sc
                        Doctoral Candidate, Information Systems
                        Graduate School of Computer and Information Sciences
                        Nova Southeastern University

UNITED STATES GOVERNMENT

memorandum

U-13-086/CFO

DATE: **OCT 28 2013**

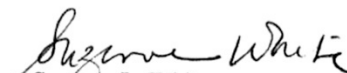REPLY TO
ATTN OF: CFO

SUBJECT: Approval to Collect Data in Support of Academic Research

TO: National Intelligence University Institution Review Board (Attn: Dr. Bradshaw)

1. I have discussed the dissertation research with Charles Perkins and hereby grant approval for him to collect data, as described in the original request dated October 17, 2013, and in the Institution Review Board (IRB) application to the Defense Intelligence Agency IRB.

2. Because this research is for an academic program that Charles is participating in related to his pursuit of a post-graduate degree, the subjects of his interview requests are under no obligation to cooperate with his endeavors. I believe that they will do so in order to explore these topics, but this approval may not be viewed as any request by the Office of the Chief Financial Officer that they make special accommodations to participate. The primary mission of the Agency will always be the first priority. Beyond the subjects' time, the endeavor should be cost neutral and mission supporting.

3. Additionally, the data collected may not include any information protected from disclosure under the Privacy Act of 1974. Prior to publication of the dissertation report, Charles will need to ensure formal review and approval through the Office of Public Affairs and any other offices as required. That review will ensure that none of the information contained within the dissertation risks harm to national security or inadvertent disclosure of any information in violation of 5 U.S.C. Section 552.

Suzanne L. White
Chief Financial Officer

October 17, 2013

Memorandum for Principal Deputy Director for Mission Services
(ATTN: Mr. James Manzelmann)

Subject: Permission to Collect Data for Academic Research

I am a doctoral student at Nova Southeastern University (NSU), Fort Lauderdale, Florida, working to complete dissertation research requirements for me to earn a Ph.D. in Information Systems. My dissertation research investigates the influence of data warehousing/business intelligence maturity on organizational performance. Pursuant to the requirements of the Defense Intelligence Agency (DIA) Institutional Review Board (IRB), this correspondence is to obtain your permission to collect data for academic research.

Academic and industry research suggest that as public and private sector organizations continue to make considerable investment in implementing data warehousing/business intelligence technologies, some find that realizing the full value proposition is elusive. Meanwhile, there is consensus among academic researchers and practitioners that a mature data warehouse environment provides the best opportunity for organizations to realize the benefits of facts-based decision making. My research objective is to investigate this phenomenon in an endeavor to understand the linkage between the enterprise data warehouse (EDW) technology, its usage, and organizational performance.

The unit of analysis for this study will be the DIA business enterprise services community, which comprises the business areas within the Mission Services and Chief Financial Officer organizations. Data collection for this study will consist of semi-structured interviews with organizational leaders and managers, functional subject matter experts, and the data warehousing project team; a survey to measure end-user perceptions of EDW capabilities and the ability of the technology to meet their individual business needs and the business needs of the organization; and a review of unclassified organizational literature that aids in illuminating the motivation for the organization's initial investment in data warehousing technology and the vision to align the technology with strategic goals. In advancing this study, there is no requirement to disclose any data stored within the organization's enterprise data warehouse. Participants will be assured of complete confidentiality; no individual survey responses will be published and the raw information will be accessible only to me and the NSU faculty that make up my dissertation committee. Prior to publication of the dissertation report I will ensure formal review and approval through the Office of Public Affairs and any other offices as required.

This research study has been reviewed and approved by the IRB for Research with Human Subjects at NSU (954.262.5369) and pending approval by the IRB at DIA (202.231.3354) predicated on obtaining your permission to collect data for academic research as described in this memorandum.

Respectfully,

Charles F. Perkins, M.Sc
Doctoral Candidate, Information Systems
Graduate School of Computer and Information Sciences
Nova Southeastern University

UNITED STATES GOVERNMENT

memorandum

U-13-307/MS
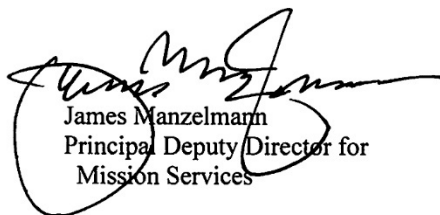
DATE: 21 Oct 13

REPLY TO
ATTN OF: MS

SUBJECT: Approval to Collect Data in Support of Academic Research

TO: National Intelligence University Institution Review Board
(Attn: Dr. Bradshaw)

I have discussed the dissertation research with Charles Perkins and hereby grant approval for him to collect data, as described in the original request dated October 17, 2013, and in the Institution Review Board (IRB) application to the Defense Intelligence Agency IRB.

Because this research is for an academic program that Charles is participating in related to his pursuit of a post-graduate degree, the subjects of his interview requests are under no obligation to cooperate with his endeavors. I believe that they will do so in order to explore these topics, but this approval may not be viewed as any request by Mission Services that they make special accommodations to participate. The primary mission of the Agency will always be the first priority. Beyond the subjects' time, the endeavor should be cost neutral and mission supporting.

Additionally, the data collected may not include any information protected from disclosure under the Privacy Act of 1974. Prior to publication of the dissertation report, Charles will need to ensure formal review and approval through the Office of Public Affairs and any other offices as required. That review will ensure that none of the information contained within the dissertation risks harm to national security or inadvertent disclosure of any information in violation of 5 U.S.C. Section 552.

James Manzelmann
Principal Deputy Director for
Mission Services

October 13, 2015

Memorandum for Chairperson, Business Enterprise Services Working Group

Subject: Request List of Registered Users of DIA's Enterprise Data Warehouse for
          Participation in Academic Research

   Pursuant to data collection authorizations as approved by authorities of the Defense Intelligence Agency (DIA) and the Institutional Review Board (IRB) of the National Intelligence University (NIU), this correspondence is to request your assistance in obtaining a list of names and business email addresses of registered users of DIA's Enterprise Data Warehouse (EDW) to participate in academic research.

   I am a doctoral candidate at Nova Southeastern University (NSU), Fort Lauderdale, Florida, working to complete dissertation research requirements for me to earn a Ph.D. in Information Systems. My dissertation research investigates the perceived influences of data warehousing/business intelligence (DW/BI) maturity on organizational performance. Academic and industry research suggest that as private and public-sector organizations continue to make considerable investments in DW/BI initiatives, some find realizing the full value proposition elusive. Meanwhile, there is consensus among academic researchers and practitioners that a mature DW/BI environment provides the best opportunity for organizations to realize the benefits of DW/BI capabilities. My research objective is to investigate this phenomenon within a government agency to understand the linkage between DW/BI, its usage, and organizational performance.

   The unit of analysis for this study is DIA's business enterprise services community, which comprises business areas within the Mission Services and Chief Financial Officer organizations. Data collection for this study will consist of a survey to measure end-user perceptions of EDW capabilities and the ability of the EDW to meet individual and organizational business needs. Your assistance will help identify potential candidates to participate in this study. Participants will be assured complete confidentiality; no individual survey responses will be published and the raw information will be accessible only to me and the NSU faculty that make up my dissertation committee. If possible, please provide EDW registered user information in a Microsoft Excel worksheet.

   This study has been approved by the IRB for Research with Human Subjects at NIU on behalf of DIA (202.231.3354) and the IRB at NSU (954.262.5369). There is no requirement to disclose any data stored within the organization's EDW. Prior to publication of the dissertation report I will ensure formal review and approval through the Office of Public Affairs and any other offices as required.

Please direct questions regarding this study to the undersigned at 301.632.9688 or via email at cperkins@nova.edu. Thank you in advance for your assistance.

Respectfully,

Charles F. Perkins, M.Sc.
Doctoral Candidate, Information Systems
College of Engineering and Computing
Nova Southeastern University

From: Dudley Mark B DIA OCC3A USA GOV
Sent: Monday, December 11, 2017 1:48 PM
To: Charles F. Perkins-DNI-
Cc: ~DIA OCC Prepub Review
Subject: DIA PREPUB RVW COMPLETE---Dissertation (17-657)

Charles,

DIA Prepublication review completed its review of your 204-page dissertation, titled "Investigating the Perceived Influence of Data Warehousing and Business Intelligence Maturity on Organizational Performance: A Mixed Methods Study." We pose no objection to open publication of the document originally submitted on November 30th, 2017.

If material is added to or, other than for minor editing, changes are made to material that has been cleared for release, these additions or changes are subject to review and clearance prior to giving them to a publisher, presenting them in a public forum, or releasing them to anyone else. In such a case, please mark or otherwise clearly indicate the new material so we can expedite the review. Additional material that is subject to review includes text, photographs, photograph captions, illustrations, diagrams, tables, charts, or maps. Please refer to case number 17-657 if you require additional information.

V/r,

Mark Dudley
Public Release/Disclosures Review Officer
Defense Intelligence Agency, Office of Corporate Communications

Appendix C

Invitation to Participate in Study

From: Perkins, Charles F.
Sent: Wednesday, May 25, 2016 5:50 PM
Subject: EDW Users: Invitation to Participate in Dissertation Research

Dear DIA EDW User,

My name is Charles Perkins and I'm assigned to DIA's Mission Services Directorate. I am a full-time employee of DIA and a full-time dissertation candidate working to fulfill requirements for me to earn a Ph.D. in Information Systems from Nova Southeastern University, Fort Lauderdale, Florida. You are receiving this invitation because you were identified as a registered user of DIA's Enterprise Data Warehouse (EDW). This invitation is to request your participation in dissertation research that endeavors to measure the influence of data warehousing/business intelligence (DW/BI) maturity on organizational performance at the Defense Intelligence Agency (DIA).

As a current or past user of the EDW, I am soliciting your participation in this research by asking you to complete a brief survey. This survey is part of a multiple-part study that aims to measure user perceptions related to DIA's EDW/BI capabilities and the ability of the technology to meet individual business needs and the business needs of the organization. In completing the survey, your honest responses are extremely important to this study's outcome. You can be assured of complete confidentiality - no individual responses will be published and the raw data will be accessible only to me and the Nova Southeastern University faculty that make up my dissertation committee. This survey contains questions regarding your perceptions of DIA's EDW, your use of the technology in performing your job, and some information about yourself.

Your participation in this study is voluntary. It will take less than 20 minutes to complete the survey. You may decline to answer any question with which you are uncomfortable answering or feel the question is inappropriate. Submitting the survey will indicate that you have given your consent for me to use your data. This research study has been reviewed and approved by the Institutional Review Boards (IRB) for Research with Human Subjects at Nova Southeastern University (954.262.5369) and the National Intelligence University (NIU) on behalf of the DIA (202.231.4439). Please direct questions regarding this study to the undersigned at 334.207.3590 or via email at cperkins@nova.edu (or by replying to this email).

The survey instrument will be accessible through June 10, 2016. To participate in this study, please click here: https://www.surveymonkey.com/r/MG79SSY. If the link does not work, then copy and paste the following link into your browser: https://www.surveymonkey.com/r/MG79SSY

Thank you in advance for taking the time to participate in this study.

Respectfully,

Charles F. Perkins
Doctoral Candidate
College of Engineering and Computing
Nova Southeastern University

From: Perkins, Charles F.
Sent: Monday, June 13, 2016 3:32 PM
To: Perkins, Charles F.
Subject: EDW Users: Invitation to Participate in Dissertation Research -Extended

Dear DIA EDW User (Current and Past),

Recently, you were sent an invitation to participate in a study that focuses on DIA's Enterprise Data Warehouse/Business Intelligence (EDW/BI) capabilities. Thank you if you've already completed the survey. If not, this correspondence is an appeal for your help in an endeavor to encourage and maximize participation. I know that you're busy, but if you have time over the next two weeks please access the web site and complete the survey, it will take less than 20 minutes of your time. The survey period has been extended until June 24, 2016.

This study began three years ago with the appropriate approvals from DIA's Chief Financial Officer (CFO), the Director of Mission Services (MS), and the National Intelligence University (NIU). This is a mixed methods study that includes quantitative and qualitative measurements. Your feedback contributes to the quantitative component of the study and represents an important contribution to measuring user perception of DIA's EDW/BI capabilities and the ability of this investment to meet individual business needs and the business needs of the organization. The qualitative aspect of the study features interviews with DIA senior executives within the Office of the CFO and the MS directorate on their perceptions of the organization's EDW/BI capabilities. The interviews with DIA senior executives will be based in part on the results of the survey. Therefore, your participation is requested.

While your participation is voluntary, I hope that you will consider contributing to this study. You can be assured of complete confidentiality - no individual responses will be published and the raw information will be accessible only to me and the Nova Southeastern University faculty that make up my dissertation committee. This study has been reviewed and approved by the Institutional Review Boards (IRB) for Research with Human Subjects at Nova Southeastern University (954.262.5369) and the National Intelligence University (NIU) on behalf of the DIA (202.231.3354). If you have questions regarding this study, please contact me at 202.231.1353 (Office) or 334.207.3590 (Mobile) or via email at charles.perkins@dodiis.mil or cperkins@nova.edu.

The survey instrument will be accessible through June 24, 2016. To participate in this study, please click here: https://www.surveymonkey.com/r/MG79SSY. If the link does not work, then copy and paste the link into your browser.

Thank you for taking the time to participate in this study.

Respectfully,

Charles F. Perkins
Chief, Acquire-to-Retire (A2R) Audit Readiness
Program Management Office (PMO)
Comm: 202-231-1353
DSN: 428-1353

Doctoral Candidate
College of Engineering and Computing
Nova Southeastern University

Appendix D

Survey Instrument

Thank you for taking the time to complete this survey. This survey instrument aims to measure your perception of the Defense Intelligence Agency (DIA) enterprise data warehouse (EDW) business intelligence (BI) capabilities and the ability of the technology to meet your individual business needs and the business needs of the organization. This survey instrument will not solicit any identifiable data from you; all responses are provided anonymously.

This survey is divided into two sections. Section I asks that you tell us about yourself. Section II addresses your perceptions of DIA's EDW capability.

Section I. Demographic Data

1. **What is your gender?**

- [ ] Male
- [ ] Female
- [ ] Choose not to answer

2. **What is your race/ethnicity?**

- [ ] White
- [ ] African American
- [ ] Asian
- [ ] Hispanic
- [ ] Native American
- [ ] If not indicated, please specify: _____
- [ ] Choose not to answer

3.   What is your age group?

	18-22
	23-30
	31-40
	41-50
	51 or over
	Choose not to answer

4.   What is your highest level of education completed?

	High School
	Some College
	Associate's Degree or equivalent
	Baccalaureate Degree or equivalent
	Graduate Degree
	Post-graduate Degree
	Choose not to answer

5.   How long have you been employed at DIA? ____ years

6.   What is your functional business area?

	Acquisition and Procurement
	Facilities
	Finance
	Human Resources
	Information Systems/Technology
	Logistics / Supply chain
	Security

☐ Other (please specify)

☐ Choose not to answer

7. What is your management level in the organization?

☐ Executive management

☐ Middle management

☐ Functional management

☐ Other (please specify)

☐ Choose not to answer

8. What is the approximate number of employees in your functional business area?

☐ Less than 100

☐ 100 – 499

☐ 500 – 999

☐ 1000 or more

☐ Choose not to answer

9. How many years of experience do have working with your agency's enterprise data warehouse (EDW)/business intelligence (BI)?

☐ Less than 1

☐ 1 -5

☐ 6-10

☐ More than 10

☐ I have never used my agency's EDW/BI

☐ Choose not to answer

Section II. Perception Data

In this area, you will be asked to provide your opinion regarding <u>your organization's</u> <u>support</u> for data warehousing/business intelligence (DW/BI). The statements presented here are designed to measure your perception of support, sponsorship, and championship for your organization's data warehouse/business intelligence (DW/BI) capability among senior managers and stakeholders. Please choose a response that best describes each of the following statements. In the study, DW/BI and enterprise data warehouse (EDW) are used interchangeably. If you do not know the answer to a question, please skip it.

Label	Construct: Org Support (OS)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
OS$_1$	My organization's DW/BI is led by influential person(s) (e.g., Senior executives and managers) from the business community of interest (e.g., contracting, finance, human resources, supply chain/logistics, facilities, security and training).					
OS$_2$	Senior executives in my agency are committed to providing financial resources for the development and operation of DW/BI.					
OS$_3$	Business stakeholders (division, functions, etc.) in my agency understand the need for DW/BI.					
OS$_4$	Overall, strong business management sponsorship exists for DW/BI within my agency.					

In this area, you will be asked to provide your opinion regarding your organization's data warehouse/business intelligence (DW/BI) information technology (IT) capabilities. The statements presented here are designed to measure your perception of the quality of IT capabilities and data related to your organization's DW/BI. Please choose a response that best describes each of the following statements. If you do not know the answer to a question, please skip it.

Label	Construct: Info Tech (IT)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
IT$_1$	Development of DW/BI solutions is based on a standard development process.					
IT$_2$	Modern agile concepts are used to develop DW/BI solutions within my Agency.					
IT$_3$	DW/BI applications are operated based on IT standards (e.g., IT Infrastructure Library [ITIL]).					
IT$_4$	Standard DW/BI reports and dashboards ensure high quality information supply.					
IT$_5$	My organization's DW/BI capability provides analytical tools and other software to support advanced, proactive business analysis					
IT$_6$	DW/BI user interfaces/frontends provide a unified view of data originating from different business systems within my organization that is integrated and enable seamless access to information.					
IT$_7$	Data connections/interfaces between my organization's DW/BI and core business systems are centralized and standardized (e.g., core business systems include contracting, finance, human resources, supply chain/logistics, and asset management).					

IT$_8$	My organization's DW/BI information is integrated across departmental borders.				
Clearly defined responsibilities, standards and principles exist in the following areas of EDW/BI:					
IT$_9$	a. Tools and applications				
IT$_{10}$	b. Business Content				
IT$_{11}$	c. Management and sourcing processes				
IT$_{12}$	d. Development Processes				
IT$_{13}$	e. Operational Processes				
IT$_{14}$	DW/BI roles, tasks, and responsibilities are clearly defined and documented in the context of data quality.				
IT$_{15}$	Core business objects, performance indicators, and dimensions are clearly defined.				
IT$_{16}$	Data quality is measured continuously and proactively to ensure the highest quality.				
My organization's DW/BI system(s) has/have the following properties:					
IT$_{17}$	a. DW/BI operations are based on defined service level agreements.				
IT$_{18}$	b. My organization's DW/BI user interfaces/frontends are modern and easy to use.				
IT$_{19}$	c. Response times of DW/BI systems enable efficient and effective usage.				

In this area, you will be asked to provide your opinion regarding your organization's practices related to data warehousing/business intelligence (DW/BI). The statements presented in this area are designed to measure your organization's DW/BI strategy, governance, and partnership between the information technology (IT) department and business functions/departments. Please choose a response that best describes each of the following statements. If you do not know the answer to a question, please skip it.

Label	Construct: Practices (PRAC)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
$PRAC_1$	Significant DW/BI decisions are made by a steering committee within the business community of interest.					
$PRAC_2$	My organization's DW/BI initiative is based on an organizational vision and comprehensive DW/BI strategy that is updated regularly					
$PRAC_3$	Performance management related to my organization's DW/BI is based on elaborated methods such as cost accounting, balance scorecard, or portfolio management.					
$PRAC_4$	My organization's Information Technology (IT) department acts as a business partner and takes an active role in improving business practices based on DW/BI.					
$PRAC_5$	Responsibilities for DW/BI management and oversight are centralized within my Agency.					

In this area, you will be asked to provide your opinion regarding <u>your use</u> and the <u>widespread organizational use</u> of the data warehousing/business intelligence (DW/BI) capability within your Agency. The statements presented here are designed to measure your perception of using DW/BI in the performance of your job and the extent of use across your organization. Please choose a response that best describes each of the following statements. If you do not know the answer to a question, please skip it.

Label	Construct: Use (U)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
USE$_1$	DW/BI applications are used by top management.					
USE$_2$	DW/BI applications are used by middle management.					
USE$_3$	DW/BI applications are used by business analysts and/or data scientists.					
USE$_4$	DW/BI applications are used by operational/functional users.					
USE$_5$	Use of my organization's DW/BI helps me minimize uncertainty in my decision-making process(es).					
USE$_6$	Use of my organization's DW/BI enhances my job performance and productivity.					

In this area, you will be asked to provide your opinion regarding the <u>impact</u> of your agency's enterprise data warehousing/business intelligence capability <u>on your business organization</u>. The statements that follow are designed to measure your perception of the <u>overall impact</u> of DW/BI on your organization's performance. Please choose a response that best describes each of the following statements. If you do not know the answer to a question, please skip it.

Label	Construct: Org Performance (OP)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
OP$_1$	Overall, my organization has experienced increased efficiency in internal business processes as a result of implementing DW/BI.					
OP$_2$	Overall, my organization has experienced improved performance as a result of implementing DW/BI.					

Note. Adapted from "Towards the Measurement of Business Intelligence Maturity," by D. Raber, F. Wortmann, and R. Winter, 2013, *Proceedings of the 21st European Conference on Information Systems*, 1–12.

Appendix E

Interview Guide

This interview guide is designed to facilitate a qualitative investigation of perceptions of senior leaders regarding DIA's enterprise data warehouse/business intelligence initiative.

Central Research Question

What are the influences of DW/BI maturity on organizational performance as perceived by constituents directly involved in DW/BI at the DIA?

Informed Consent

Demographic

Interviewee Name:

Interviewee Position:

Interview Questions

1. What is your perception of the Enterprise Data Warehouse/Business Intelligence (EDW/BI) within your organization and its perceived value to the business enterprise?
   a. What are the benefits of using the technology?
   b. What are the challenges?
   c. Are you a champion for EDW/BI?

2. What is the level and breadth of leadership, sponsorship, and commitment for your organization's EDW/BI initiative?

3. To what extent do leadership and management refer to the data warehouse to support organizational decision-making and have these decisions had any financial impact for the organization?

4. How does your organization's EDW/BI initiative and practices align with your organization's strategic goals and IT strategy?

5. Does your organization have a governance board for data warehousing development and maturation? If so, how does the governance board ensure alignment with your organization's strategic goals and IT strategy?

6. What is the business scope of your organization's EDW? To what extent does the EDW integrate with core business processes and data from organizational business areas?

7. What processes and (or) procedures are in place to ensure accuracy and timeliness of data to EDW users?

8. In some industries, business intelligence competency centers (BICC) have been established as a dedicated team to deliver data warehousing/business intelligence decision support to senior leaders and managers. How is your organization structured to address the EDW/BI needs of your business enterprise today and in the future?

9. To what extent does your organization ensure availability of fiscal resources to sustain and grow your EDW/BI capabilities? What organizational element is responsible for programming and budgeting for your DW/BI capabilities?

Appendix F

Informed Consent

NOVA SOUTHEASTERN UNIVERSITY
Graduate School of Computer and Information Sciences

Consent Form for Participation in the Research Study Investigating the Influence of Data Warehousing/Business Intelligence Maturity on Organizational Performance

Funding Source: None.

IRB protocol #:

Principal investigator
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For questions/concerns about your research rights, contact:
Human Research Oversight Board (Institutional Review Board or IRB)
Nova Southeastern University
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Site Information:
Defense Intelligence Agency
200 MacDill Blvd
Joint Base Anacostia-Bolling
Washington, DC 20050-6563

What is the study about?
This study involves research to investigate the Influence of Data Warehousing/Business Intelligence Maturity on Organizational Performance.

Why are you asking me?
You have been selected to participate in this research study because of your knowledge, familiarity and use of the Defense Intelligence Agency's Enterprise Data Warehouse (EDW) Business Intelligence (BI) environment. Your insight will be helpful in understanding the business value of the EDW/BI to you in performing your work and to the organization. You are one of approximately 120 subjects being asked to participate in this study.

What will I be doing if I agree to be in the study?
Your involvement in the study is to complete an online survey or to participate in a personal interview with the Principal Investigator.

Survey Participants. The survey instrument will be used to capture some information about you and your perceptions regarding your experience(s) with DIA's Enterprise Data Warehouse Business Intelligence environment. As a survey participant, you will be notified via electronic mail (e-mail) with a hyperlink to the web-enabled survey. Upon notification, you will have two weeks to navigate to the web site to complete the survey. The survey instrument will not solicit any identifiable data from you; therefore, all responses are provided anonymously. The survey should take approximately 30 minutes to complete.

Interview Participants. The Principal Investigator will conduct personal semi-structured interviews with DIA senior leaders, managers, and the EDW/BI staff. During the interview process, the Principal Investigator will not solicit any identifiable data from you. The goal is to engage in a semi-structured discussion regarding DIA's Enterprise Data Warehouse Business Intelligence environment that is facilitated by a set of open-ended interview questions. Personal interviews should take no more than 1 hour to complete; however, a follow-up interview may be necessary for members of the EDW/BI staff. Your time is valuable; therefore, the Principal Investigator will work with you to schedule interviews at a time and location that you find convenient within the timeframe of this study.

Is there any audio or video recording?
This research project will not use any audio or video recording devices.

What are the dangers to me?
The risks associated with this research study are minimal. The procedures or activities in this study may have unknown or unforeseeable risks. If you have any questions about the research, your research rights, or have a research-related injury, please contact Charles Perkins or Dr. Junping Sun. You may also contact the IRB at the numbers indicated above with questions as to your research rights.

Are there any benefits for taking part in this research study?
There are no direct benefits.

Initials: _____   Date: _____   Page 2 of 4

Will I get paid for being in the study? Will it cost me anything?
There are no costs to you or payments made for participating in this study.

How will you keep my information private?
All information obtained in this study is strictly confidential unless disclosure is required by law. In accord with federal guidelines, the NSU IRB, and the DIA IRB all data and information obtained by the Principal Investigator will be safeguarded to protect your confidentiality. The safeguard measure for data storage is a locked file at the Principal Investigator's residence where the data will be retained securely for a period of 36 months after the study is complete. Representatives of the NSU IRB, the DIA IRB, regulatory agencies, and the dissertation chair may review research records. Upon expiration of the 36 month retention period, the Principal Investigator will permanently destroy all research-related data and information pertaining to this study using commercial incineration.

What if I do not want to participate or I want to leave the study?
You have the right to leave this study at any time or refuse to participate. If you do decide to leave or you decide not to participate, you will not experience any penalty or loss of services you have a right to receive. If you choose to withdraw, any information collected about you before the date you leave the study will be kept in the research records for 36 months from the conclusion of the study and may be used as a part of the research.

Other Considerations:
If significant new information relating to the study becomes available, which may relate to your willingness to continue to participate, this information will be provided to you by the investigators.

Voluntary Consent by Participant:
By signing below, you indicate that
- this study has been explained to you
- you have read this document or it has been read to you
- your questions about this research study have been answered
- you have been told that you may ask the researchers any study related questions in the future or contact them in the event of a research-related injury
- you have been told that you may ask Institutional Review Board (IRB) personnel questions about your study rights
- you are entitled to a copy of this form after you have read and signed it
- you voluntarily agree to participate in the study entitled "Investigating the Influence of Data Warehousing/Business Intelligence Maturity on Organizational Performance"

Initials: _____   Date: _____   Page 3 of 4

Appendix G

Certificate of Authorship

NSU NOVA SOUTHEASTERN UNIVERSITY
College of Engineering and Computing

Certification of Authorship

Submitted to Dr. Junping Sun:

Student's Name: Charles F. Perkins

Date of Submission: July 31, 2017

Purpose and Title of Submission: Dissertation Report: Investigating the Perceived Influence of Data Warehousing and Business Intelligence Maturity on Organizational Performance: A Mixed Methods Study

Certification of Authorship: I hereby certify that I am the author of this document and that any assistance I received in its preparation is fully acknowledged and disclosed in the document. I have also cited all sources from which I obtained data, ideas, or words that are copied directly or paraphrased in the document. Sources are properly credited according to accepted standards for professional publications. I also certify that this paper was prepared by me for this purpose.

Student's Signature:

References

Anderson-Lehman, R., Watson, H. J., Wixom, B. H., & Hoffer, J. A. (2004). Continental airlines flies high with real-time business intelligence. *MIS Quarterly Executive*, *3*(4), 163–176.

Ariyachandra, T., & Watson, H. (2010). Key organizational factors in data warehouse architecture selection. *Decision Support Systems, 49*, 200–212.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Baruch, Y. (1999). Response rate in academic studies-A comparative analysis. *Human Relations, 52*(4), 421–438.

Bazeley, P., & Jackson, K. (2013). *Qualitative data analysis with NVivo* (2nd ed.). Thousand Oaks, CA: Sage.

Becker, J., Knackstedt, R., & Poppelbub, J. (2009). Developing maturity models for IT management. *Business & Information Systems Engineering, 1*(3), 213–222.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly*, *11*(3), 369–386.

Bennett, T. A., & Bayrak, C. (2011). Bridging the data integration gap: from theory to implementation. *SIGSOFT Software Engineering Notes, 36*(3), 1–8.

Bijker, M., & Hart, M. (2013). Factors influencing pervasiveness of organisational business intelligence. *Proceedings of the 3rd International Conference on Business Intelligence and Technology*, 21–26. Retrieved from http://www.thinkmind.org/

Bloomberg, L. D., & Volpe, M. (2012). *Completing your dissertation: A roadmap from beginning to end* (2nd ed.). Thousand Oaks, CA: Sage.

Bowen, G. A. (2005). Preparing a qualitative research-based dissertation: Lessons learned. *Qualitative Report, 10*(2), 208–222. Retrieved from http://www.nova.edu/ssss/QR/QR10-2/bowen.pdf

Brace, N., Kemp, R., & Snelgar, R. (2006). *SPSS for psychologists* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Bucher, T., Gericke, A., & Sigg, S. (2009). Process-centric business intelligence. *Business Process Management Journal, 15*(3), 408–429.

Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An overview of business intelligence technology. *Communications of the ACM, 54*(8), 88–98.

Chenoweth, T., Corral, K., & Demirkan, H. (2006). Seven key interventions for data warehouse success. *Communications of the ACM, 49*(1), 114–119.

Chuah, M. H., & Wong, K. L. (2011). A review of business intelligence and its maturity models. *African Journal of Business Management, 5*(9), 3424–3428.

Cosic, R., Shanks, G., & Maynard, S. (2012). Towards a business analytics capability maturity model. *Proceedings of the 23rd Australasian Conference on Information Systems*, 1–11. Retrieved from http://dro.deakin.edu.au/view/DU:30049067

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage.

Curran, M. J. (2012). Traditional issues during migration to an integrated data warehouse system: A case study. *Issues in Information Systems, 13*(1), 17–24.

Davenport, T. H. (2006). Competing on analytics. *Harvard Business Review, 84*(1), 98. Retrieved from https://hbr.org/

Davenport, T. H. (2010). Business intelligence and organizational decisions. *International Journal of Business Intelligence Research*, *1*(1), 1–12.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340.

Dayal, U., Castellanos, M., Simitsis, A., & Wilkinson, K. (2009). Data integration flows for business intelligence. *Proceedings of the 12th International Conference on Extending Database Technology: Advances in Database Technology*, Saint Petersburg, Russia, 1–11.

Defense Intelligence Agency. (2012). 2012-2017 Defense intelligence strategy: One mission, one agency, one team. Retrieved from http://www.dia.mil/about/strategic-plan/2012-2017-DIA-Strategic-Plan.pdf

Defense Intelligence Agency. (n.d.). Organization of the defense intelligence agency. Retrieved from http://www.dia.mil/pdf/dia-org-chart.pdf

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information systems research, 3*(1), 60–95.

DeLone, W. H., & McLean, E. R. (2003). The Delone and Mclean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9–30.

Devlin, B. A., & Murphy, P. T. (1988). An architecture for a business and information system. *IBM Systems Journal, 27*(1), 60–80.

Dinter, B. (2012). The maturing of a business intelligence maturity model. *Proceedings of the Eighteenth Americas Conference on Information Systems,* 1–10.

Dooley, K., Subra, A., & Anderson, J. (2001). Maturity and its impact on new product development project performance. *Research in Engineering Design*, *13*, 23–29.

Driscoll, D. L., Appiah-Yeboah, A., Salib, P., & Rupert, D. J. (2007). Merging qualitative and quantitative data in mixed methods research: How to and why not. *Ecological and Environmental Anthropology*, 3(1), 18–28. Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1012&context=icwdm eea

Eckerson, W. (2008). Pervasive business intelligence, techniques and technologies to deploy BI on an enterprise scale. *TDWI Best Practice Reports, 4*. Retrieved from http://www.umsl.edu/~sauterv/DSS4BI/links/pdf/BI/pervasiveBI.sas.pdf

Edjlali, R., Fienberg, D., Beyer, M. A., & Adrian, M. (2012). The state of data warehousing in 2012. Retrieved from http://www.gartner.com

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

Elbashir, M., & Williams, S. (2007). BI impact: The assimilation of business intelligence into core business processes. *Business Intelligence Journal*, *12*(4), 45.

Elbashir, M. Z., Collier, P. A., & Davern, M. J. (2008). Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. *International Journal of Accounting Information Systems*, *9*(3), 135–153.

Elbashir, M. Z., Collier, P. A., & Sutton, S. G. (2011). The role of organizational absorptive capacity in strategic use of business intelligence to support integrated management control systems. *Accounting Review*, *86*(1), 155–184.

Elbashir, M. Z., Collier, P. A., Sutton, S. G., Davern, M. J., & Leech, S. A. (2013). Enhancing the business value of business intelligence: The role of shared knowledge and assimilation. *Journal of Information Systems, 27*(2), 87–105.

Ellis, J., & Harris, B. (2014, July 20). What is a front office? Retrieved from http://www.wisegeek.com/what-is-a-front-office.htm

English, L. (2005). Business intelligence defined. Retrieved from http://www.b-eye-network.com/view/1119

Evolution. (n.d.). In *Merriam-Webster's online dictionary* (11th ed.). Retrieved from http://www.m-w.com/dictionary/evolution

Eybers, S., Kroeze, J. H., & Strydom, I. (2013). *Towards a classification framework of business intelligence value research.* Retrieved from the Italian Chapter of Association for Information Systems website: http://aisnet.org/group/ITAIS

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2014). *G*Power version 3.1.9* [computer software]. Uiversitat Kiel, Germany. Retrieved from http://www.gpower.hhu.de/en.html

Fernandez-Gonzalez, J. (2008). Business intelligence governance: Closing the IT/business gap. *European Journal of Informatics Professionals*, *9*(1), 23-30.

Flynn, M. T. (2014, June 5). *Defense Intelligence Agency pre-certification authority out-of-cycle portfolio request* [Memorandum]. Washington, DC: Defense Intelligence Agency.

Frazier, P. A., Tix, A. P., & Barron, K. E. (2004). Testing moderator and mediator effects in counseling psychology research. *Journal of Counseling Psychology, 51*(1), 115–134.

Gable, G. G., Sedera, D., & Chan, T. (2008). Re-conceptualizing information system success: The IS-impact measurement model. *Journal of the Association for Information Systems, 9*(7), 377–408.

George, D., & Mallery, P. (2010). *SPSS for windows step by step: A simple guide and reference, 18.0 Update*: Pearson Education.

Gibson, C. F., & Nolan, R. L. (1974). Managing the four stages of EDP growth. *Harvard Business Review*, 76–87. Retrieved from https://hbr.org/

Goede, R. (2011). Improved data warehousing: Lessons learnt from the systems approach. *World Academy of Science, Engineering and Technology, 54.* Retrieved from https://waset.org/journals/waset/v54/v54-131.pdf

Goeke, R. J., & Faley, R. H. (2007). Leveraging the flexibility of your data warehouse: How data warehouse flexibility affects use. *Communications of the ACM*, *50*(10), 107–111.

Gonzales, M. L. (2011). Success factors for business intelligence and data warehousing maturity and competitive advantage. *Business Intelligence Journal*, *16*(1), 22–29.

Gonzales, M. L., Bagchi, K., Udo, G., & Kirs, P. (2011). Diffusion of business intelligence and data warehousing: An exploratory investigation of research and practice. *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS),* 1–9.

Gordon, A. (2002). SurveyMonkey. com—Web-based survey and evaluation system: http://www. SurveyMonkey. com. *Internet and Higher Education, 5*(1), 83–87.

Grubljesic, T., & Jaklic, J. (2014). Three dimensions of business intelligence systems use behavior. *International Journal of Enterprise Information Systems, 10*(3), 62–76.

Grubljesic, T., Coelho, P. S., & Jaklic, J. (2014). The importance and impact of determinants influencing business intelligence systems embeddedness. *Issues in Information Systems, 15*(1).

Guba, E. G., & Lincoln, Y. S. (1998). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks, CA: Sage.

Gutierrez, N. (2006). *Business intelligence (BI) governance* [White paper]. Retrieved from http://www.infosys.com/industries/consumer-packaged-goods/white-papers/Documents/bi-governance.pdf

Hawking, P., & Sellitto, C. (2010). Business intelligence (BI) critical success factors. *Proceedings of the 2010 Australasian Conference on Information Systems*, 1–11.

Henderson, J. C., & Venkatraman, N. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, *32*(1), 4–16.

Hostmann, B. (2007). BI competency centers: Bringing intelligence to the business. *Business Performance Management, 5*(4), 4–10.

Howson, C. (2006, September). The seven pillars of BI success. Retrieved from Intelligent Enterprise website: http://www.intelligententerprise.com/showArticle.jhtml?articleID=191902420

Huang, R., Zmud, R. W., & Price, R. L. (2010). Influencing the effectiveness of IT governance practices through steering committees and communication policies. *European Journal of Information Systems, 19*(3), 288–302.

Hwang, M. I., & Xu, H. (2007). The effect of implementation factors on data warehousing success: An exploratory study. Retrieved from http://digitalcommons.butler.edu/cob_papers/77

IBM Corp. (2013). IBM SPSS statistics for windows, version 22.0. Armonk, NY: IBM Corp.

Inmon, W. H. (1996). *Building the data warehouse* (2nd ed.). New York, NY: Wiley.

Inmon, W. H., Strauss, D., & Neushloss, G. (2008). DW 2.0: *The architecture for the next generation of data warehousing*. Burlington, MA: Morgan Kaufmann.

Isik, O. (2009). Business intelligence success: An empirical evaluation of the role of BI capabilities and the decision environment. *Proceedings of the Fifteenth Conference on Information Systems, San Francisco, CA,* 1–13. Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1018&context=amcis2009_dc

Isik, O., Jones, M. C., & Sidorova, A. (2013). Business intelligence success: The roles of BI capabilities and decision environments. *Information & Management, 50*(1), 13–23.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14–26.

Jourdan, Z., Rainer, R. K., & Marshall, T. E. (2008). Business intelligence: An analysis of the literature. *Information Systems Management, 25*(2), 121–131.

Kavanagh, S. C. (2005). Data warehousing. In Kavanagh, S. C. & Miranda, R. A. (Eds.), *Technologies for government transformation: ERP systems and beyond* (pp. 221–234). Chicago, IL: Government Finance Officers Association of the United States and Canada.

Khan, A. (2012). *Business intelligence & data warehousing simplified: 500 questions, answers, and tips.* Dulles, VA: Mercury.

Kimball, R., & Ross, M. (2002). *The data warehouse toolkit: The complete guide to dimensional modeling* (2nd ed.). New York, NY: John Wiley and Sons.

Kimball, R., Ross, M., Thornthwaite, W., Mundy, J., & Becker, B. (2008). *The data warehouse lifecycle toolkit: Practical techniques for building data warehouse and business intelligence systems* (2nd ed.). Indianapolis, IN: Wiley.

Lahrmann, G., Marx, F., Winter, R., & Wortmann, F. (2010). Business intelligence maturity models: An overview. *Proceedings of the VII conference of the Italian Chapter of AIS (itAIS 2010)*, 1–12.

Lahrmann, G., Marx, F., Winter, R., & Wortmann, F. (2011). Business intelligence maturity: Development and evaluation of a theoretical model. *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS),* 1–10.

Lonnqvist, A., & Pirttimaki, V. (2006). The measurement of business intelligence. *Information Systems Management*, *23*(1), 32-40.

Luftman, J. (2004). Assessing business-IT alignment maturity. In Grembergen. W. V., *Strategies for information technology governance*, (pp. 99-128). Hershey, PA: Idea Group.

Luftman, J., & Ben-Zvi, T. (2010). Key issues for IT executives 2010: Judicious IT investments continue post-recession. *MIS Quarterly Executive, 9*(4), 263-273.

Luftman, J., & Brier, T. (1999). Achieving and sustaining business-IT alignment. *California Management Review, 42*(1), 109-122.

Luhn, H. P. (1958). A business intelligence system. *IBM Journal of Research and Development, 2*(4), 314–319.

Lupu, A., Bologa, R., Lungu, I., & Bara, A. (2007). The impact of organizational changes on business intelligence projects. *Proceedings of the 7th WSEAS International Conference on Simulation, Modeling and Optimization, Beijing, China*, 415–419.

Mannino, M. V., & Walter, Z. (2006). A framework for data warehouse refresh policies. *Decision Support Systems, 42*, 121–143.

March, S. T., & Hevner, A. R. (2007). Integrated decision support systems: A data warehousing perspective. *Decision Support Systems, 43*(3), 1031–1043.

Matney, D., & Larson, D. (2004). The four components of BI governance. *Business Intelligence Journal, 9*, 29–36.

Maté, A., & Trujillo, J. (2014). Tracing conceptual models' evolution in data warehouses by using the model driven architecture. *Computer Standards & Interfaces, 36*(5), 831–843. doi:10.1016/j.csi.2014.01.004

Maturity. (n.d.). In *Merriam-Webster's online dictionary* (11th ed.). Retrieved from http://www.m-w.com/dictionary/maturity

Maxwell, J. A. (2005). Qualitative research design: An interactive approach (2nd ed.). Thousand Oaks, CA: Sage.

McGee, M., & Fritsky, L. (2014, July 9). What is back office support? Retrieved from http://www.wisegeek.com/what-is-back-office-support.htm

Mukherjee, D., & D'Souza, D. (2003). Think phased implementation for successful data warehousing. *Information Systems Management, 20*(2), 82–90.

Niranjan, V., Anand, S., & Kunti, K. (2005). Shared data services: An architectural approach. *Proceedings of the IEEE International Conference on Web Services-2005 (ICWS'05)*, Orlando, Florida, 683–690.

Nylund, A. (1999). Tracing the BI family tree. *Knowledge Management*. Retrieved from http://www.scholarosity.net/documents/dw_family_tree.pdf

Ong, I. L., & Siew, P. H. (2013). An empirical analysis on business intelligence maturity in Malaysian organizations. *International Journal of Information System and Engineering, 1*(1), 1–10.

Ong, I. L., Siew, P. H., & Wong, S. F. (2011). Assessing organizational business intelligence maturity. *Proceedings of the 5th International Conference on IT & Multimedia*, 1–6.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health, 42*(5), 533–544.

Pant, P. (2009). *Business Intelligence: How to build successful BI strategy*. Retrieved from http://www.loria.fr/~ssidhom/UE909R/1_BI_strategy.pdf

Patrick, P. (2005). Impact of SOA on enterprise information architectures. *Proceedings of the 2005 ACM SIGMOD International Conference on Management of Data*, 844–848.

Peng, G. C., Nunes, J. M. B., & Annansingh, F. (2011). Investigating information systems with mixed-methods research. In *Proceedings of the IADIS International Workshop on Information Systems Research Trends, Approaches and Methodologie*s. Western Bank, United Kingdom: University of Sheffield.

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems, 17*(3), 236–263.

Pitt, L. F., Watson, R. T., & Kavan, C. B. (1995). Service quality: A measure of information systems effectiveness. *MIS Quarterly, 19*(2), 173–187.

Popovic, A., & Jaklic, J. (2010). Benefits of business intelligence system implementation: An empirical analysis of the impact of business intelligence system maturity on information quality. *Proceedings of the European, Mediterranean & Middle Eastern Conference on Information Systems 201*0 (EMCIS2010).

Popovic, A., Coelho, P. S., & Jaklic, J. (2009). The impact of business intelligence maturity on information quality. *Information Research, 14*(4), 1–26.

Popovic, A., Hackney, R., Coelho, P. S., & Jaklic, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. *Decision Support Systems, 54*(1), 729–739.

Popovic, A., Turk, T., & Jaklic, J. (2010). Conceptual model of business value of business intelligence systems. *Journal of Contemporary Management Issues, 15*(1), 5–29.

Power, D. J. (2007). *A brief history of decision support systems*. Retrieved from http://dssresources.com/history/dsshistory.html

Presthus, W., Ghinea, G., & Utvik, K. R. (2012). The more, the merrier?: The interaction of critical success factors in business intelligence implementations. *International Journal of Business Intelligence Research, 3*(2), 34–48.

Raber, D., Winter, R., & Wortmann, F. (2012). Using quantitative analysis to construct a capability maturity model. *Proceedings of the 45th Hawaii International Conference on System Sciences* (HICSS), 4219–4228.

Raber, D., Wortmann, F., & Winter, R. (2013). Towards the measurement of business intelligence maturity. *Proceedings of the 21st European Conference on Information Systems*, 1–12.

Rajteric, I. H. (2010). Overview of business intelligence maturity models. *Management, 15*(1), 47–67.

Ramamurthy, K., Sen, A., & Sinha, A. P. (2008a). An empirical investigation of the key determinants of data warehouse adoption. *Decision Support Systems, 44*(4), 817–841.

Ramamurthy, K., Sen, A., & Sinha, A. P. (2008b). Data warehousing infusion and organizational effectiveness. *IEEE Transactions on Systems, Man, and Cybernetics, 38*(4), 976–994.

Ranjan, J. (2008). Business justification with business intelligence. *Vine, 38*(4), 461–475.

Reich, B. H., & Benbasat, I. (1996). Measuring the linkage between business and information technology objectives. *MIS Quarterly, 20*(1).

Sabherwal, R., & Becera-Fernandez, I. (2011). Business Intelligence. Practices, Technologies and Management. Hoboken. NJ: John Wiley & Sons.

Sammon, D., & Finnegan, P. (2000). The ten commandments of data warehousing. Database for Advances in Information Systems, 31(4), 82–91.

Schieder, C., & Gluchowski, P. (2011). Towards a consolidated research model for understanding business intelligence success. *Proceedings of the 19th European Conference on Information Systems*, 1–13.

Schuff, D., Corral, K., & Turetken, O. (2011). Comparing the understandability of alternative data warehouse schemas: An empirical study. *Decision Support Systems, 52*(1), 9–20.

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research, 8*(3), 240–253.

Sen, A., & Sinha, A. P. (2005). A comparison of data warehousing methodologies. *Communications of the ACM, 48*(3), 79–84.

Sen, A., Ramamurthy, K., & Sinha, A. P. (2012). A model of data warehousing process maturity. *IEEE Transactions on Software Engineering, 38*(2), 336–353.

Sen, A., Sinha, A. P., & Ramamurthy, K. (2006). Data warehousing process maturity: An exploratory study of factors influencing user perceptions. *IEEE Transactions on Engineering Management, 53*(3), 440–455.

Shanks, G., Bekmamedova, N., & Willcocks, L. (2013). Using business analytics for strategic alignment and organizational transformation. *International Journal of Business Intelligence Research, 4*(3), 1–15.

Sledgianowski, D., Luftman, J. N., & Reilly, R. R. (2006). Development and validation of an instrument to measure maturity of IT business strategic alignment mechanisms. *Information Resources Management Journal, 19*(3), 18–33.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). Mahwah, NJ: Routledge Academic.

Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics* (6th ed.). Boston, MA: Pearson.

Tatum, M., & Harris, B. (2014, July 7). What is a back office? Retrieved from http://www.wisegeek.com/what-is-a-back-office.htm

Terrell, S. R. (2012). Mixed-Methods Research Methodologies. *Qualitative Report, 17*(1), 254–280. Retrieved from http://nsuworks.nova.edu/tqr/vol17/iss1/14

Tracy, S. (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact.* West Sussex, UK: Wiley-Blackwell.

Turban, E., Sharda, R., Delen, D., & King, D. (2011). *Business intelligence: A managerial approach* (2nd ed.). Boston, MA: Pearson.

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly, 37*(1), 21–54.

Vesset, D., & McDonough, B. (2009). Improving organizational performance management through pervasive business intelligence. Retrieved from https://www.realtech.com/wNewzealand/pdf/Improving_Organizational_Perform ance_Through_Pervasive_Business_Intelligence__1_.pdf

Viaene, S. (2008). Linking business intelligence into your business. *IT Professional, 10*(6), 28–34.

Watson, H. J. (2002). Recent developments in data warehousing. *Communications of the Association for Information Systems, 8*(1), 1–25.

Watson, H. J. (2013). All about analytics. *International Journal of Business Intelligence Research, 4*(1), 13–28.

Watson, H. J., & Wixom, B. H. (2007a). The current state of business intelligence. *Computer, 40*(9), 96–99.

Watson, H. J., & Wixom, B. H. (2007b). Enterprise agility and mature BI capabilities. *Business Intelligence Journal, 12*(3), 4.

Watson, H. J., Goodhue, D. L., & Wixom, B. H. (2002). The benefits of data warehousing: why some organizations realize exceptional payoffs. *Information Management, 39*(6), 491–502.

Watson, H., Ariyachandra, T., & Matyska, R. J. (2001). Data warehousing stages of growth. *Information Systems Management, 18*(3), 42–50.

Wieder, B., Ossimitz, M. L., & Chamoni, P. (2012). The impact of business intelligence tools on performance: A user satisfaction paradox? *International Journal of Economic Sciences and Applied Research, 3*, 7–32.

Williams, N., & Thomann, J. (2003). BI maturity and ROI: How does your organization measure up? *Decision Path*. Retrieved from http://www.decisionpath.com/_ docs_downloads/TDWI%20Flash%20%20_BI%20Maturity%20and_ %20ROI%20110703.pdf

Williams, S. (2004). Assessing BI readiness: A key to BI ROI. *Business Intelligence Journal, 9*, 15–23.

Williams, S. (2011). 5 barriers to BI success and how to overcome them. *Strategic Finance, 1*(6), 28–33.

Williams, S., & Williams, N. (2007). *The profit impact of business intelligence*. San Francisco, CA: Morgan Kaufmann.

Wixom, B., Ariyachandra, T., Douglas, D., Goul, M., Gupta, B., Iyer, L., & Turetken, O. (2014). The current state of business intelligence in academia: The arrival of big data. *Communications of the Association for Information Systems, 34*(1), 1.

Wixom, B., & Watson, H. (2010). The BI-based organization. *International Journal of Business Intelligence Research, 1*(1), 13–28.

Wixom, B. H., & Watson, H. J. (2001). An empirical investigation of the factors affecting data warehousing success. *MIS Quarterly, 25*(1), 17–41.

Wixom, B. H., Watson, H. J., Reynolds, A., & Hoffer, J. A. (2008). Continental airlines continues to soar with business intelligence. *Information Systems Management, 25*(2), 102–112.

Wrembel, R. (2009). A survey of managing the evolution of data warehouses. *International Journal of Data Warehousing and Mining, 5*(2), 24-56.

Yeoh, W., & Koronios, A. (2010). Critical success factors for business intelligence systems. *Journal of Computer Information Systems, 50*(3), 23.

Yin, R. K. (2003). *Case study research design and methods*. Thousand Oaks, CA: Sage.