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The Diffusion Of Digital Dashboards: An Examination Of Dashboard Utilization And The Managerial Decision Environment

Jeffrey Reinking
University of Central Florida

THE DIFFUSION OF DIGITAL DASHBOARDS: AN EXAMINATION OF DASHBOARD UTILIZATION AND THE MANAGERIAL DECISION ENVIRONMENT

by

JEFF REINKING
B.S. Florida Southern College, 1990
M.B.A. Stetson University, 2008

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ABSTRACT

This dissertation consists of three related studies examining the diffusion of digital dashboard technology throughout today's organizations. Dashboards, once reserved for the executive level, are now available to managers at the lower levels of the organization. For these managers, dashboards have become an integral part of their work life to support their decision environment, to provide consistency in measures, to monitor performance, and to communicate information throughout the organization. Prior research in the practice literature has shown that dashboards improve managerial performance and organizational performance as well as communicate organizational goals and objectives; however, empirical research has not been conducted in this area to confirm this anecdotal evidence. Using three theories, the phenomenon surrounding the diffusion of dashboards to the lower levels of the organization are examined based on 1) dashboards as a source of interactive management control and strategy alignment, 2) the impact of dashboard quality on strategy alignment, decision environment, and performance, and 3) the impacts on dashboard utilization from the antecedents of information content and task uncertainty and the consequences of user satisfaction and managerial performance.

The first study investigates *why* dashboards have been diffused to the lowers levels of today's organizations. The primary focus of this study is to develop an understanding about the extent of dashboard utilization by decision-makers and the antecedents and consequences of utilization that is responsible for the widespread acceptance of this technology. The data for this study is collected and analyzed through an explanatory cross-sectional field study utilizing a semi-structured questionnaire. Using data from interviews with 27 managers, a framework is developed that indicates strategy alignment and dashboards associated with interactive

management control are the primary antecedents that drive dashboard diffusion. The dimensions of dashboard system quality and dashboard information quality mediate the relationship between an interactive dashboard and the extent of dashboard utilization, which leads to higher levels of managerial performance and organizational performance. This study contributes to the dashboard, strategy, and MCS literature by revealing that dashboards are not isolated technologies, rather they play an important role in the execution of strategy at the operational levels of an organization. In addition, dashboards can also function as an interactive management control, which leads to high levels of diffusion of dashboards throughout organizations. Prior strategy literature has examined strategy alignment at the higher levels and this study extends this research stream by investigating strategy alignment at the lower operational levels of the organization.

The second study utilizes the IS Success Model to explore the impacts of the antecedents of dashboard system quality and dashboard information quality on the managerial decision environment in addition to the resulting consequences or 'net benefit' of managerial performance and organizational performance. A field survey is used to collect data from 391 dashboard using managers to enable the analysis of the relationships predicted in the theoretical model. The theoretical model is analyzed utilizing PLS. The results show that two dimensions of dashboard quality, system *flexibility* and information *currency*, have a positive effect the managerial decision environment. The model indicates support for the consequences of managerial performance and organizational performance resulting from higher levels of decision quality in the managerial decision environment. The model also reveals that when the dashboard measures are strategy aligned, lower levels of dashboard system flexibility are associated with improved

managerial decision environment. Therefore, when organizations design their dashboard systems to support strategy alignment, managers should not be afforded high levels of system flexibility to maintain their attention on the key performance indicators selected to align with strategy. This result is a primary contribution to the strategy literature that reveals that strategy aligned dashboards are more effective in environments where the dashboard flexibility is lower. Additionally, study two also extends the strategy literature by examining strategy alignment at the lower levels of the organization, since prior research has concentrated on the higher level strategic outcomes.

As dashboards become highly diffused and more managers utilize the technology, the likelihood that dashboard designers cannot provide dashboard content that fits the tasks performed by managers is higher. The third study investigates this fit between dashboard information content and task uncertainty to understand if the fit between the technology and task impacts the extent of dashboard utilization by managers based on the theory of task-technology fit (TTF). TTF predicts higher levels of utilization will increase user satisfaction and managerial performance. Data is collected from 391 managers that utilize dashboards in their weekly work life to analyze the relationships predicted in the theoretical model. PLS is utilized to analyze the theoretical model and indicates weak support of TTF impacting the extent of dashboard utilization. The model supports the hypotheses for the links between the extent of dashboard utilization and user satisfaction and managerial performance. Based on the weak findings from this theoretical model, a second model is developed and analyzed. The second model measures TTF through the mediation of task uncertainty between dashboard information content and the extent of dashboard utilization, while the first model measured TTF through interacting task

uncertainty and dashboard information content. The results of the second model show strong support that TTF, as measured through mediation, increases the extent of dashboard utilization. This study contributes to the literature by empirically showing that more extensive levels of dashboard utilization are achieved through the antecedent of TTF, resulting in increased managerial satisfaction and managerial performance.

To my wife, Tammy
Thank you for all of your love, patience, and support.

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GENERAL INTRODUCTION

Twenty years ago, McKinnon and Bruns (1992) speculated what management accounting systems should provide to managers in the future to increase managerial effectiveness. Information should be provided continuously from a single real-time database. Access to the database should be provided in a manner that is user friendly so that managers can find the information they need and customize their own reports. Managers should be able to retrieve the information directly, without the assistance of the information technology (IT) department or accounting department. The presentation format of the information should be flexible to allow the manager to use either graphical or tabular displays. Additionally, "(o)nly when systems are designed with each manager's needs and preferences in mind will every manager be well served by management accounting and the information mosaic be complete and effective" (McKinnon and Bruns, 1992: 194).

Two decades later, innovations in IT have allowed this continuous customized management accounting information (MAI) to be provided in real time from any location in the world through digital dashboards. Dashboards are a visual digital display containing key measures and information essential to the achievement of organizational goals and objectives, and are designed to be viewed in a glance (Few, 2005). Initially, when dashboards were introduced, they were primarily reserved for the executive suite and the marketing function of organizations; however, advances in technology have allowed for the diffusion of dashboards throughout todays' organizations, and managers at all levels now have access to dashboards. As shown in study one, dashboards are now utilized by managers to perform one, some, or all of these various tasks: making decisions, verifying prior decisions, guiding activities, monitoring personal performance, managing overall work, achieving the goals and objectives of the

organization, managing subordinates, informing superiors, analyzing trends, and getting feedback on new initiatives.

Prior research examining the impacts of dashboards at the individual level as well as the organizational level has been limited to practice related articles examining the design and implementation of executive and marketing dashboards (Ballou et al., 2010; LaPointe, 2008; Few, 2005, 2006; Clark et al., 2006; Wind, 2005; Brath and Peter, 2005, Miller and Coiffi, 2004; DeBusk et al., 2003). Although dashboards are extensively utilized in todays' organizations, empirical research has yet to examine what the extent of dashboard utilization is, why they are utilized by managers in multiple levels of the organization, how the managerial decision environment is impacted by dashboards, and what the antecedent and consequences of dashboard utilization are. Additionally, the practice related literature has examined dashboards as a technology in isolation (Cokins, 2010) and as an individual performance management tool (Velcu-Laitinen and Yigitbasioglu, 2012; Yigitasioglu and Velcu, 2012); however, no empirical research exists that indicates dashboards may actually be a part of the organization's management control system (MCS: Yigitasioglu and Velcu, 2012) and/or utilized to execute and communicate strategy.

The three papers encompassing this dissertation provide empirical evidence to fill in the gaps in the dashboard literature as stated previously. Each study contributes a unique and separate investigation of the varying phenomenon surrounding the diffusion of dashboards, and together the studies provide a combined view of dashboard utilization and their impact on managers and the organization. Since the extant literature on dashboards is limited, a cross-sectional field study is conducted as the first study to gain an informed understanding of the constructs that are important to the diffusion of dashboard technology and to develop a

framework showing the relationships between these constructs. Specifically, study one examines dashboard system qualities, dashboard information qualities, dashboard utilization, interactive management control, strategy alignment, and performance. The second study is concerned with the impact dashboards make to the managerial decision environment, which is comprised of information needs, information delivery, and the resulting quality of decision-making. This study examines whether or not dashboards contribute to higher levels of decision quality based on the antecedents of dashboards systems and information quality. The net benefits of higher quality decisions are investigated based on the association with managerial performance and organizational performance. In addition, the second study explores how strategy aligned dashboards may affect the strength of the relationships between the dashboard qualities and the decision environment. The third study examines the impact of the task-technology fit antecedent upon the extent of dashboard utilization. Details for each study are presented in the three following subsections.

Study One
Digital dashboards: A source of interactive management control and strategy alignment

The purpose of study one is to develop an understanding of why dashboards have been diffused throughout today's organizations. The diffusion of technology can only occur through the utilization of that technology; consequently, in addition to examining the utilization of dashboards, this study also examines the antecedents and consequences to this dashboard utilization. Information processing theory (IPT; Galbraith, 1973), attribution substitution theory (Kahnemen and Frederick, 2002), and the information system (IS) Success Model (DeLone and McLean, 1992, 2003) are used to guide the inquiry for this study. An explanatory cross-sectional field study is utilized to provide an explanation about why dashboards have been diffused

throughout organizations. Twenty-seven managers are interviewed utilizing semi-structured questions to collect the data concerning the constructs of interest. These initial constructs of interest and their potential relationships are based on the IS Success Model: dashboard system quality, dashboard information quality, dashboard utilization, managerial performance, and organizational performance. Through the iterative process of data collection and analysis, causal links emerged from the data to allow relationships to be specified in a framework explaining dashboard diffusion.

First, the framework indicates that dashboards designed to achieve strategy alignment are related to increased utilization when the dashboard is an interactive management control. The resulting increases to utilization cause the dashboards to become further diffused in the organization. The alignment of strategy at the lower levels of the organization is achieved through the phenomenon known as strategy surrogation, which is the process of managers substituting easily accessed heuristics attributes (operational strategic tactics) for the target attributes (strategic objectives) that are more difficult to access in order to perform a task (Choi et al., 2012, 2013; Kahnemen and Frederick, 2002). This study reveals that strategy surrogation is necessary for the diffusion of organizational strategy through lower levels of an organization. Next, the framework shows that both dashboard system quality and dashboard information quality mediate the link between dashboards associated with interactive management control and the extent of dashboard utilization. Lastly, more extensive dashboard utilization leads to improvements in managerial performance and organizational performance.

This study contributes to the literature on the use of technology as a management control by providing empirical evidence on why dashboards are diffused throughout today's organizations through strategy alignment and interactive management control. This study makes

a second and equally important contribution to strategy and MCS literature by showing that dashboards do not operate in isolation and actually support the execution and communication of strategy while also operating within the organizations' MCS. Lastly, strategy surrogation, which has been characterized as a negative impact to performance at the higher levels of an organization, is shown to be a positive influence on performance at the lower levels of the organization.

Study Two
The impact of digital dashboard qualities and strategy alignment on the managerial decision environment and performance

Study two examines the impact dashboards have on the decision environment of managers as well as the antecedents and consequences of this impact. DeLone and McLean's (1992, 2003) IS Success Model is utilized as the framework to examine the antecedents of dashboard system quality and dashboard information quality as well as the 'net benefits' of managerial performance and organizational performance. Additionally, this study looks into whether strategy aligned dashboards may strengthen or weaken relationships between dashboard qualities (system and information) and the decision environment. IPT theory (Galbraith, 1973) and attribution substitution theory (Kahneman and Frederick, 2002) are utilized to develop the theoretical model for this study. A field survey is used to collect data from 391 middle to upper level managers located in the United States who use dashboards in their weekly work life. The theoretical model is tested using components based structural equation modeling.

The theoretical model indicates that only one dimension from each dashboard system quality (flexibility) and dashboard information quality (currency) are strong antecedents to the managerial decision environment. Additionally, the moderation hypotheses examining the effect

of strategy aligned dashboards are not supported, except for the relationship between dashboard system flexibility and the managerial decision environment. When dashboards are strategy aligned, higher levels of system flexibility lead to lower levels of decision quality since the managers may be able to change their dashboard content to information that does not align with strategy. The model confirms that higher quality decisions in the managerial decision environment lead to higher levels of both managerial performance and organizational performance.

Study two makes a key contribution to the strategy literature by showing decision quality declines when dashboards are allowed to be flexible in a strategy aligned environment. Consequently, allowing their managers a high level of flexibility to alter the information displayed on their dashboards may not be positive for organizations that use their dashboard systems to support strategy alignment. By limiting flexibility, managers' attention may maintain focus on the specifically selected key performance indicators. Further, the examination of strategy alignment at the lower levels of the organization extends the strategy research, which has concentrated on high level strategic outcomes (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004).

Study Three
The examination of dashboard utilization based on the antecedents of information content and task uncertainty and the consequences of user satisfaction and performance

The purpose of this study is to examine the fit between dashboard information content and task uncertainty and the impact to the extent managers' utilize their dashboards. The antecedent of this 'fit' is studied through the lens of task-technology fit (TTF) theory. TTF

predicts a high level of user satisfaction and managerial performance based on the high level of fit between technology and tasks (Goodhue and Thompson, 1995; Lim and Benbasat, 2000). The theoretical model is developed through TTF theory and tested utilizing components based structural equation modeling. The data for this model is collected from 391 managers through a field survey. The results from the analysis of the theoretical model show that dashboard information content and task uncertainty both affect the extent of dashboard utilization directly; however, the model does not show support for the hypotheses of the 'fit' of the technology with the task as operationalized through interaction variables. However, the model still confirms that more extensive levels of utilization lead to improved user satisfaction and managerial performance. A second model is developed, again based on TTF theory, as additional analysis to investigate TTF through the mediation of dashboard information content and task uncertainty to measure the level of TTF. The results show strong support for the alternative model where TTF was operationalized as task uncertainty mediating the relationship between dashboard information content and the extent of utilization.

The key contribution of study three is to provide empirical evidence that higher levels of TTF are needed to increase dashboard utilization. This study extends the TTF research to incorporate the information 'content' construct as an important construct proxy for technology. Additionally, this research extends the prior practice related literature that indicate higher performance is achieved when dashboards contain performance indicators linked to organizational goals and objectives.

Overall Contribution

The three studies in this dissertation examine the diffusion of dashboards throughout today's organizations. As a whole, these three studies advance our knowledge of how dashboards impact the individual and the organization. Our understanding of why dashboards are diffused throughout organizations has increased in addition to our understanding of the antecedents that improve dashboard utilization and the managerial decision environment.

Overall, this study contributes to the dashboard, strategy, and MCS literature in the following manners. These studies are the first to empirically model the antecedents of dashboard utilization and the managerial decision environment as well as the associated consequences. TTF, strategy alignment, and dashboards that provide interactive management control are shown to be important antecedents to dashboard utilization and diffusion throughout an organization. The results confirm that more extensive dashboard utilization leads to the net benefits of user satisfaction, managerial performance, and organizational performance. Additionally, based on dashboards associated with strategy alignment and interactive management control, these studies empirically place dashboards in both the strategy and MCS literature whereas, previously, the evidence that dashboards supported these activities was only anecdotal.

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STUDY ONE
DIGITAL DASHBOARDS: A SOURCE OF INTERACTIVE MANAGEMENT CONTROL AND STRATEGY ALIGNMENT

Introduction

"*Dashboards: a solution in search of a problem?*" (LaPointe, 2008: 17)

Innovations in information technologies (IT), such as digital dashboards (hereinafter referred to as dashboards), provide a great opportunity for the examination of the relationships between the management control system (MCS) and strategy execution (Henri, 2006; Kober et al., 2007; Tucker et al., 2009). Dashboards are defined as a "visual display of the most important information needed to achieve one or more objectives which fits entirely on a single computer screen so it can be monitored at a glance" (Few, 2006: 34). Further, dashboards provide managers with a common language to support the achievement of both short-term and long-term organizational objectives (Pauwels et al., 2009). Consequently, dashboards are a technological element of organizations' overall MCS (Chapman and Kihn, 2009).

The primary purpose of this study is to examine why dashboards have been diffused throughout today's organizations. The diffusion of technologies in organizations occurs through the utilization of the technology and higher levels of diffusion are achieved when a technology is utilized to accomplish differing types of activities and tasks. Therefore, the *extent* of dashboard utilization is the primary focus of the study to understand why dashboards have been diffused throughout organizations to decision-makers. Given that the extent of dashboard utilization is central to the diffusion of dashboards throughout the organization, understanding the antecedents and consequences of the extent of dashboard utilization is important. The antecedents examined include dashboard system quality and dashboard information quality (DM, 1992, 2003; Nelson et

al., 2005; Tucker et al., 2009). The consequences of the extent of dashboard utilization are managerial performance and organizational performance.

This study's primary motivation is in response to the call for more research investigating the interfaces between modern information technology and the MCS, since this relationship is the foundation for the entire field of modern management control (Granlund, 2011). Specifically, there is a lack of empirical work examining the utilization of dashboards throughout the organization and the impact on the MCS (Yigitasioglu and Velcu, 2012). Another important area of dashboard utilization where our knowledge is limited is the implementation of the strategy process and communication of strategy in relation to MCS (Kober et al., 2007; Tucker et al., 2009).

This study utilizes an explanatory cross-sectional field study to understand why dashboards have been diffused throughout organizations. A cross-sectional field study is selected as the appropriate research method for this study since management control practices can only be understood within the context of where they occur, in the actual organization; therefore, the empirical work for this study is conducted inside the organizations of interest (Kaplan, 1986). Semi-structured questionnaires are utilized to interview managers from the following industrial sectors: manufacturing, financial services, IT, healthcare, consulting, and retail. In order to gain a wide perspective of dashboard utilization throughout organizations, all levels of management are included in the study including executive managers (Chief Executive Officer, Chief Financial Officer, Chief Information Officer, and Executive Vice President), operational managers, IT managers, finance directors, marketing managers, organizational trainers, and industry consultants. Twenty-seven interviews in total are conducted and a framework of dashboard diffusion is developed using Yin's (2009) analytical process of explanation building. Explanation

building is the specification of a set of causal links in the emergent categories of field study data achieved through the iterative process of data collection and analysis (Yin 2009).

The key results of this study reveal that dashboards that are designed to support the execution of organizational strategy increases their utilization, which in turn increases diffusion throughout the organization. Subsequently, the dashboard develops into an interactive management control that directs organizational attention, induces vertical and horizontal communication, and assists with learning based on the messages created by the top management level (Simons, 1994). Because of the interactive nature of the dashboard, utilization increases throughout the organization, particularly when the quality of the system and the information are high. Dashboards assist in the execution of operational strategy throughout all levels of an organization through strategy surrogation. Strategy surrogation is the process by which managers substitute easily accessed heuristics attributes (operational strategic tactics) in lieu of the much more complex and difficult to access target attributes (strategic objectives) to perform a task, as predicted through the lens of attribution substitution theory (AST; Choi et al., 2012, 2013; Kahnemen and Frederick, 2002). Prior research views strategy surrogation as a negative impact to strategic level outcomes (Choi et al., 2012, 2013); however, this study reveals that strategy surrogation is necessary for the diffusion of organizational strategy through lower levels of an organizations.

The initial focus of this study was on the examination of dashboard system quality and dashboard information quality as antecedents to the diffusion and utilization of dashboards throughout organizations; however, the patterns that emerged in the data reveal that strategy alignment and dashboards as interactive MCS are the real antecedents that drive the diffusion of dashboards. The final results show that the dimensions of dashboard system quality and

dashboard information quality are not the primary antecedents to the diffusion of dashboards; rather, they mediate the relationship between the interactive dashboard and the extent of dashboard utilization.

A framework displaying the categories and relationships that emerged from the patterns in the data is developed for this study. The framework shows that dashboards that are closely aligned with organizational strategy and objectives are also positively associated with interactive management control. Interestingly, the framework reveals that dashboards can be both strategically aligned and associated with the organization's MCS if the dashboard is interactive. The interactive management control characteristic of dashboards leads to a higher extent of dashboard utilization. Dashboard accessibility, viewpoint integration[1], dashboard information completeness, and dashboard information currency are important mediators between interactive dashboards and the extent of dashboard utilization. Higher levels of the extent of dashboard utilization lead to improved managerial performance and organizational performance. In addition to the framework, the data also reveals that strategy alignment is negatively associated with flexibility (level of user control) thus limiting managers' ability to change the measures contained in their dashboard.

The primary contribution of this study is the provision of empirical evidence in the area of why dashboards are being diffused throughout today's' organizations. This study shows that dashboards play an important role in both the organization's MCS as an interactive management control and the alignment of strategy at the operational level. These two primary constructs (interactive management control and strategy alignment) emerge as the most important

[1] Viewpoint integration is achieved when information shared between managers and departments is presented in a common language and measured equally so that the information is viewed in the same light when dialogue occurs, even between disparate parts of the organization (Pauwels et al., 2009).

phenomenon impacting the extent of dashboard utilization; and consequently, the diffusion of dashboards throughout organizations. This study contributes to strategy research by examining strategy execution at the lower levels of the organization through strategy surrogation, whereas, prior research has investigated strategy in the context of executive level strategic outcomes: evaluations, changes, or initiative implementations. The results indicate that strategy surrogation has a positive impact at these levels.

The remainder of this paper is organized as follows: Section 2 presents the background and literature review. Section 3 discusses the theories utilized in this study. Section 4 discusses the research methods. Section 5 shows the findings of the cross-sectional field data collection. Section 6 provides a summary and concludes the paper.

Background and Literature Review

According to Few (2006), a properly designed dashboard should show diagnostic performance measures on a single computer screen that can be viewed and understood with a quick glance. The practice related literature has examined executive and marketing departmental dashboards regarding dashboard design and implementation (Ballou et al., 2010; LaPointe, 2008; Few, 2005, 2006; Clark et al., 2006; Wind, 2005; Brath and Peter, 2005, Miller and Coiffi, 2004; DeBusk et al., 2003); however, today's' dashboards are designed to be utilized by all levels of management within an organization. Empirical research examining dashboards is limited, and this line of literature has not examined dashboards functioning within the organizational MCS or in the operational execution of strategy. The practice related literature has concentrated in two primary areas: dashboard system design and dashboard system implementation. Anecdotal evidence suggests that the effective dashboards should link measures to organizational objectives

and goals and support the decision–making process. These streams of research are reviewed next.

The first stream of literature focuses on dashboard design and the best approach for data visualization (Yigitbasioglu and Velcu, 2012; Ballou et al., 2010; Few, 2005, 2006). The practice related literature suggests that when dashboards are designed effectively, important data can be viewed and understood quickly, and aid managers in the identification of visual trends, patterns, and variances for effective decision-making (Few, 2005; Brath and Peters, 2005). The second stream of literature examines the implementation processes utilized by organizations to understand what antecedents lead to successfully installed dashboards. This stream of literature initially focused on dashboards installed in the context of the corporate marketing department of organizations. Dashboards devoted to an organizations' marketing function are usually the second phase of dashboard implementations, following the executive dashboards. An early practice related article examining the dashboard deployed at Unisys revealed that the success of the implementation is dependent on effectively tying the performance measures to the goals and objectives of the organization (Miller and Cioffi, 2004). Prior to the implementation of the Unisys dashboard, 25 executives invested considerable time and energy to determine which processes and outcomes needed to be measured to drive organizational strategies. These measures are then added to the dashboard to be utilized by the marketing managers. The successful implementation at Unisys showed that dashboards actually drive operational effectiveness through the more disciplined decision-making process (Miller and Cioffi, 2004).

The implementation literature also puts forward that successfully implementing a dashboard requires a significant investment of time on the front end to understand what processes or outcomes are linked to achieving organizational goals and objectives (Miller and

Cioffi, 2004; Wind, 2005; Clark et al., 2006; LaPointe, 2008). The key function of executive management is to invest the time to understand this process and select the *right* performance measures that drive processes or outcomes for their business before implementing the dashboard (Miller and Cioffi, 2004; Wind, 2005; Clark et al., 2006; LaPointe, 2008).

Overall, the literature from practice suggests that the measures included on a dashboard need to be linked to organizational goals and objectives and that effective dashboard design aids in managerial decision-making. The literature in this area examines dashboards implemented at the highest levels of the organization (i.e. executive or marketing dashboards) that are viewed in isolation and not part of the larger MCS of an organization or as a method to facilitate strategic objectives throughout the organization. An emerging line of practice related literature examines how dashboards may interact with organizational strategy and balanced scorecards (BSC; Cokins, 2010). Although there is no empirical research in this area yet, this area holds promise in that the dashboards are part of the overall MCS (Yigitasioglu and Velcu, 2012), and this study posits that they assist with the execution of strategy.

Theory

Two theories are utilized to guide the inquiry of this field study. The use of theoretical guidance in field studies is supported by Miles and Huberman (1994) since it provides an initial basis for the investigation (variables of interest) but still allows for empirical flexibility during data collection and analysis. The two theories used to inform this study are information processing theory (IPT; Galbraith, 1973) and AST (Kahneman and Frederick, 2002).

Information Processing Theory

IPT developed by Galbraith (1973) is composed of three primary concepts: the information *needs* of an organization, the *actual* processing capacity of an organization, and the match between the needs and capacities (Ismail and King, 2005; Premkumar et al., 2005). The level of uncertainty encountered by an organization impacts this match between needs and capabilities. As an organization experiences higher levels of uncertainty, they need to either reduce their demand (need) for information or increase their ability to process information to maintain the specified level of performance (Galbraith, 1973). IPT puts forth four organizational design strategies that either reduces the demand for information or increases the information processing capability (Galbraith, 1973). See Figure 1.

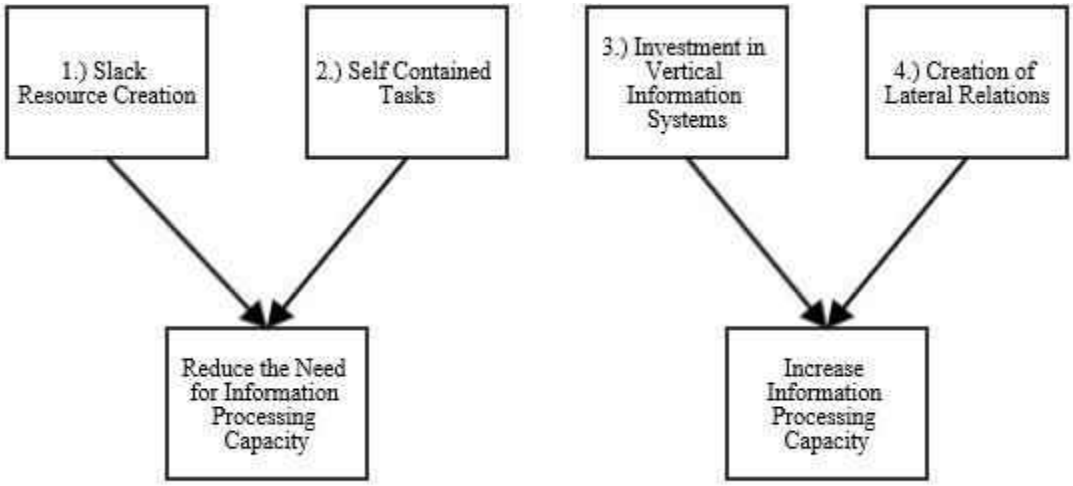

Figure 1: Organizational Design Strategies
Source: Adapted from Galbraith (1973)

The two design strategies on the left of Figure 1 decrease an organization's information need by increasing slack resources and/or the development of self-contained tasks. The second

set of design strategies on the right side of Figure 1 increase the processing capacity for an organization through higher levels of vertical integration and/or horizontal integration. Galbraith (1973) posits that these four design alternatives are an exhaustive set of options; therefore, organizational performance will suffer if uncertainty increases and none of these strategies are employed to counterbalance the increase in uncertainty.

An integrated information system (IIS), such as an enterprise resource planning (ERP) system, incorporates data across an organization and is the primary platform that provides higher levels of vertical and horizontal integration in today's organizations, which leads to higher levels of information processing (Ghani, 1992; Premkumar et al., 2005). Organizations are utilizing IIS's and supporting applications, such as dashboards, to increase their information processing capacity (Seddon et al., 2010).

This study utilizes IPT as the lens to understand why dashboards are being diffused throughout today's' organizations. According to IPT, organizations that invest in IT capabilities will increase information processing capabilities to the benefit of the organizational decision-making process (Ismail and King, 2005; Premkumar et al., 2005; Galbraith, 1973).

The Theory of Attribute Substitution

Attribute substitution occurs when a manager assesses a target attribute (strategy) through the mapping of the value of a heuristic attribute (tactics) on the target attribute (Kahneman and Frederick, 2002). Attribute substitution can occur when three conditions are satisfied: 1.) the target attribute is relatively inaccessible; 2.) an associative and semantic attribute (heuristic attribute) is very accessible; and 3.) the substitution of the heuristic attribute for the target attribute cannot be consciously rejected (Kahneman and Frederick, 2002: 54; Choi et al., 2012,

2013). In the context of dashboards used for the diffusion of strategy throughout an organization, the first of these conditions is satisfied due to the conceptual, ill-defined, and complex nature of strategic constructs. The second and third conditions are typically met at the lower levels of the organization where tactics are substituted for the strategic objectives.

Research Methods

> *"...[C]ontrol cannot be studied apart from technology and context because one will never get to understand the underlying 'infrastructure' — the meeting point of many technologies and many types of control" (Dechow and Mouritsen, 2005: 691).*

This study utilizes a cross-sectional field study to examine the theoretical constructs associated with the diffusion of dashboards to the lower levels of the organization. A field study is the appropriate method for this type of study since the research questions ask "why" questions, the research examines contemporary issues, and the investigator exerts minute or no control over the events (Yin, 2009). While a single field study examines one organization in depth, a cross-sectional field study provides more breadth through the examination of multiple organizations. Since dashboard utilization can vary greatly between organizations, the choice of conducting this study in a cross-sectional format will deepen our understanding of the constructs and relationships through the analysis of cross-case patterns in the data (Lillis and Mundy, 2005).

Research Design

The research design for this study follows Lillis and Mundy's (2005) four methodological components of research design: 1.) the research begins with the development of the research protocol to guide the research; 2.) a domain of concisely defined observables is established to constrain the research questions; 3.) a sampling strategy is employed to increase the expected

variance of the dimensions of the variables of interest; and 4.) the data is analyzed in a disciplined systematic manner to ensure that patterns are drawn out of the data across the cases and then linked back to theory. The research design relating to each of these four components of field study research design is reviewed in greater detail in the ensuing paragraphs.

1 - Research Protocol

The first component of the research design is the establishment of a protocol prior to any collection of data. A protocol is designed to help the researcher focus and guide the data collection and analysis (Lillis and Mundy, 2005; Yin, 2009). The protocol for this study is included for review in the Appendix. The protocol provides a consistent set of questions to each informant, provides propositions to guide the inquiry, and establishes the framework that is utilized to analyze the data from the interviews (Yin, 2009). Semi-structured questions are established in the protocol as a basis for conducting the interviews. The semi-structured questionnaire constrains data collection to the preconceived constructs and variables of interest; however, the questionnaire also allows the interviewer to deviate and delve deeper when new information is revealed (Lillis and Mundy, 2005). The semi-structured interviews increase consistency for the internal validity, but they do not preclude the ability to uncover new ideas and concepts in the field. Additionally, the interviews with managers who used digital dashboards are digitally recorded and transcribed.[2]

The next step is establishing propositions for the study protocol. The study's propositions are designed to direct attention to phenomenon that will be examined within the scope of the

[2] All of the interviews where the informant was utilizing a dashboard were digitally recorded and transcribed. The interviews that occurred where no dashboard was available at the organization level or the manager was not utilizing a dashboard were not digitally recorded. In these latter instances, the researcher relied on written notes taken during the interview to construct interview related notes.

study and they begin to direct attention concerning where to look for the appropriate evidence (Yin, 2009). The propositions for this study are developed from the review of prior research in related literature streams. An example of a proposition for this study is "(d)ashboard system quality will be positively associated with dashboard utilization," which is based on the DeLone and McLean (DM; 1992; 2003) information system (IS) Success Model and advanced in Nelson et al. (2005). The explanation building process in a cross-sectional field study does not set out to prove or disprove the propositions; rather the propositions help to guide the research data collection and analysis process to build categories and show the relationships that emerge from the data.

2 - Constructs of Interest

The constructs of interest for this study are defined in the research protocol so that the research questions guiding this inquiry are restrained. Defining the constructs of interest in field studies also increases construct validity (Lillis and Mundy, 2005). The initial constructs of interest for this study are based on prior literature in related fields. These constructs are dashboard quality, dashboard information quality, extent of dashboard utilization, managerial performance, and organizational performance based on the DM (1992, 2003) IS Success model.

IS Success Model Constructs

This study relies on DM (1992, 2003) IS Success model to identify the constructs that may be antecedents to dashboard utilization and the diffusion of dashboards throughout organizations. DM proposed an IS Success model that identifies six interrelated dimensions for IS Success: systems quality, information quality, utilization, user satisfaction, individual impact,

and organizational impact. DM's model is the predominate model utilized in literature today to examine the components of successful systems. See Figure 2 below.

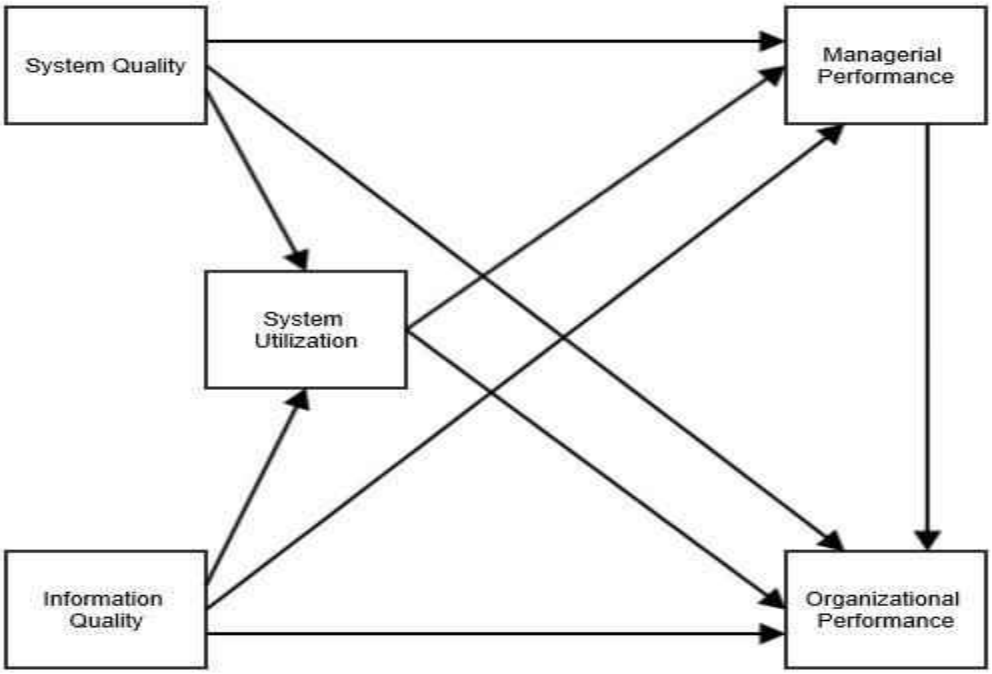

Figure 2: IS Success Model
Source: Adapted from DeLone and McLean (2003)

This study examines the systems quality, information quality, as antecedents to the extent of dashboard utilization, and managerial performance and organizational performance as the consequences of the extent of dashboard utilization. Dashboard system quality is comprised of dashboard system accessibility, data integration, and flexibility (DM, 1992, 2003; Nelson et al., 2005). Accessibility relates to the level of effort required to access the dashboard; integration relates to the extent that the dashboard system can combine information from various sources; and flexibility signifies the level of user control to select the information content (performance measures) and the display format (Nelson et al., 2005). The construct of information quality is comprised of completeness, currency, and accuracy. Information completeness is the degree that

all of the possible states applicable to a particular manager are displayed on the dashboard or available through drill down capabilities; currency reflects how well the information represents the current state of the world that the information represents; and accuracy is the extent to which information is correct, unequivocal, believable, and consistent (Nelson et al., 2005).

Dashboard utilization by managers is primarily voluntary; consequently, dashboard utilization is investigated based on the extent of dashboard utilization. The extent of utilization examines the quantity of different tasks and types of uses (i.e. coaching employees, trend analysis, personal performance tracking, or feedback on new initiatives) for which the dashboard is utilized by the end user. The net benefits shown in the IS Success model link success to both managerial performance and organizational performance. This study examines both of these constructs to understand if the diffusion of dashboards has benefited organizations in either of these areas: managerial performance and/or organizational performance. Prior research shows positive associations between managerial/organizational performance and the dimensions of systems and information quality as well as utilization (LaValle et al., 2011; Chapman and Kihn, 2009; Teo and Wong, 1998; Goodhue and Thompson, 1995). Additional research has positively linked strategy aligned performance measures to managerial performance (Burney et al., 2009).

3 - Sampling Strategy

The third component of research design prescribed by Lillis and Mundy (2005) is establishing a sampling strategy to increase the expected variance of the variables of interest. However, the selection of organizations for inclusion in field studies is typically not random (Kaplan, 1986); rather, it is viewed as sampling by convenience. As noted by Bruns and McKinnon (1993: 90) who openly admit that they ‘‘selected on the basis of location and

accessibility, personal contacts, and expected willingness to help with the research process'', researchers sometimes experience difficulties gaining access to organizations. In the beginning of this study, access to informants is obtained through convenience so that the range of dashboard utilization could be understood from multiple angles. Once the initial data is collected and analyzed, the sampling strategy is redirected toward informants who could provide the data needed to further saturate the categories emerging from the data.

The suitable context for examining management controls is the through their utilization and level of importance to decision-makers (Langfield-Smith, 1997). Consequently, the unit of analysis for this study is upper level to mid-level operations managers. The majority of the previous research in the area of providing information to managers concentrates on the manufacturing sector (Johnson and Kaplan, 1987; McKinnon and Bruns, 1992) since this industry requires a high level of information processing and relies heavily on the vertical integration of the IT system to provide the information processing capacity (Raymond and Magnenat-Thalman, 1982; Ismail, Abdullah, and Tayib, 2003). This study includes more sectors than manufacturing in order to observe greater variation in dashboard utilization. The following industry sectors are included in the study: manufacturing, financial, IT, healthcare, consulting, and retail. A cross-section of executives and managers are interviewed to gauge the impact of the diffusion of dashboards from multiple perspectives. Consequently, in addition to interviewing upper level and mid-level managers in operational positions, executive managers, IT managers, finance directors, marketing managers, organizational trainers, and industry consultants are also interviewed.

In total, 27 interviews are conducted for this study. Out of the 27 interviews conducted, 20 interviews focus on managers that utilize, service, or design dashboards in their daily work

life. The remaining 7 interviews are conducted with individuals that are not currently utilizing dashboards in their daily work life, and these interviews are used to gain perspective on why dashboards are not utilized by the individual or organization. For example, the chief financial officer at a Fortune 500 restaurant conglomerate states that their organization is still at least two years away from implementing any kind of dashboard system based on poor data integration and legacy system issues. The reasons of poor data integration and the coordination of old legacy systems is a consistent for the organizations that have yet to implement dashboards in their organizations. Table 1 shows the descriptive statistics for the informants and their organizations.

Table 1: Informant Descriptive Statistics

Dashboard Utilization		
Dashboard System Utilized	20	74.1%
Dashboard System not Utilized	7	25.9%
		100.0%
Manager Position		
Chief Executive Officer	1	3.7%
President	2	7.4%
Chief Financial Officer	1	3.7%
Chief Information Officer	2	7.4%
Executive Vice President	1	3.7%
Vice President	3	11.1%
Director of Finance	2	7.4%
Director of Strategic Customers	1	3.7%
Assistant Vice President - Financial Planning	1	3.7%
Mid -Level Operational Manager	11	40.7%
Certified Public Accountant	1	3.7%
Consultant	1	3.7%
	27	100.0%
Organization Size		
Less than $100 million	9	34.6%
$100 Million to $1 Billion	4	15.4%
Greater than $1 Billion	14	50.0%
	27	100.0%
Sectors		
Accounting	1	3.8%
Construction	2	7.7%
Consulting	3	11.5%
Education	3	11.5%
Financial Services	2	7.7%
Healthcare	3	11.5%
Information Technology	5	19.2%
Manufacturing	4	15.4%
Restaurant	2	7.7%
Retail	2	3.8%
	27	100.0%

The majority of the managers interviewed utilize dashboards (73 percent) and hold positions ranging from the chief executive officer to consultants. The largest quantity of interviews took place with mid-level managers (38 percent). The size of the organizations participating in this study ranged from young internet start-ups (less than $10 million in annual revenue) to large multi-national financial institutions. One half of the managers worked for large organization with annual revenue in excess of $1 billion. The interviews are spread over 10 general industry sectors ranging from IT firms (software, internet sales, and internet marketing) to healthcare. The highest concentration of interviews occurs in the IT and manufacturing sectors. These two industry sectors account for 35 percent of the interviews.

4 - Systematic Analysis

Lastly, Lillis and Mundy (2005) recommend that the data analysis take place in a disciplined, systematic manner to assure that patterns in the data are drawn out across the multiple cases and then linked back to theory. This systematic analysis of the data is modeled after Yin's (2009) explanation building process. Explanation building is the stipulation of a set of causal links between categories. The explanation building process is iterative, starting with the establishment of the initial propositions and then comparing the initial cases against the propositions. Next, the propositions are revised as needed based on the emerging patterns found in the data to guide the additional data collection. In order to collect the data in relation to revised propositions, semi-structured interview questions are updated to include coverage of any new emerging categories. Next, additional data is collected and compared to the propositions again. This process is repeated as many times as needed until data saturation is achieved. Data saturation is achieved when the interview process does not yield any new data and only confirms

the patterns emerging from the previous interviews (Sutton et al., 2012; Yin, 2009). After saturation is achieved, relationships between the categories are then proposed based on the patterns revealed in the cross-section of data (Yin, 2009; Lillis and Mundy, 2005).

Validity and Reliability

In addition to the four components of research design specified by Lillis and Mundy (2005), the research design for this study is established to increase the study's level of validity and reliability. Based on the inherent design of field studies, achieving acceptable levels of construct validity, internal validity, external validity, and reliability is always a concern that is addressed in the research design. The first type of validity addressed is construct validity, which is the successful operationalization of the theoretical constructs. In order to attain a high level of construct validity, four processes need to occur. First, the specific types of changes to phenomenon to be studied are clearly identified (Yin, 2009). For this study, the changes to phenomenon are in the context of the diffusion of dashboards throughout the organization and the impact on utilization. Second, clear construct definitions are defined in the research protocol (Lillis, 2006). Third, multiple sources of evidence and the creation of a study database increase construct validity as well (Yin, 2009). Multiple sources of evidence are obtained as outlined in the protocol; however, archival data surrounding the dashboard proved difficult to collect. The actual dashboard content is observed and described in the interview notes. Fourth, a study database is created for each organization containing the interview transcripts, interview notes, and any additional reports or documents collected at the interview.

Internal validity is the proper conclusion of the effect of independent variables on dependent variables (Yin, 2009; Lillis, 2006). Internal validity is addressed in this study through

seeking common patterns across the data in a disciplined, systematic manner until the evidence converges and the analysis reaches saturation. In addition, the analysis process is open to rival or alternative explanations for the data that do not match the propositions (Yin, 2009; Lillis, 2006). In order to achieve external validity, the contribution from the field research should be *potentially* generalizable; and, cross-sectional field research has an advantage in establishing this potential generalizability over single field studies (Lillis, 2006, emphasis added).

Attaining reliability in field studies is difficult, since no statistical test can be employed to verify the level of reliability in the data. The potential for bias in observation and data collection is always a concern for this type of research (Lillis, 2006). Therefore, two strategies are utilized to increase reliability: preparing a study protocol and increasing the researcher's knowledge of effective interview techniques. The research protocol is discussed in the previous section. The researcher studied literature on interviewing techniques in order to increase knowledge in this specialized area (Gordon, 1987; Patton, 1987).

Collecting, Coding, and Analyzing Case Study Data

The following discourse outlines the actual steps involved in collecting and analyzing the data from this cross-sectional case study. Before each interview is conducted, the informants are provided a copy of the semi-structured questions to prepare for the interview and follow along with the questions as the interview progresses. The interviews are digitally recorded. At the beginning of each of the interviews, a brief overview of the study's research purpose is reviewed with the informant to help the informant understand the context of the research. After each interview is completed, 'interview notes' are written down by the researcher. The interview notes contain the following types of items: the researcher's initial thoughts about the

interview/informant; any special circumstances involving the informant, organization, or dashboard; any special notes about the dashboard; initial thoughts on how the interview data relates to the propositions; any emergent relationships between the constructs of interest revealed through the interview; and key takeaways from each interview. Lastly, the digital recording from each interview is transcribed by the researcher.

Next, theoretical notes are written down by the researcher throughout the entire data collection and analysis process. A theoretical note is written during any stage of the data collection or analysis process to store ideas as they are occur concerning categories or relationships emerging between categories (Glaser and Strauss, 1967; Strauss, 1987; Strauss and Corbin 1998). Eventually, the theoretical notes are sorted into an outline that reveals all of the relationships among the categories (Glaser 1978). Examples of the theoretical notes that are written during the analysis of this study are as follows:

> 'Higher levels of dashboard information completeness are associated with user control' (Based on interview with Informant #13).
>
> 'Interactive data may be linked to strategy alignment/surrogation' (Based on interviews with managers #13 and #19).
>
> 'Lower levels of user control are associated with higher levels of strategy alignment/surrogation' (Overall assessment after the analysis of several interviews).

Once the initial phase of the interviews is complete, the interview transcriptions, interview notes, and theoretical notes are imported into NVIVO software. NVIVO software is utilized to facilitate the manual coding and analysis of the data through efficient data storage, ease of manual coding, ease of coded item retrieval, key word searches in all data sources, and the manual designation of relationships. However, NVIVO is not utilized to automatically code

or analyze any of the data for this study. The initial categories used to code the data are based on the variables of interest outlined in the study protocol.

The next step in the analysis is the open coding for the interview transcripts, interview notes, and theoretical notes in NVIVO, which is performed by the researcher reading through each of these items and manually coding the specific words, phrases, sentences, or paragraphs into the initial categories. As the analysis progressed, additional categories are added as they are emerging from the data coding and analysis (Mile and Huberman, 1994; Yin, 2009). The list of the codes utilized in the open coding is shown in Table 2.

Table 2: Categories Utilized for Coding Data

Initial set of categories at the beginning of the study
Accessibility
Accuracy
Completeness
Currency
Decision Environment
Flexibility
Format
Information Content
Integration
Interactive Information content
Performance Drivers
Response Time
Scope of information
Task Uncertainty
Dashboard Utilization
Categories added through the explanation building process
Balanced Score Card
Drill Down
Feedback
Knowledge Creation
Performance
Process Management
Strategy Alignment
Interactive Management Control
Truth
Uses of Dashboards
Why Dashboards are utilized

Once the open coding is complete, the initial placement of words, phrases, sentence(s), and paragraphs into the appropriate categories is reviewed; and the preliminary relationships are manually established between categories in NVIVO. This portion of the analysis is the initial data reduction activity. Next, in order to further understand the developing relationships and the

emergence of the primary categories, the activity of data display is conducted. A primary category accounts for the largest portion of the variation that develops from patterns of behavior (Glaser 1992; Sutton et al., 2012). The researcher places all of the important categories on a poster board with the emerging primary categories of strategy alignment and interactive management control in the middle to understand how all of the other categories interact with the emerging primary categories. Each coding entry is summarized and written under the specified category on the poster board. As the entries are filled in for all of the categories, any of the emerging relationships are highlighted and written next to the category. Additionally, the relationships outlined on the theoretical notes are written next to the affected categories. Once this portion of the data display activity is complete, the emerging relationships induced from the data are drawn out on paper.

As the initial cases are analyzed in relation to the original propositions, the data begins to either confirm or show patterns that differ from the original propositions. The patterns in the data show that strategy and interactive MCS emerge as important constructs; therefore, additional propositions are written to guide inquiry regarding these emerging categories. In addition, new semi-structured questionnaires are developed to guide the inquiry surrounding strategy and MCS. The second round of propositions and semi-structured questions are shown in the case study protocol in the Appendix. Initially, 17 interviews are conducted using the original semi-structured questions and propositions contained in the protocol where the importance of interactive management control and strategy emerged as the primary categories. Another 3 interviews are conducted to examine the new propositions using the updated semi-structured questionnaire to capture data concerning the new primary categories of strategy and interactive MCS. The new data is then compared against the new propositions, This process is repeated until

saturation is accomplished. Overall, the explanation building process occurred in two iterations. The average length of the first set of interviews (17) for managers that utilized dashboards is 48 minutes. The average time for the last three interviews is 27 minutes.

Case Study Findings

The results of the field study provide insight into why dashboards are diffused throughout organizations. Additionally, the quality of the dashboards that managers utilize as well as the reasons why managers utilize them is revealed as a finding in the data. Before discussing the primary findings concerning the diffusion of dashboards throughout organizations are discussed below, results regarding dashboards utilized in practice and the extent of dashboard utilization will first be discussed.

Dashboards Utilized in Practice

Both the academic and practice literature have a very narrow definition of dashboards. According to Few (2006), a properly designed dashboard should show diagnostic performance measures on a single computer screen that can be viewed and understood with a quick glance.[3] However, the data from this study reveal a very different picture of the dashboards that managers actually utilize. The dashboards come in various configurations with differing levels of functionality. The majority of the dashboards are developed in-house, only three out of the twenty dashboards observed are provided by third-party software vendors. The other 17 dashboards (85 percent) are internally designed and developed based on the platforms of Microsoft Excel, Microsoft Sharepoint, or Business Objects. For example, the dashboard for a

[3] Diagnostic information presentation only attracts the attention of managers when the performance measures pre-set limits are exceeded and a manger needs to take action to correct the underlying issues (Mikes, 2012).

large retailer with annual revenue in excess of $1 billion consists of one intranet page containing performance measures and hyperlinks to multiple 'portable document format' (PDF) documents that could be accessed to 'drill down' into more detail. The currency of the PDF documents accessed through the intranet is 1 day to 30 days old and the updated documents are provided by the central office. In another case, a high level manager in a large multi-national financial institution chose to forego the dashboard provided through their third party software for a custom built in-house dashboard built on a Microsoft Excel platform. This dashboard is prepared by 5 to 6 in-house analysts and deployed across the globe to manage the business division. Interestingly, the data show that the larger organizations in the sample typically develop their own dashboards organically in-house (not using a third party dashboard software provider), and these in-house dashboards typically do not contain the advanced features typically associated with third-party dashboards providers. However, the in-house dashboard still exhibited a high level of utilization.

Three different types of measures are observed as being present on manager's dashboards: strategic indicators, operational tactics linked to organizational goals, and indicators not associated with overall organizational goals or objectives In fact, all of the dashboards that contain the operational tactics are built organically within the organization on less powerful platforms (i.e. Excel, Sharepoint, Business Objects, etc.) The dashboards not linked to organization goals are typically provided by a third party software vendor, with higher levels of 'dashboard system quality'. The manager of the large multi-national financial institution that chose an in-house dashboard over a third-party software dashboard discusses their dashboard.

> The automated dashboard [attached to the ERP] did not really help us very much at all. What we ended up doing is I had a group of five or six people in our big division, we could afford to spend $3 to $4 million a year in support and personnel and external help and all that stuff. What we would do is we had highly customized spreadsheets rolled up in excel. We would depend on the judgment of the people in my department to pull the stuff locally together acting as a filter.

> And that is something the software could not do, right. So what would happen is we get a highly refined rollup. The downside was you could only get it every couple of weeks. It was very useful, but it was a retroactive view (Informant #1).

Overall, the data from this study reveals that the 'utopian' dashboards discussed in the literature and by software vendors actually exist; however, the lower quality and more effective dashboards are created organically by the organizations. Even when the organizations that had the resources, both financial and personnel, they typically created their own strategy surrogated dashboards rather than to employ the system provided through the ERP.

The Extent of Dashboard Utilization

The extent of dashboard utilization has been identified as the key focus of this study to explain the diffusion of dashboards throughout organizations. Prior research has indicated organizations make dashboards available to their managers throughout their organizations for the following reasons: 1.) to provide consistent measures and measurement procedures; 2.) to monitor business performance; 3.) to plan for future goals and strategies; and 4.) to communicate information to important stakeholders (Pauwels et al., 2009). However, this prior research is only informative from an organizational perspective; prior research does not provide insight into the extent managers choose to utilize their dashboard to help manage their work life. The results of this study reveal the three most prominent areas in which managers exhibit a high extent of dashboard utilization: 1.) managing the business and employees; 2.) decision-making and directing actions/activities; and 3.) creating new knowledge. Each of these reasons for dashboard utilization is reviewed below.

First, the managers utilize their dashboards in their work life to differing extents. Some of the managers utilize dashboards merely to manage their own daily activities; while others utilize

dashboards to manage their employees and report to their supervisors. Managers commonly utilize dashboards to gain a sense of direction for their work and to direct their activities.

> It [the dashboard] gives you a focus or direction. So if volumes are down, you need to find out where. Or if they are up, what have we been doing that is making it successful. There are a lot of different factors going into it and it gives us the opportunity to drill down and see why that is….[a] sense of direction (Informant #15).

> When things get busier and only some of the metrics you may… pay attention to and since they are on the dashboard you pay attention to [them] and it forces better behavior (Informant #7).

With regards to managing the 'business', one manager in a multi-national financial institution explains best how dashboards are leveraged in the management of their business.

> Could we run the business properly? Remember, we are running a global business and you are not on site and you cannot get to a site quickly. My own units were in Asia, South America, North America, and Europe. So I guess we were on 4 out 7 continents. A dozen plus cities, but we were supporting business 24 hours a day in anything that traded in all currencies. The sun never set on the empire. The dashboard really becomes critical because you are using it to really run the business… (Informant #1).

The next two managers utilize the dashboard to help work with their subordinates, both directly and indirectly.

> If I need to do a quick coaching session during the day, it is helpful to use the data [from the dashboard]… It is used for coaching…. If they are aware they care. They need to understand where the organization is, what their role is, and having that transparency so their job has a meaning. (Informant #13)

> My number one reason is around creating transparency that allows people to self-correct without having to manage them. It is a lot easier when people see it and you don't have to have a discussion with them (Informant #17).

Other managers view the dashboard as keeping their superior up to date with their activities.

[T]ell my boss what is going on (Informant #8).

From the 20 interviews, two noteworthy cases emerge where the dashboard inadvertently acted as a catalyst for major capital expenditure projects. The first scenario (Informant #11) explains how an executive happened upon information about occupancy rates in the dashboard, and that started the discussions concerning constructing two new building towers. The second scenario (Informant #21) at a University located in the northeastern United States demonstrates how a dashboard's content of accurate information on the determination of bed counts caused a planned capital project to be discontinued.

> There was one executive who looked at the dashboard and saw the occupancy rates [and] made a decision that we need to add a tower to location A and Location B. That was six years ago and that all happened. Now, that may be an extreme case. (Informant #11).

> The report [dashboard] had a tremendous influence for the prior VP of student affairs. We pushed him to put data in the scorecard [dashboard] regarding housing occupancy, so when we put those numbers in, he created a dialogue around the desirability of rooms or beds. The addition of the information was a major contributor to changing the Cabinets mind about not building two new dorms. (Informant #21).

Second, while none of the informants specifically state that they utilize their dashboards to make decisions or to improve their decision environment. This lack of focus on the actual construct of decision environment appears to be in contrast to the literature stream that views dashboards as decision support systems (Peng et al., 2007; Pauwels et al., 2009); however, an alternative interpretation of the data reveals that managers utilize dashboards extensively to make decisions and verify prior decisions in support of a particular activity, task, or process. The informants view their dashboards usage in the light of their activities, tasks, and processes versus actual decisions that are made.

Third, the dashboards are viewed in the feedback loop to create new business knowledge. Managers in sales related positions utilized the dashboard as a feedback mechanism when they are implementing new sales initiatives where the success can be monitored in a dashboard. These managers all refer to the feedback of information through the dashboard as developing 'new knowledge' through experimentation concerning their marketing efforts. One manager's comments specifically about this technique are shown below:

> When testing new strategies [initiatives], it is not good to wait three to four months in order to get the results. What did we do right and what did we do wrong. It gives direction. Building new knowledge (Informant #15).

The 'Diffusion' of Dashboards throughout Organizations

The main purpose of this study is to develop a framework to explain how and why dashboards have been diffused down to the lower levels of organizations. The data from this study reveal two patterns impacting the extent of dashboard utilization and the subsequent diffusion throughout organizations. Dashboards are utilized (1) for strategy alignment and (2) as an interactive management control. A framework containing these two primary categories (strategy alignment and interactive management control) is developed to explain their influence on the extent of dashboard utilization, which has resulted in wide spread diffusion of dashboards throughout organizations. The relationship between a dashboard as an interactive management control and the extent of dashboard utilization is mediated by the dimensions of dashboard quality. As dashboards become more dispersed throughout organizations, the consequences of a higher extent of dashboard utilization are managerial performance and organizational performance. Figure 3 shows the relationships that emerged from the data in this study.

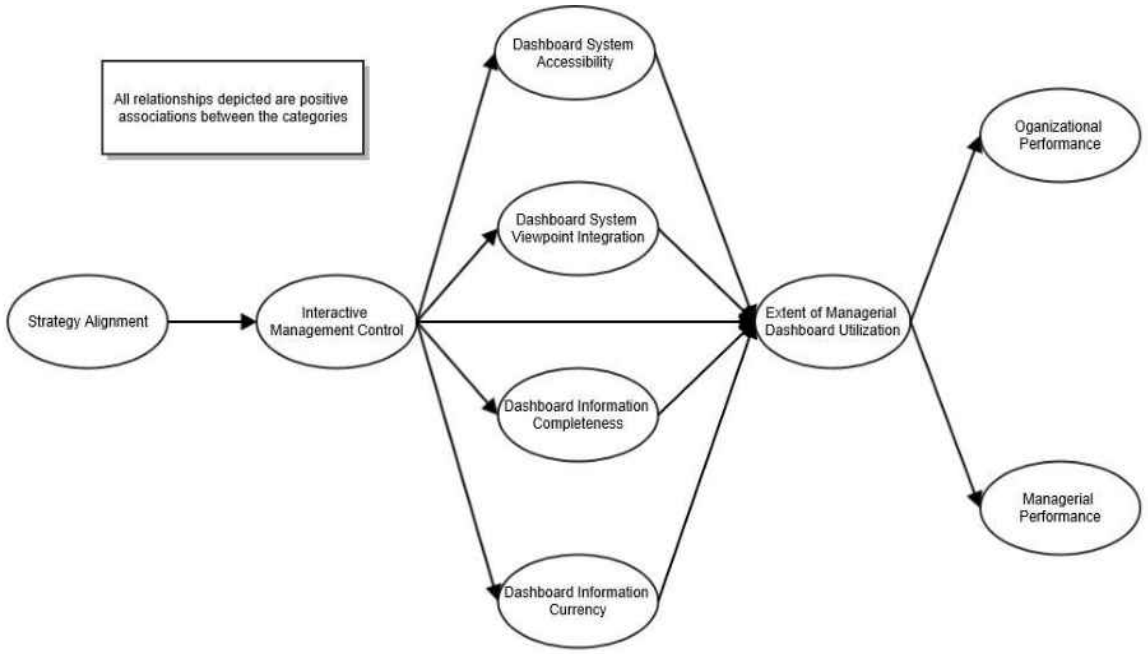

Figure 3: Framework for Dashboard Diffusion

The framework shows that dashboards that are aligned with strategy are positively associated with interactive management control. Interactive dashboards are associated with higher extent of dashboard utilization by managers throughout the organization. Dashboard system quality (accessibility and viewpoint integration) and dashboard information quality (completeness and currency) mediate the relationship between interactive management control and the extent of dashboard utilization. Lastly, the extent of dashboard utilization is positively associated with managerial performance and organizational performance.

The framework shown in Figure 3 is developed through the lens of IPT. According to IPT, as organizations make additional investments in IS such as dashboard systems, the information processing capacity of the organization increases (Ghani, 1992; Premkumar et al., 2005). When dashboards are strategically aligned, they have a higher level of association with dashboards exhibiting interactive management control characteristics. The managerial utilization

of dashboards associated with interactive management control is the method that increases the vertical (supervisor/subordinate) and horizontal (peer) information processing capacity of the organization. Interactive dashboards lead to higher levels dashboard utilization, which allows managers to gain greater access to information. Finally, IPT predicts that as the organization increases their information processing capacity through vertical and horizontal integration, higher levels of managerial and organizational performance will result (Ismail and King, 2005; Premkumar et al., 2005). The primary categories of strategy alignment and interactive management control and their respective contributions to the diffusion of dashboards throughout organizations as viewed through the lens of IPT are discussed below.

Strategy Alignment

In order to build an understanding of strategy in the context of the diffusion of dashboards to the lower levels of the organization where outcomes are typically not 'strategy' specific, the relationship between strategy, BSC's, and dashboards needs to be explored. Recent strategy and MCS literature focuses on BSC systems and performance measurement systems as the context for their studies; however, BSC or performance measurement systems are not the focus of this study. The study of dashboards fits into the strategy/BSC/performance measurement stream of literature based on the common usage of performance measures.

The principal purpose of BSC systems is to periodically report measures that are carefully selected by the executive team to reflect the strategic objectives of the organization (Cokins, 2010). Cokins further suggests that BSC's are connected to strategy whereas dashboards operate in isolation and are strictly focused on operations. The scorecard contains key performance indicators (KPI's) that are derived from the strategy diagram, whereas, the

dashboard just contains performance indicators (PI's). The difference between KPI's and PI's is the word 'key' which designates the link between measures and the progress towards the execution of strategy. Conversely, PI's are operational measures that are not connected to strategy (Cokins, 2010). The frequency of reporting for the scorecard ranges from quarterly to hourly while the dashboard is displayed in real-time. The depiction of the strategy to BSC relationship portrayed in prior practice related literature (Cokins, 2010) is observed in the field; however, dashboard content is also linked to strategy through KPI's based on operational tactics. Therefore, the dashboard is viewed as part of the MCS and not an add-on IT gadget utilized in isolation of the overall organizational goals and strategies. A manager of a regional financial institution supports this view of the dashboard in their organization.

> It [the dashboard] drills down from the organizational goals and strategies from the CEO which flows down to the executive team and then down to the departmental level…. So you have the strategy and our tactics that we are looking at the same time (Informant #13).

A manager in the finance area of a large healthcare network discusses the role their executive committee plays in the development of strategy, the selection of KPI's, and the selection of what is displayed on the dashboard.

> The organization has said, here is the view of the information as identified by the executive committee for the key metrics. There is a strong alignment between the strategy of the organization and the scorecard [and dashboard]. The key metrics, we believe, are the focus of the strategies. Again behind each of these metrics is a lot of planning and sub-drivers that go into the outcome that we see (Informant #11).

Additionally, other managers feel as if their dashboards are indispensable in relation to the diffusion of strategy in their organization.

> The value of business intelligence [with dashboard reporting] comes in to align everyone's goals to the corporate goals (Informant #12).

> If you are any good and you want this stuff to work, the KPI's [key performance indicators linked to strategy though operational tactics] become the topic of the day. You should be able to wake a manager from a deep sleep, at the edge of the organization, they can tell you what the seven KPI's are and what they mean (Informant#1).
>
> It [dashboard] helps me meet strategy. I make decisions more quickly and fine tune what we are doing as a department (Informant #13).

The data in this study reveals that about 40 percent of the cases in this study are utilizing dashboards with KPI's. Although the researcher is able to ascertain the existence of KPI's, not all of the operational managers are adept at understanding the concept of KPI's linked to strategy. The lack of recognition of the strategic objective on the part of the managers may result from the phenomenon of strategy surrogation, where managers substitute heuristic attributes (tactics or leading indicators) for target attribute (strategy) and may not even know the target attribute exists (Choi et al., 2012, 2013). An example of the occurrence of attribute substitution at the lower levels of an organization is found in the banking industry, which considers credit quality to be a highly desirable, although complex, core strategic objective. However, the underlying dimensions of credit quality can prove to be too complex and difficult to access at the lower levels of the organization. Therefore, the target attribute of credit quality (strategy) may be substituted with heuristics attributes such as times interest earned, cash flow, or owner's personal credit scores since these measures are easier to understand and calculate. In this example, a lending manager may surrogate a customer' calculation of times interest earned (heuristic attribute) for credit quality (target attribute) when underwriting the loan. This example shows the use of the surrogated heuristic attribute would be the tactic to achieve the actual strategic construct of credit quality. The lending manager does not need to fully comprehend or appreciate all of the thought processes that the executive management team has invested in defining credit

quality. The only understanding the lending manager needs is his/her underwriting criteria (tactics) as set forth by the executives, so any actual knowledge of the target attribute is superfluous.

An actual occurrence of strategy surrogation in the area of credit quality is discussed by a manager in a multi-national financial institution.

> You have to ask yourself a basic question: which is, how much of your time are (you) going to spend talking to people about something as 'wafflely' as credit quality…. Or are you actually going to peel it off once you get your own team on board …pretty much that is the team that developed the strategy…. [D]o you actually want to implement the bloody thing… or do you actually want to spend time trying to explain to people why you got there because that [how you got there] is very subtle, you have to have access to a lot of data for it to make any sense…. So the whole notion of strategy alignment is at some level, something that is hoisted on the literature and everybody else by people that aren't practitioners…. (Informant #1).

Prior literature views the strategy surrogation to be undesirable in the context of higher level strategic outcomes (Choi et al., 2012, 2013). However, when the strategy is diffused below the executive level in an organization where operational tactics are employed, the surrogation of strategy is intentional and is positively associated with dashboard utilization and performance.

Strategy literature also examines the concept of strategy alignment, which refers to the situation where KPI's are linked directly to strategy *and* the manager understands the link to the strategic objective; whereas, as discussed above, strategy surrogation is achieved through operational tactics associated with strategy and the knowledge of the strategic objective is unnecessary (Choi et al., 2013: 105). Figure 4 shows where strategy alignment and strategy surrogation typically occur in the context of strategy, BSC, and dashboards.

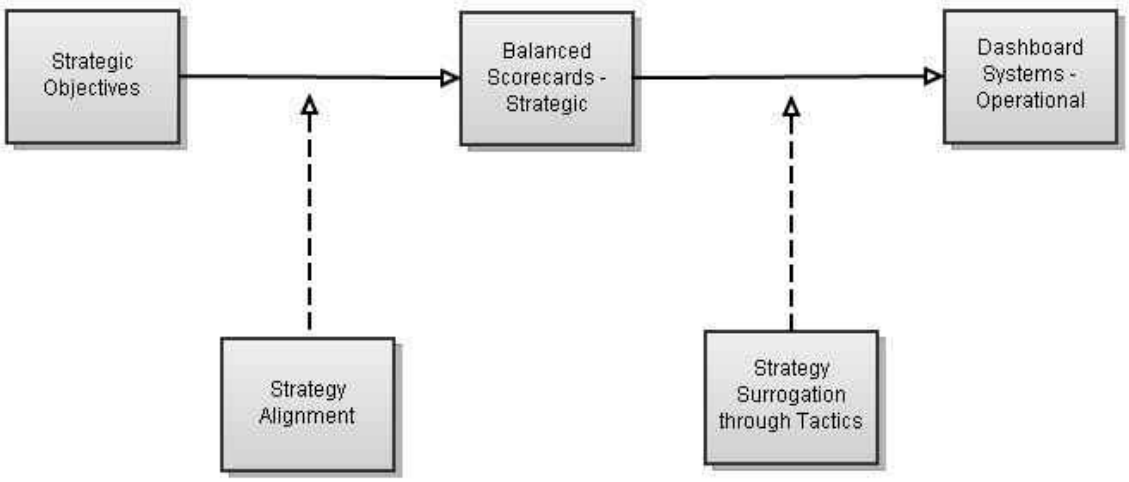

Figure 4: Links between Strategy, BSC, and Dashboards

The following managers confirm the strategy flow in the context of BSC and dashboards.

> They seem to diligently try to tie strategy to the scorecard to the dashboard (Informant #11 discussing the efforts of the executive committee).
>
> My point is those dashboards metrics should ideally be associated with other measures that they influence. At some point, you get to the strategy or strategy map. The real impact is the cause and effect relationships (Informant #4).
>
> It [the dashboard] drills down from the organizational goals and strategies from the CEO which flows down to the executive team and then down to the departmental level…. So you have the strategy and our tactics that we are looking at the same time….I can easily communicate different drivers to different stakeholders (Informant #13).

Prior literature has examined strategy alignment by linking strategy to performance measures in the context of 'strategic' performance evaluations, strategic changes, or strategic initiatives (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004). Typically, this research reveals that

when participants are aware of the organizational strategic objectives through either strategy maps or causal links, the decisions or judgments made by the participants are associated with higher levels of alignment to strategic objectives.[4]

Research in the area of strategy alignment/surrogation, where the research context does not include the strategic outcome, is limited. Recent research found that the MCS helped to communicate the strategic agenda throughout the organization (Kober et al., 2007). Malina and Selto (2001) examined whether the effective communication of BSC's throughout the organization is associated with strategic alignment. Their results show that effective communication of the BSC is not associated with strategic alignment. Although the term 'strategy surrogation' is not used in the literature at the time of this study, the results may have been due to strategy surrogation.

The data analyzed in this study indicate that strategy surrogation is an important (primary category) variable associated with the diffusion of dashboards to the lower levels of the organization. The more effective dashboards observed in the field use centrally developed KPI's to surrogate for the strategic objectives of the organization. A manager in a large multi-national organization comments on the use of strategy surrogation in their dashboard through two examples in their organization.

> Strategy, no I would not say it was widespread. You really do not align strategy. You align tactics. A small number of people develop strategy and then a much large number of people execute the tactics…. Are you getting alignment around the execution of strategy? Strategy is really a series of tactics. We execute strategy as a series of tactics. The real question is - are we getting alignment around the tactics? (Informant #3).

[4] This stream of research focusing on strategic outcomes uses the term 'manager' as the unit of analysis; however, the generalizability of these studies do not appear to broad since only a very few executive level 'managers' really select or develop strategies for the organizations. Managers throughout the organization may be able to select their tactics to execute the organizational strategy; however, the use of tactics may cause the managers to lose sight of the strategy and surrogate the strategy tactics for the strategy.

> You have to take a step back and look at the human condition. Does my office clerk in Japan really give a damn about some corporate strategy that is hatched in New York and then implemented on the 43rd floor of some tower, you know, I do not think so. Does he or she care about if I [they] stamp this particular trade ticket and make sure it is correct before I [they] type it in, so that I [they] do not get …[their] KPI [marked] downward….I convinced her of that, then my… strategy of reducing unit cost, so that we can be the low cost provider against our competitor which is a very big strategic outcome, happens…. (Informant #1).

Choi et al. (2012) describes a critical feature of strategy alignment which is the need for the manager to be able to 'see through' the measures to the actual strategy underlying the measures. "This transparency allows managers to infer the firm's desired course of action, gauge the appropriateness of the strategy, and adjust the strategy as deemed necessary" (Choi et al., 2012: 1136); however, these adjustments may actually occur at the tactical level and not the strategic level. The executive management team is responsible for setting and adjusting strategy. Lower level managers can adjust tactics, but not the strategy itself. Choi et al., (2012: 1136), further states that strategy surrogation may not have negative impacts for some "low-level employees who do not make strategic judgments and decisions". Overall, the data from this study reveal that strategy surrogation should and does take place for managers in much higher positions than the 'low-level' employees discussed in prior research, and the results of the surrogation are posited to be positive.

Based on the data in this study, the concept of strategy alignment is defined to include both the KPI's linked directly to strategic objectives (strategy alignment) and operational tactics linked indirectly to strategy (strategy surrogation) that are considered to still be representative of the strategic objectives. Therefore, strategic alignment will proxy both strategic alignment as viewed in prior literature (Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004) and strategy surrogation (Choi et al., 2012, 2013)

since both constructs are designed to achieve the strategic objectives at the lower levels of an organization.

Overall, the dashboards are viewed as effective vehicles that assist with the diffusion and communication strategy throughout the organization. Based on the analysis of the data in this study, strategy aligned dashboards are positively associated with dashboards that are utilized as interactive MCS, either intentionally or inadvertently. Interactive dashboards are discussed next.

Interactive Management Control

The second primary category that emerged from this study is the interactive management control aspect of dashboards as part of an organization's MCS. MCS's are considered to be a "process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives" (Anthony, 1965:17). More recent interpretations of MCS see the control package as a set of processes and procedures designed for utilization by managers to help employees achieve the organizations goals and objectives (strategy) as well as their own personal goals (Otley and Berry, 1994; Bisbe and Otley, 2004; Tucker et al., 2009). Additionally, MCS focuses organizational attention, creates shared beliefs, and provides the underlying logic to develop a common language (Swieringa and Weick, 1987), which is accomplished through the interactive management control aspect of dashboards.

The purpose of designating a system as interactive is to focus organizational attention, compel dialogue, and facilitate learning at all levels of the organization based on the signals sent by top managers (Simons, 1994). For these reasons, MCS are an integral part of the strategy process in an organization (Simons, 1994) and the ability to communicate strategy throughout

the organization (Kober et al., 2007), based on either the strategic objectives or the operational tactics. Specific MCS, such as dashboards, are designated as interactive based on meeting four criteria: "(i) the information generated is a recurrent and important agenda for top managers; (ii) frequent and regular attention is fostered throughout the organization; (iii) data are discussed and interpreted among organizational members of different hierarchical levels; and (iv) continual challenge and debate occur concerning data, assumptions and action plans" (Henri, 2006: 533; Simons, 1994). Additionally, interactive management controls often set the agenda at meetings with subordinates and other peer organizational members to assess data and make decisions for action (Simons, 1991).

One of the key findings in this study is how strategy alignment facilitates the use of the dashboard as an interactive management control. The dashboard allows the strategy that is established by upper level management to be communicated systematically throughout the organization. The diffusion of strategy/tactics is aided by the interactive dashboard's ability to achieve viewpoint integration through the use of a common language, transparency, and consistent measures. An interesting phenomenon surrounding the interactive management control aspect of dashboards is the pattern where dashboards are not intentionally designed by upper management to serve as an interactive management control. The 'designation' of dashboards as an interactive management control seems to be an unexpected benefit that emerges organically as the dashboards are further dispersed throughout the organization. Even though the data shows that the interactive management control is not a main emphasis in the implementation of the dashboard, the data reveals that dashboards eventually emerge as an interactive management control when they are strategy aligned. The following managers commented on their use of their dashboards interactively.

> So yes, it [the dashboard] is a common topic, horizontally, vertically, with auditors (Informant #1).
>
> I can easily communicate different drivers [operational tactics] to different stakeholders. Whether [it] is managers, the employees to motivate, or even the dealers (Informant #13).
>
> It [the dashboard] gives us consistency. We are all going in the same direction. It gives us direction. It allows all of our employees to go in the same direction. If our hospitals are judged on one measure and another on another set, it creates inconsistencies. It was decided these are the indictors for a successful quality hospital (Informant #15).

When dashboards are utilized in an interactive manner, the extent dashboard utilization for managers is posited to increase since the number and types of applications of dashboard utilization increases as well. If dashboards are not interactive, a manager may only utilize their dashboard to complete their own tasks; however, when dashboards are interactive, the extent of utilization increases to include activities such as decision-making, verification of prior decisions, guiding activities, monitoring personal performance, managing overall work, achieving the goals and objectives of the organization, managing subordinates, informing peers/superiors, creating meeting topics, trend analysis, and feedback on new initiatives. The following comments from managers show the extent of utilization for their interactive dashboards.

> Visibility of data among peers helped utilization (Informant #13).
>
> Standardized way of looking at format is important to use (Informant #12).
>
> We use it extensively in meetings. We will pull up our dashboards often in these meeting…. We use this in meetings because it dumbs down the data to make it easier to understand (Informant #13)
>
> We use charts, line, bar, pie and then just numbers. We focus on the performance over prior year or week. It removes the ability to have a blip in one week without a good comparison. It removes the questions (Informant #6 discussing how the dashboard is utilized in meetings).

> The data is available when I need it. When I go to a strategy meeting, I have it and it is available as of now and it is already conforming to a vision that helps explain what has been going on over the past period that we are interested in (Informant #12).
>
> I use it constantly. Daily. hourly. Looking for trends. If I need to do a quick coaching session [with an employee] during the day, it is helpful to use the data. It is ad hoc (Informant #13).
>
> The reason I review the CEO dashboard is because I want to see what he is seeing (Informant #5).
>
> It gives me quick snapshot overview and tells my boss what is going on (Informant #8).

Mediation of Interactive Management Control and the Extent of Dashboard Utilization

The relationship between interactive management control and the extent of dashboard utilization is mediated by the dimensions of both dashboard systems quality (accessibility and viewpoint integration) and dashboard information quality (completeness and currency). Mediation takes place when a third variable, such as a dimension of dashboard system quality, also influences the independent/dependent variable relationship. Further, mediator variables "explain how external physical events take on internal psychological significance" (Baron and Kenny, 1986: 1176). As applied to this study, the physical event is the change in either dashboard system quality or dashboard information quality that explains why the managers with dashboard associated with interactive management exhibit a greater extent of dashboard utilization. The mediator variables of accessibility, viewpoint integration, completeness, and currency are reviewed below.

Dashboard System Accessibility

The extent of dashboard utilization achieved through a dashboard associated with

interactive management control is mediated based on the increased accessibility to the dashboard system. This increased accessibility to dashboard information is achieved in a variety of ways, such as through smart phones and tablet computers. These changes to how managers can access their dashboard enables more ways a dashboard can be utilized to manage the work environment, including decision-making, problem solving, and/or guide meetings. Managers had the following comments about the importance of dashboard accessibility.

> The thing I love best about it besides that it is easy to use. Is that it is a cloud based tool, so I can access it anywhere. I can access it from my mobile phone, ipad using a sales force app or my work or home computer. So the data sits in the cloud, so I can pull it and use from anywhere, anytime. I do not just have to be in my office (Informant #4).
>
> The entire company looks at the dashboards at a meeting once a week (Informant #6).
>
> Phone, ipad, laptop….Accessibility is huge (Informant #14).
>
> Easy to access like the mobile ability of a tablet (Informant #16).
>
> Sales force has mobile apps. Anywhere with a mobile network, I can log in and get access (Informant #18).
>
> When I go to a strategy meeting, I have it and it is available as of now and it is already conforming to a vision that helps explain what has been going on over the past period that we are interested in (Informant #12).
>
> Available to me at any given moment with current data. Not only do I know the raw numbers but if it is going up or down. My travel is about 70 days a year. We do not have cloud access, so we log in through the internet based on privacy concerns (Informant #7).
>
> We use it extensively in meetings. We will pull up our dashboards often in these meeting…. We use this in meetings because it dumbs down the data to make it easier to understand (Informant #13)

Dashboard System Viewpoint Integration

Viewpoint integration is defined as a shared understanding through a consistency of measures or common language (Pauwels et al., 2009). Dashboard system viewpoint integration is essential to enable managers to develop consistent and understandable dialogues within all levels of the hierarchy as well as across geographic boarders. If the managers and employees are all speaking the same language, everyone can be oriented in the same direction to achieve the organizational objectives. The data reveals that viewpoint integration is associated with dashboards that exhibit interactive management control and accounts for a portion of the increases to the extent of utilization as discussed by the following managers.

> And then you have a common language that is pushed down. You can now have an actual conversation with some in Tokyo that someone will understand, right. It is immensely valuable. That is the work. It is not easy. The work is not easy. It is incredibly more difficult than trying to push strategy into the organization. A group of senior managers actually has to convert and be accountable for the conversion of strategies into a series of tactics and KPI's that everyone understands (Informant #1).

> The short answer is what a dashboard does is gives you a common language, which is a plus. It absolutely does that, which is all the more reason you want it centrally defined. You cannot have conversations where someone has picked a different number. It is just not helpful (Informant #1)

> It [the dashboard] gives us consistency. We are all going in the same direction. It gives us direction. It allows all of our employees to go in the same direction. If our [organization] is judged on one measure and another on another set, it creates inconsistencies. It was decided these are the indictors for a successful quality [organization] (Informant #15).

Dashboard Information Completeness

Dashboard information completeness is the extent that the relevant potential states of information are available to managers by their dashboard (Nelson et al., 2005). A dashboard can provide information completeness through either static information or information hyperlinked to

more detailed information (known as drill down capabilities). Today's dashboards typically offer the drill down capability in order for managers to obtain a more complete picture of their environment, and this level of information completeness is posited to account for higher levels of dashboard utilization for interactive dashboards. The dashboard drill down capabilities is discussed by managers below:

> Most frequently I use the drill down capabilities when I have a partner or distributor that introduces a lead to us and I finish my work and I hand it off to one of our sales people, I hand it off in our dashboard to them and they add in notes. So there is multiple people that are adding records that is in the tool, so it is important to me for tracking and planning and reporting to be able to go in and go down deep and see what people have added to the record (Informant #5).

> Drill down – helps understand why results are not positive so that you can communicate with boss (Informant #8).

Dashboard Information Currency

Information currency is the degree that the current state of the environment is correctly presented (Nelson et al., 2005). Dashboards available by today's third party software providers are typically linked to the organizations IIS and can provide highly current real-time information; however, a higher percentage of the managers observed in this study (85 percent) do not utilize the 'prepackaged' dashboards offered by these providers. Most of the organizations internally designed and developed their dashboards on common platforms such as Microsoft Excel, Microsoft Sharepoint, or Business Objects. As a consequence, all of the information is not always tied into the main IS and provided in real-time. As revealed in the data, when dashboards are strategy aligned and interactive, a lower level of currency does not negatively impact utilization; however, highly current information contained in the dashboard does improve utilization. Therefore, the framework shows that dashboard information currency explains some of the increases to the extent of dashboard utilization based on interactive management control.

> The downside was you could only get it every couple of weeks. It [the dashboard] was very useful, but it was a retroactive view (Informant #1).
>
> It lags a little bit…. There never is going to be immediate data on everything (Informant #8).
>
> [The dashboard is] [a]vailable to me at any given moment with current data (Informant #7).

Performance – Managerial and Organizational

Lastly, the framework shows the consequences of the extent of dashboard utilization are a positive association with managerial performance and organizational performance.

> These dashboards tell me if I am off and that is a beautiful thing. They tell me if I am not doing job. The dashboard definitely tells me if I am doing my job or not (Informant #6).
>
> I use the dashboard to evaluate how I did (Informant #5)
>
> [He] seemed really interested in performing well at his job in order to move the organization forward. …I think the dashboard really tied him into the goals and objectives of the organization and made him feel a part of something bigger (Interview note written by researcher about Informant #15)
>
> I see it as meeting company objectives versus personal (Informant #8).

Dashboard System Flexibility

One final phenomenon, not related to the framework shown in Figure 3, is the relationship between dashboard system flexibility and strategy alignment. Dashboard flexibility denotes how much control users possess to personalization and change their dashboards presentation format and content (Nelson et al., 2005). This study reveals that organizations with strategy aligned dashboards do not provide their managers with highly flexible dashboards. In fact, the flexibility functionality of dashboards may actually impede the effective communication of and diffusion of strategy. Strategy focused organizations develop strategy at the higher levels

of the organization and then disseminate the information to the lower levels of the organization with the assistance of dashboards. Consequently, if highly flexible dashboards are allowed in this process of strategy diffusion, managers may substitute their own personal measures for the strategy aligned measures selected by executive management, which would be detrimental to the organization. Overall, dashboard flexibility is negatively associated with strategy alignment. The managers that are utilizing strategy aligned measures had the following comments concerning dashboard flexibility:

> The flexibility is oversold by the software companies. You do not need flexibility; it actually causes more problems (Informant #1).
>
> All of these metrics are developed and set up by the executive team (with no flexibility) (Informant #11).
>
> User control (flexibility) should be used sparingly – mostly central KPI's attached to strategy and give user a minimal amount of selection (Informant #12).
>
> No, we (the executive team) picked the KPI's because the KPI's are the ones that make a difference. That is single biggest strategic thing you can do is pick the right KPI's (Informant #1).
>
> The division president selects what goes on the dashboard (Informant #8).

Conclusion

This study examined the diffusion of dashboards throughout today's organizations. A cross-sectional field study is conducted utilizing 27 informants from 24 different organizations operating in 10 industrial sectors. The study utilizes the explanation building process to develop a framework to explain the diffusion of digital dashboards down to the lower levels of the organization. The diffusion of a technology throughout an organization is predicated on extensive utilization of the technology.

Two core categories emerged that are antecedents to the extent of dashboard utilization: strategy alignment and interactive management control. The primary finding from this study indicates that the diffusion of dashboards throughout organizations is the result of an increased extent of dashboard utilization at the lower levels of the organization, which is directly attributable to the dashboards being strategically aligned and part of the organization's interactive management control. The execution of operational tactics/strategy in dashboards typically occurs through the phenomenon known as strategy surrogation. Prior research has shown that strategy surrogation is negatively associated with strategic level outcomes (Choi et al., 2012, 2013); however, the data in this study shows that strategy surrogation is a necessary condition for 'strategy' execution at the middle to lower levels in large organizations. As dashboards are utilized extensively in strategy aligned environments, the dashboards become an integral part of a managers' tool set and the organization's MCS as an interactive management control.

The study provides a strong support for managers utilizing dashboards as interactive management control at all levels of the organization. The data observed in this study supports the notion that strategy aligned dashboards promote the dashboards as interactive management control. Dashboards with interactive management control are associated with higher levels of extent of utilization, and this relationship is mediated by dashboard system accessibility, dashboard system viewpoint integration, dashboard information completeness, and dashboard information currency. An additional finding in this study is that strategy alignment is negatively associated with high levels of flexibility in dashboard systems, since tactically oriented KPI's are typically developed by a small group of the executives in the central organization and dispersed throughout the organization.

The main contribution to this stream of research is the examination of dashboards to explain why they have been diffused throughout organizations. This study extends previous practice related literature on dashboard design and implementation to reveal why strategy alignment and interactive management control has increased the extent of utilization and further the diffusion of dashboards. The results of this study place dashboard research in the stream of MCS and strategy; whereas, the research stream is isolated previously. Additionally, prior MCS and strategy research have examined strategy based on strategic outcomes: evaluations, changes, or initiative implementations, which are executive level activities. This study contributes to this area of research through examination of the execution of 'strategy' at the middle and lower levels of the organization based on surrogating tactics for strategy; and strategy surrogation is shown to have a positive impact on performance at these levels.

The limitations of this study are inherent to the research method employed to examine the constructs of interest. Qualitative research is inherently biased based on the researchers background and thought processes. This researcher brought biases into the research process, which is mitigated through the research design, protocol, and validity procedures employed; however, some bias may still exist.

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STUDY TWO
THE IMPACT OF DIGITAL DASHBOARD QUALITIES AND STRATEGY ALIGNMENT ON THE MANAGERIAL DECISION ENVIRONMENT AND PERFORMANCE

Introduction

Innovations in the key features of dashboards have made it possible for managers to receive management accounting information that is customizable, highly accessible, and available in real-time (Vasarhelyi and Alles 2008). Seminal research conducted by McKinnon and Bruns (1992) regarding managers' information utilization posited what features the systems should provide managers in the future.

> "…[M]anagement accounting systems of the future should consist, in part, of a large real-time database into which information is continually flowing. Labeling and storage should be sufficiently flexible to allow managers throughout the company to find what they want easily and to construct their own reports to get the information they need. This implies that managers will need to have the ability to connect with the MAS directly rather than through the management accounting function. The MAS needs to be accessible and friendly. Output formats should be as flexible as possible to allow managers to use quantitative summaries or graphic displays. The goal should be to allow any manager to work with the data in any way chosen with the full confidence that the information obtained will be current and reliable" (McKinnon and Bruns, 1992: 222).

By all accounts, this system of the "future" has arrived and is available in todays' organizations through digital dashboards (Few, 2006; Pauwels et al., 2009; Yigitbasioglu and Velcu, 2012). This study posits that these innovations, as they relate to dashboards and the provision of accounting information to managers, have positively impacted the quality of managerial decision-making as well as managerial performance.

Few (2005, 2006) defines a dashboard as a visual display of the key information or performance measures necessary to achieve managerial or organization level objectives that can be readily understood by a manager within a single glance. Practice oriented research has shown

that the primary function of a dashboard is to present key performance measures, which are linked to objectives for the manager, functional area, and/or the organization (La Pointe, 2008). Prior literature has placed dashboards within the broader management control systems (MCS) of an organization (Yigitbasioglu and Velcu, 2012; Granlund, 2011) since MCS's are viewed as a set of procedures and processes put in place in organizations to help ensure that employees achieve both their own objectives and organizational objectives (Otley and Berry, 1994; Bisbe and Otley, 2004; Tucker et al., 2009). Dashboards keep managers focused on goals and objectives by providing guidance on which activities are important and need attention as well as supporting quality decision-making (Peng et al., 2007; Pauwels et al., 2009). Additionally, research has also shown that MCS are an integral part of the strategy process (Simons, 1994). The appropriate context for studying management controls is based on their utilization and level of importance to the primary decision makers in the organization (Langfield-Smith, 1997). Overall, dashboards have been developed to provide managers with the right information, at the right time, and in the right format to improve the managers' decision environment to achieve organizational objectives (Gartner, 2011).

The overall purpose of this study is to examine how dashboards have impacted the decision environment of managers as well as the antecedents and consequences to this impact. DeLone and McLean's (DM: 1992, 2003) information system (IS) success model is utilized to investigate the effects of the antecedents of dashboard system quality and dashboard information quality on the decision environment as well as the resulting consequences or 'net benefit' of managerial performance and organizational performance. The dimension for the dashboard system quality include accessibility (access to the dashboard system), data integration (how well a dashboard combines data across the organization), and flexibility (adaptability of dashboard by

users). The dimensions that comprise dashboard information quality include completeness (level of data needed by user), currency (faithful representation of current state of environment), and accuracy (correct, meaningful, and consistent). Additionally, research has shown that MCS aid in the communication of strategic agendas throughout the organization (Kober et al., 2007); therefore, this study also investigates if the relationship between dashboard qualities (system and information) and the decision environment is moderated by the alignment of the dashboard's content with the organizational strategic agenda. These research questions are examined through the lens of information processing theory (IPT; Galbraith, 1973) and attribution substitution theory (Kahneman and Frederick, 2002).

The importance of this study is based on our limited knowledge and understanding of dashboard utilization by managers (Yigitbasioglu and Velcu, 2012) and the effect on the decision environment. The majority of the prior literature concerning dashboards is in the area of design and implementation. Research is needed in the area of dashboards impact on the managerial decision environment, as well as understanding the associated antecedents and consequences. Nelson et al. (2005) calls for research to continue in the area of systems quality and information quality as new innovations in technology are introduced that may affect users' perceptions (Nelson et al., 2005). Most recently, new innovations have affected dashboard system quality through higher levels of accessibility and flexibility while dashboard information quality has been impacted by means of continuous real-time information.

A theoretical model is developed and tested utilizing components based structural equation modeling. The model is tested utilizing data collected from 391 middle to upper level managers located in the United States who use dashboards in their weekly work life. A survey is used to collect the data from these managers regarding their perception of the dimensions of

dashboard systems quality (accessibility, integration, and flexibility), dashboard information quality (completeness, currency, and accuracy), the level of strategy alignment contained in the dashboard, the decision environment, managerial performance, and organizational performance. The theoretical model is tested and the results indicate that dashboard system flexibility and dashboard information currency are positively associated with the managerial decision environment. This study also hypothesizes that the level of strategy alignment in the dashboard will moderate the relationship between the dashboard qualities (system and information) and the managerial decision environment. These moderation hypotheses are not supported, except for the hypothesized relationship between dashboard system flexibility and the managerial decision environment. The interaction between flexibility and strategy alignment weakens the positive association between flexibility and the decision environment. This indicates that when strategy alignment is high, the flexibility of the dashboard system is low. Conversely, when strategy alignment is low, a higher level of flexibility is needed by managers to impact decision quality. The model shows that higher quality decisions in an improved managerial decision environment lead to the consequences of higher levels of both managerial performance and organizational performance.

This study contributes to dashboard research by being the first to report on the effect of the recent innovations in the antecedents of dashboard system quality and dashboard information quality to the managerial decision environment. A key contribution to the strategy literature is the examination of the impact of strategy alignment at the lower levels of an organization and the results showing strategy aligned dashboards have lower levels of flexibility to maintain managers' attention on the specifically selected key performance indicators (KPI's). Further, this study contributes to the MCS and IS literature stream by extending the prior dashboard research

from the highest levels of an organization to the impact of the diffusion of the dashboards to the managers responsible for the day-to-day operations of the organization. This study reports on the effects of an organization's MCS embedded in a dashboard and strategy when the outcome is operational (decision environment of lower level managers) and not at the highest strategic levels of the organization as studied in prior literature (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004).[5] Lastly, this study extends Nelson et al.'s research by examining the impact of new innovations in dashboard through the lens of IS Success.

The remainder of this paper is organized as follows: Section 2 presents the theory, background, and hypotheses development for the study. Section 3 discusses the research methods Section 4 shows the results. Section 5 provides a summary and concludes the paper.

Theory, Background, & Hypotheses

Information Processing Theory

IPT (Galbraith's 1973) is utilized as the lens to predict how innovations in dashboards impact the managerial decision environment and performance based on the improved provisioning of information to managers. IPT is comprised of three key concepts: an organization's information processing needs, the actual capability to process information, and how well the needs and capabilities match in order to achieve a higher level of performance (Ismail and King, 2005; Premkumar et al., 2005). The amount of information which an

[5] This study examines the diffusion of dashboards apart from the executive and departmental dashboards; therefore, when this study refers to the lower levels of an organization, upper level managers (below the executive level) and middle management are included in this reference. This study does not include line managers or other lower level managers as the unit of study.

organization needs to process is impacted by the level of uncertainty associated with organizational tasks or the organizational environment. As levels of uncertainty increase, information processing capabilities also need to increase to maintain the same level of performance (Galbraith, 1973). As shown in Figure 5, IPT proposes four organizational design strategies based on either decreasing information processing needs or increasing information needs.

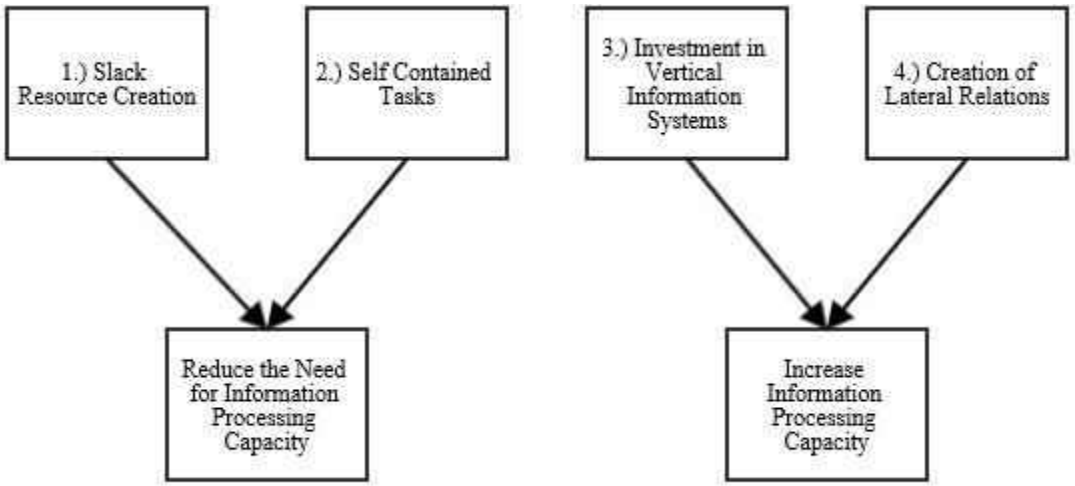

Figure 5: Organizational Design Strategies
Source: Adapted from Galbraith (1973)

The first two strategies on the left side of the figure shows strategies for reducing an organization's information processing needs through the creation of slack resources and/or the development of self-contained tasks. The right side of the figure reveals two strategies for increasing an organization's information processing capacity by developing higher levels of vertical integration and/or developing higher levels of horizontal integration (Galbraith, 1973). These four design strategies are an exhaustive set of alternatives and Galbraith posits that organizational performance will be reduced if one or more of these design strategies are not employed in the face of increased uncertainty (Galbraith, 1973, 1974). Prior research has shown

that investments in computer systems (such as dashboard) increase the horizontal and vertical integration in an organization (Ghani, 1992; Premkumar et al., 2005), which increases the processing capacity in the organization. Implementing technologies which assist with data integration and data delivery are one of the primary design strategies selected by today's' organization to effectively increase information processing capabilities. Organizations integrate their IS and supporting applications, such as business intelligence (BI) and dashboards, to increase their information processing capacity to reduce the effect of the higher levels of uncertainty encountered in the organizational environment (Seddon et al., 2010). BI systems increase the levels of information processing capacity in the today's' organizations by creating new relationships in the data and providing an effective flow of information through dashboards at unprecedented levels (Chang et al., 2003). This increased processing capacity also aids the managerial decision environment (Seddon et al., 2010). In summary, IPT suggests that investments in IT (Ghani, 1992) for applications such as dashboard will create higher levels of vertical and horizontal integration of the information within the organization, which lead to improved information processing capacity, and ultimately, higher quality decision-making (Seddon et al., 2010).

Attribute Substitution Theory

Attribute substitution is a phenomenon that takes place when a target attribute is assessed by an individual through the representation of the value of a heuristic attribute on the target attribute (Kahneman and Frederick, 2002). Three conditions need to be present to enable attribute substitution to occur: 1.) the target attribute is reasonably difficult to access; 2.) an associative and semantic attribute (heuristic attribute) is very accessible; and 3.) the heuristic

attribute's substitution for the target attribute is not consciously rejected (Choi et al., 2013; Choi et al., 2012; Kahneman et al., 2006; Kahneman and Frederick, 2002; Schkade and Kahneman 1998). Prior literature has examined the occurrence of attribution substitution in the context of strategic objectives and performance measures. Strategic objectives may be substituted by the more easily accessible operational tactics since strategic objectives can be conceptual, ill-defined, or complex in nature, which meets the first criteria for attribute substitution. The attribute substitution in the context of strategy will usually take place at the lower levels of the organization where the strategic agenda is more abstract and less meaningful in the fulfillment of daily work tasks. The second and third conditions of attribute substitution are met at the lower levels of an organization when operational tactics are substituted for the strategic objectives; and consequently, as the organization grows, this 'substitution' may aid in the effective management of the organization.

Consider the example of the strategic objective of 'credit quality' in a large multi-national banking institution. Credit quality is viewed as a target attribute and is a complex construct that may be judged and measured using multiple perspectives that can be difficult for lower level managers to understand or properly implement. When a high measure of credit quality is pursued during the lending process that occurs in the lower levels of the organization, managers may be permitted to substitute the heuristic attributes of net income, times interest earned, cash flow, or an owner's personal credit score for the target attribute of credit quality based on ease of acquisition, comprehension, and calculation. Accordingly, a bank credit manager may analyze the cash flow (heuristic attribute) of a loan seeking business as a substitute for the bank's strategic objective of credit quality (target attribute) in order to effectively underwrite the loan. In this example, the examination of the business's cash flow is the

operational tactic utilized to accomplish the organization's strategic agenda. Consequently, the credit manager does not need to fully comprehend the complexity underlying the credit quality construct or need to be focused on the actual strategic objective in order to perform well at their job. Therefore, when a manager substitutes heuristic attribute (operational tactic) for the target attribute (strategic objective), it is known as strategy surrogation (Choi et al., 2012, 2013). As dashboard becomes more diffused throughout organizations, the occurrence of this type of strategy surrogation is posited to increase as managers' move further away from the executive level where the strategy is developed.

Digital Dashboards

Dashboards allow managers to select, organize, and present information that has been combined from across the organizational database(s) (Dilla et al., 2010). Three types of dashboards are utilized in business today and each type is put into service based on differing design concepts to fit the end use: strategic, analytical, and operational (Few, 2006). Strategic dashboards, also known as executive dashboards, are initially the most prevalent type of dashboards utilized in organizations when dashboards are first introduced. The executive dashboard is designed to support the highest level of management and/or overall departmental functions by focusing on the strategic level metrics and performance measures. Strategy surrogation is not a common occurrence for this type of dashboard since the dashboards are linked directly to the actual strategic measures. Analytical dashboards support data analysis, usually through comparisons, extensive histories, and more subtle forms of performance evaluators. The analytical dashboards are most commonly established in the central offices of an organization and utilized by analysts or other higher level employees to uncover and exploit new

relationships in databases. Operational dashboards provide tactical measures that managers use to monitor the operations of the business throughout the lower levels of the organization (Few, 2006). Since the operational dashboards are used by managers that are not in daily contact with the strategic agenda for the organization, they typically contain performance measures that are strategy surrogated. This study focuses on operational dashboards, since this type of dashboard is most prevalent today at the lower levels of the organization.

To date, empirical research beyond the practice oriented literature in the area of design and implementation, is limited (Yigitbasioglu and Velcu, 2012; Ballou et al., 2010; LaPointe, 2008; Few, 2005, 2006; Clark et al., 2006; Wind, 2005; Brath and Peter, 2005, Miller and Coiffi, 2004; DeBusk et al., 2003). Anecdotal evidence from the practice based literature has shown that when dashboards are designed effectively, they have been associated with increasing managerial decision-making effectiveness, managerial performance, and organizational performance (Ballou et al., 2010; Few, 2005, 2006). Additionally, this stream of literature shows that effective dashboard designs provide managers with important data that can be viewed and understood quickly to support decision-making (Few, 2005; Brath and Peters, 2005).

Early research in the area of marketing management indicates that successful dashboard implementations are dependent upon a link from the dashboard's performance measures to the organizational goals and objectives (Miller and Cioffi, 2004; Wind, 2005). Research further reveals that successfully implemented dashboards increase operational effectiveness through a more methodical decision-making process (Miller and Cioffi, 2004). The literature continues to confirm that one of the key purposes of dashboard is providing guidance on decisions through organizational level integration and alignment (Peng et al., 2007; Pauwels et al., 2009). Overall, dashboards are viewed as increasing the information processing capacity throughout the

organization both vertically and horizontally; and according to IPT, higher levels of information processing capacity lead to more effective decision-making and performance (Ghani, 1992; Chang et al., 2003; Premkumar et al., 2005; Seddon et al., 2010).

IS Success Model

Since an organizations' utilization of IS increases information processing capacity (Ghani, 1992; Premkumar et al., 2005), understanding the level of success associated with the deployment of these technologies is critical. Early literature on IS success examined the 'factors' associated with systems quality and information quality to understand their impact on user satisfaction and systems development (Debons et al., 1978; Halloran et al., 1978; Bailey and Pearson, 1983). Not until the seminal research of DM (1992) are the independent factors associated with systems quality and information quality viewed in the context of a model, now known as the IS Success model. Prior research had produced multiple methods of measuring IS success; however, the DM (1992, 2003) model has been the predominant model utilized and tested in the literature. The overall model is based on the process nature of the information flowing through a sequence of stages beginning with the system itself and ending with net benefits achieved by the user or organization (DM, 2003).

DM's IS Success model is comprised of six constructs: systems quality, information quality, use, user satisfaction, individual impact (includes both decision quality and performance), and organizational impact/performance (DM, 2003). The IS Success Model is depicted in Figure 6.

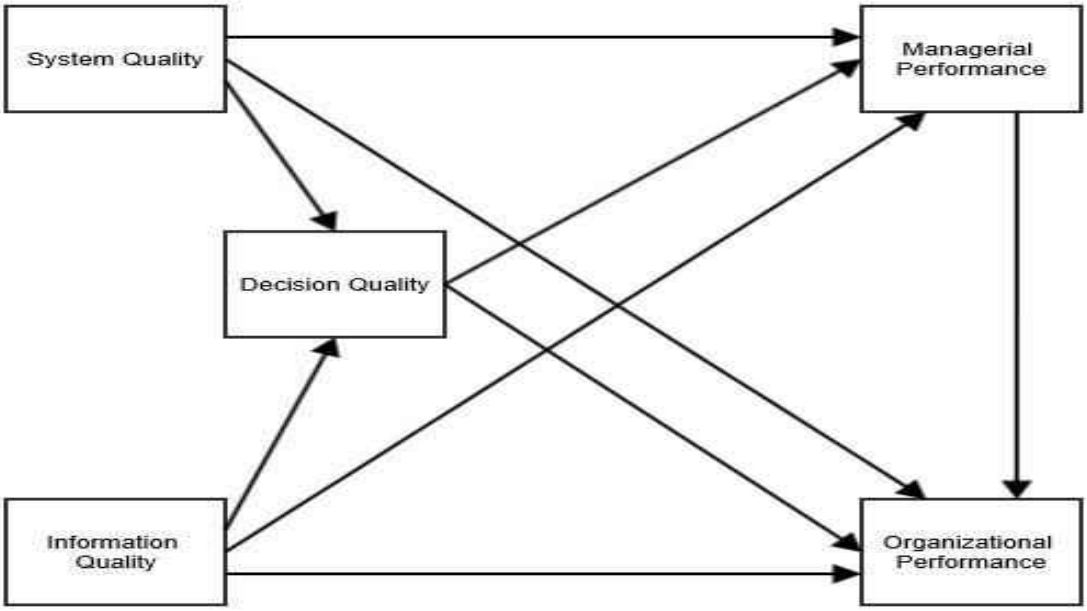

Figure 6: IS Success Model
Source: Adapted from DeLone and McLean, (2003)

Specifically, this study models the impacts of dashboard systems quality, dashboard information quality, the managerial decision environment, managerial performance, and organizational performance. Dashboard system quality is examined in this study based on the dimensions of accessibility, integration, and flexibility (Nelson et al., 2005). Dashboard information quality is examined through the dimensions of completeness, currency, and accuracy. Both dashboard systems quality and dashboard information quality are viewed as antecedents to the managerial decision environment. Lastly, managerial performance and organizational performance are the consequences of the dashboards' impact on the managerial decision environment. These relationships are depicted in the research model shown in Figure 7 and are reviewed below.

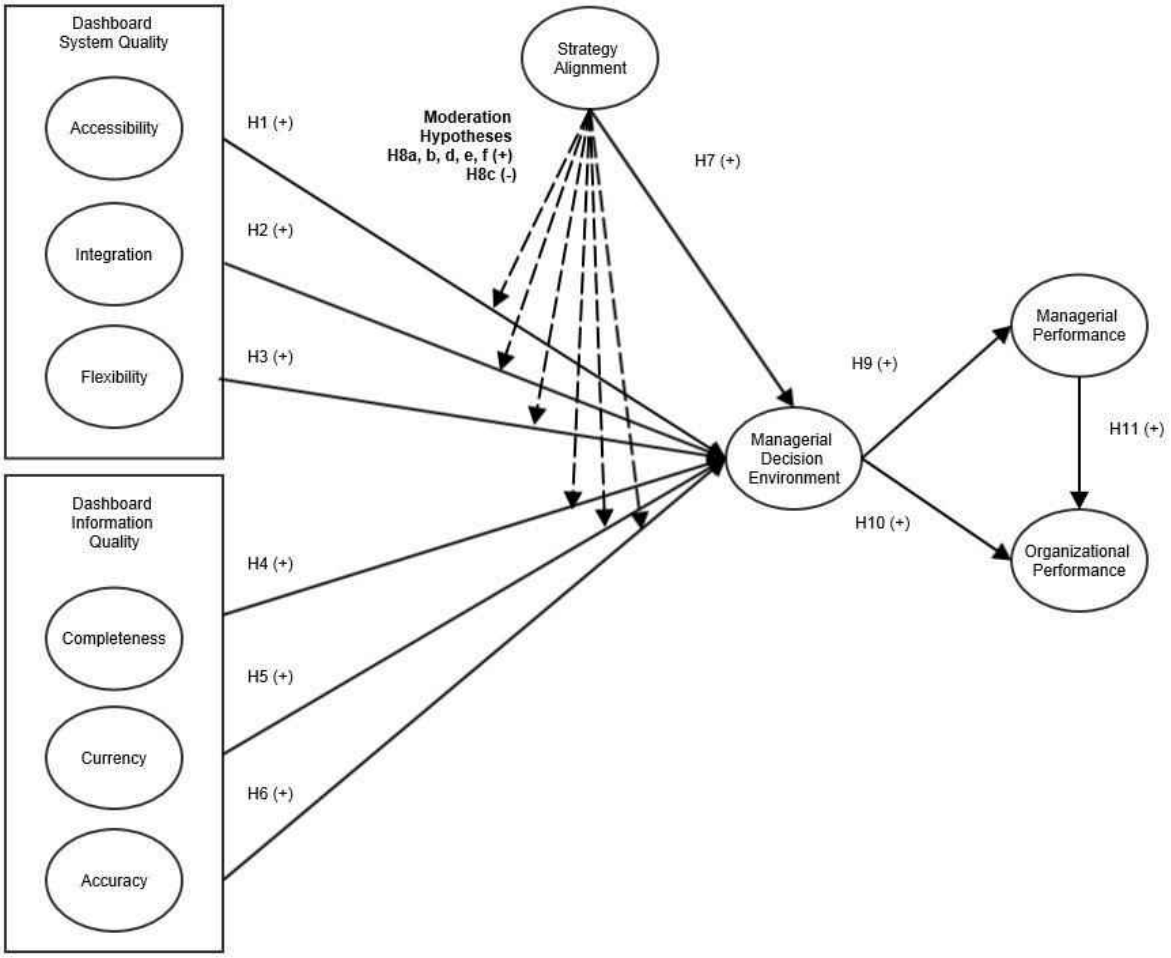

Figure 7: Theoretical Model – Study Two

Managerial Decision Environment

Dashboards are designed to solve two issues involving the delivery of information to managers through IS in an effort to aid the decision-making process by 1) organizing disparate pieces of information in a format that enables more effective decision-making, and 2.) reducing the amount of managerial bias present in decision-making and information processing (Pauwels et al., 2009). The objective of dashboards, as a part of an organization's broader MCS package, is to provide managers with the information needed to aid in decision-making or activity directing rather than to monitor manager's behaviors (Henschen, 2009). Prior research examining the managerial decision-making *process* reveals the following successive activities need to take place for quality decision-making: gather the right information; interpret the information in a timely manner; and synthesize the information to be used in the context of decision-making (Tushman and Nadler, 1978) all of which are aided through dashboards. Consequently, the primary construct of interest for this study is the managerial decision environment, which is comprised of the content of information managers need, the manner in which this information is provided to managers, and the impact on the quality of decision-making.

Dashboards support the managerial decision environment by providing the manager with the following: 1.) the right information; 2.) at the right time; 3.) and in the right format (Gartner, 2011). This support of the decision environment is accomplished through each of the individual dashboard 'quality' (system and information) dimensions in the following ways. Starting with the dimensions of dashboard systems quality, *accessibility* will affect how 'timely' the information can be accessed by managers (Henschen, 2009); the *integration* of organizational databases will allow the dashboards to provide the 'right' information needed by managers; and

the *flexibility* of the dashboard system will allow the information to be synthesized in multiple 'formats' that can be fit to each individual manager. The dimensions of dashboard information quality will support the decision environment in the following manner: the level of information *completeness* will impact the dashboard's provisioning of the 'right' information needed by the manager; the *currency* of the dashboard information affects the 'timeliness' of the information obtained by managers (Henschen, 2009); and the dashboard provides *accurate* information throughout the decision-making process in order to maintain the manager's trust in the dashboards (LaValle et al., 2011).

The extant literature on effect of a dashboard on the managerial decision environment is not extensive; however, the following studies do provide empirical support for the association between the managerial decision environment and the antecedents of dashboard system quality and dashboard information quality. The literature shows positive associations between decision support and the dimensions of dashboard system quality and dashboard information quality (Wixom and Watson, 2001; Yong-Tae, 2006). Additionally, dashboards have been shown to drive operational effectiveness through the more disciplined decision-making process (Miller and Cioffi, 2004).

A related stream of literature on fully integrated database systems such as enterprise resource planning systems can also provide insight into how dashboards may affect the decision environment. The primary object of implementing integrated systems is improved decision-making (Davenport et al., 2004); and, approximately 75 percent of the organizations surveyed had achieved some level of improved decision making through their integrated systems and supporting applications (Harris and Davenport, 2006). Seddon et al. (2010) posits that the link between these integrated systems and better decision making shown in Harris and Davenport

(2006) appears to be a causal link. Overall, this study posits the managerial decision environment will be positively associated with the antecedents of the dimensions that comprise dashboard system quality (accessibility, integration, and flexibility) and dashboard information quality (completeness, currency, and accuracy).

Dashboard System Quality

Dashboard systems quality refers to the quality of the actual processing system which delivers the output (information) to the manager (Nelson et al., 2005).[6] The current study examines three key dimensions of systems quality as they relate to the dashboard: accessibility, integration, and flexibility. Prior research has shown that the antecedent of systems quality is positively associated with managerial performance as proxied by decision support (Wixom and Watson, 2001; Yong-Tae, 2006). Each of the dashboard systems quality dimensions is discussed in detail in the following sections.

Accessibility

Accessibility is defined as the level of effort required to access the dashboard system (Nelson et al., 2005). Recent innovations in software and hardware have exponentially increased the accessibility of dashboard systems to managers in just the last five years. The introduction of smart phones, tablet computers, and cloud based computing have transformed the manner in which managers access and interact with their dashboard systems. Smart phones and tablet computers are small, lightweight, and highly portable; and now provide access to software in a

[6] The dimensions of the dashboard system are invariant to differing uses and can be examined without relation to context, task, or application (Nelson et al., 2005); therefore, the level of dashboard quality should not vary by the end use of the dashboard.

manner similar to a desktop or laptop computer. Cloud based computing moves services and applications off an organization's central computer servers to the internet; and, it has greatly increased where and how managers can connect and work with their dashboard systems (Srivastava and Kumar, 2011; Nicolaou et al., 2012). This increased level of accessibility has made it easier and less cumbersome for managers to stay in contact with the information provided through their dashboard system to manage workflows and make decisions from anywhere in the world (Vasarhelyi and Alles 2008).

Access or 'convenience of access' to computers has been an important construct in the IS success research for at least 40 years. The accessibility to the system itself and convenience of access are both important predictors of user satisfaction (Debons et al., 1978; Bailey and Pearson, 1983). Research has also shown accessibility to be an important dimension of both systems quality and information quality (Nelson et al., 2005; Wang and Strong, 1996). As organizations invest in additional IS through the deployment of dashboards, the organizational information processing capacity increases (Ghani, 1992; Premkumar et al., 2005). Consequently, dashboards with higher levels of accessibility should further increase the organizations information processing capacity. According to IPT, higher levels of processing capacity have been shown to support managerial decision-making (Seddon et al., 2010); therefore, this study posits that accessibility will be positively associated with the managerial decision environment.

H1: Dashboard system accessibility is positively associated with the managerial decision environment.

Integration

Early IS research viewed integration as the capability of the multitude of IS to *communicate* and *share* data across different functional areas (Bailey and Pearson, 1983). Modern views of integration have evolved from communicating and sharing data to combining data from multiple databases to aid business decisions (Nelson et al., 2005) as well as the degree that all of the data is managed in a single database (Chapman and Kihn, 2009). Dashboards play an important role in decision-making based on their technological capability to organize and combine disparate pieces of information to enable more effective decision-making (Pauwels et al., 2009). The dashboards role of facilitating decision-making is advanced through higher levels of systems integration.

Early research examined system integration in relation to the net benefit of user satisfaction. This research indicates that the inability to integrate systems is one of the top five reasons for higher levels of user dis-satisfaction (Bailey and Pearson, 1983). More recent research examines integration as an important dimension of systems quality and finds that integration is positively associated with managerial performance as measured by decision support (Wixom and Watson, 2001; Yong-Tae, 2006). As organizational databases become more fully integrated, managers gain access to greater levels of information, thus increasing the organization information processing capacity. As processing capacity increases, so does the support for managerial decision-making according to IPT (Seddon et al., 2010); therefore, this study posits that dashboard systems that are highly integrated will be a strong antecedent to the managerial decision environment.

H2: Dashboard system integration is positively associated with the managerial decision environment.

Flexibility

The dimension of flexibility signifies the level of user control managers can exert on their dashboards to change the information content and presentation format (Nelson et al., 2005). The format of the dashboard may be personalized by managers based on their own desires and/or organizational role (DeBusk, 2003; Few, 2006; Pauwels et al., 2009; Yigitasioglu and Velcu, 2012). Currently, dashboards allow users to choose the content and presentation format of the output in a design that fits the role of a manager and/or their personality. Managers have their own unique cognitive styles which they bring with them to the work environment; and, these various styles require differing methods for utilizing IS (Macintosh, 1985).

Research has identified system flexibility (or ease to change or adapt) as one of the top five factors of importance in determining user satisfaction (Bailey and Pearson, 1983); however, the research in this area has not been conclusive as to whether flexibility improves the net benefits of utilization or performance. Prior research has shown that when flexibility is combined with decisional guidance, performance does improve (Wilson and Zigurs, 1991). More recent research has shown that the dimension of flexibility is positively associated with performance as operationalized through decision support (Wixom and Watson, 2001). Conversely, research has also shown tailoring systems to individual preferences has not provided a large impact on either the efficiency or effectiveness of solving problems (Vessey and Galletta, 1991; Wilson and Zigurs, 1991). Overall, this stream of literature has been inconclusive as to the overall benefits of flexibility and when it is appropriate to allow user control (Dilla et al., 2010).

This study posits that flexible will be positively associated with the managerial decision environment since prior research has linked data visualization tools such as dashboards to

increasing information processing capacity (Dilla et al., 2010), and information processing is linked to improved decision-making in IPT (Seddon et al., 2010; Granlund, 2011).

H3: Dashboard system flexibility is positively associated with the managerial decision environment.

Dashboard Information Quality

Dashboard information quality measures the quality of the output from the dashboard (DM, 1992; Nelson et al., 2005). Dashboard information quality can be viewed from either an intrinsic or contextual basis. The intrinsic view examines the dimensions of dashboard information quality without reference to either the context or task. Conversely, the contextual view considers how the information is used as an important component when studying the dimensions of information (Nelson et al., 2005). This study examines the dashboard information quality from the intrinsic view. Under the purview of IPT, managers utilize quality information to mitigate the effects of increasing uncertainty to make more effective decisions (Premkumar et al., 2005). The quality of information is critical to decision-making and research has shown that managers continue to seek better information to inform decisions (Wouters and Verdaasdonk, 2002). The three key dimensions of information that are most important to decision-making aided through dashboards are completeness, currency, and accuracy. Each of these dimensions is discussed in detail in the following sections.

Completeness

The dimension of completeness is described as the degree that all the possible states of information relevant to a user are represented in the available information (Nelson et al., 2005). Completeness can be achieved through drill-down capable presentations. Drill-down capability

allows users to access enterprise level information by clicking on a chosen metric to access less aggregated information showing more detail as back-up to the highly aggregated data shown on the dashboard (Peng et al., 2007). Drill-down capabilities are commonly utilized by management to inquire about variances experienced in the performance of their work (Pauwels et al., 2009) and to aid decision-making (Peng et al., 2007). The drill-down capabilities provisioned through dashboards provide managers with a more complete set of data to assist them in their decision environment.

Early research investigating the construct of completeness viewed it in the context of user satisfaction, and the results show that completeness is not a strong predictor of user satisfaction (Bailey and Pearson, 1983). However, and more importantly, completeness has been shown to be significantly associated with the relevancy of data and data quality (Wang and Strong, 1996) and effective decision support (Wixom and Watson, 2001). Recent literature suggests that completeness is one of the key dimensions of information quality in the IS Success model (Nelson et al., 2005).

As organizations invest in dashboard IS that enable higher levels of integration such as dashboards, managers will have access to higher levels of 'complete' information, resulting in increased organizational information processing capacity (Ghani, 1992; Premkumar et al., 2005). Based on IPT, increases to information processing capacity are associated with managerial decision-making (Seddon et al., 2010); therefore, this study hypothesizes that completeness will be positively associated with the managerial decision environment.

H4: Dashboard information completeness is positively associated with the managerial decision environment.

Currency

Today's dashboards are capable of delivering information content that is highly current through the real-time data processing features in the underlying databases. Current (timely) information displayed in dashboards is viewed close to or simultaneously with the time the changes occur (Agbejule, 2005). Currency of information has been an important factor in IS research since the early studies in IS. This construct has been examined both as timeliness, the amount of time required for a system to respond to a users' needs (Halloran, 1978), and currency, the age of the information that is output from the system (Chenhall and Morris, 1986; Bailey and Pearson, 1983). As the level of systems integration has increased over the years, research extended the currency construct to include how well the information correctly presented the current state of the world (Nelson et al., 2005).

The majority of research in the area of providing continuous (timely and current) information has concentrated on internal and external audits, external financial reporting, and continuous budgeting (Alles et al., 2006; Hunton et al. 2010; Turner and Owhoso 2009; Searcy et al., 2009; Frow et al. 2010; Kuhn and Sutton, 2010). The results in this area of research have generally indicated positive benefits for the user. Research examining IS success has shown currency to be significantly associated with user satisfaction, data relevancy, and data quality (Bailey and Pearson, 1983; Wang and Strong, 1996). Prior research in the area of providing current (continuous real-time) information to managers and the impact on decision-making has been limited, especially in the context of modern integrated information systems; however, a study examining data warehousing shows that currency is positively associated with managerial decision performance (Yong-Tae, 2006).

Based on prior research, this study posits that when dashboards deliver information that is highly current, the level of uncertainty experienced by a manager is reduced since uncertainty is caused by the absence of information (Guo, 2011). Based on IPT, when managers utilize dashboards with current information to alleviate the impact of increasing uncertainty, they make more effective decisions (Premkumar et al., 2005); therefore, this study hypothesizes that dashboards that display highly current information will be positively associated with the managerial decision environment.

H5: Dashboard information currency is positively associated with the managerial decision environment.

Accuracy

The dimension of accuracy is concerned with the level of correctness, meaningfulness, believability, and consistency of the information (Halloran et al., 1983). Stated more succinctly, accuracy is the capability of the information stored in the data warehouse to be mapped to the appropriate state that it represents in the real world (Nelson et al., 2005). Early research in the area of IS accuracy focused on systems reliability measures (Halloran et al., 1978) and the impact on user satisfaction (Bailey and Pearson, 1983; Wang and Strong, 1996). This research indicates that accuracy is *the* most important factor affecting user satisfaction (Bailey and Pearson, 1983); and, accuracy is one of four overall factors that impact data quality (Wang and Strong, 1996). Accuracy of information content is studied as part of the construct of information quality in a data warehousing context and shown to be positively associated with managerial decision support (Wixom and Watson, 2001). Recent literature finds that accuracy is an antecedent to information quality when examined through the lens of the IS Success model (Nelson et al., 2005).

Prior qualitative research in the area of dashboard has associated accuracy with dashboard utilization. A practice oriented study examining the implementation of a marketing dashboard shows that dashboard utilization is low due to 'dirty data' or a low level of accuracy (LaPointe, 2008). Further, the study revealed that the low level of accuracy resulted in mistrust of the dashboard information and ultimately led to the dashboard system failing to be effective within the organization.

As organizations make additional investments in IS to achieve higher levels of accuracy, the level of information processing capability in the organization will increase (Ghani, 1992; Premkumar et al., 2005). This study posits that as processing capacity increases as a result of information that is more accurate, the level of support for managerial decision-making will also increase, according to IPT (Seddon et al., 2010). Therefore, this study hypothesizes that accuracy is an important antecedent that positively impacts the decision environment of managers.

H6: Dashboard information accuracy is positively associated with the managerial decision environment.

The Moderating Role of Strategy

Strategy Alignment and Surrogation

Dashboards are a part of the organization's overall MCS (Yigitbasioglu and Velcu, 2012; Granlund, 2011); and prior research views MCS as an essential piece of the strategic process (Simons, 1994). Recent research has shown MCS's are utilized to communicate the strategic objectives throughout an organization (Kober et al., 2007), and dashboards can be utilized for that purpose very effectively. Therefore, dashboards, as part of the broader MCS package, may be utilized by management to disseminate the strategic objectives throughout an organization.

Strategy and MCS have been examined in prior literature extensively, especially in the area of the balanced scorecard (BSC) and performance measurement systems. Dashboards fit together with strategy/BSC/performance measurement area of research based on the common utilization of performance measures; however, prior research concerning dashboards places them in the BSC stream of literature (Cokins, 2010). To gain an understanding of how dashboards fit in this literature, strategy and BSC are briefly reviewed. The primary purpose of BSC systems is to regularly report on the strategic performance measures that have been selected by the highest levels of management; and to measure progress and communicate the progress made towards the strategic agenda for the organization (Cokins, 2010). Cokins shows that BSC's are *directly* linked to strategy; whereas, dashboards function in isolation.

The BSC is comprised of KPI's that are aligned with the strategic agenda established in the strategy diagram, whereas, the dashboard merely displays performance indicators (PI). The difference between KPI's and PI's, designated by the word 'key', is that KPI's are connected directly to the strategic objectives of the organization, either through the strategic objective itself, or through operational tactics. Conversely, PI's are not connected to strategy in any form and are viewed as purely operational measures (Cokins. 2010).

Study one reports that the dashboards observed in a cross-sectional field study contained both KPI's and PI's, which extends our understanding of how dashboards are actually being utilized within the strategy and performance measure framework. Further, the dashboards utilized by managers in the field contain one or more of the following three types of performance measures: 1.) KPI's that are linked directly to the strategic objectives; 2.) KPI's that are operational tactics designed to accomplish the overall strategic objectives without being strategic

in nature themselves; and 3.) PI's which are merely operational measures not attached or linked to strategy or other measures in the organization (Study One).

The first type of performance measure represents strategy alignment. Strategy alignment occurs when an organization's performance measures, contained in either the BSC or the dashboard, are linked directly to the strategic objectives in an organization; and, more importantly, the manager remains aware of the actual strategic objective (Choi et al., 2012, 2013). Prior literature has examined this strategic alignment in the context of high level strategic outcomes involving the evaluation of 'strategic' performance evaluations, changes in strategy, or the implementation of strategic initiatives (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004). Overall, the results of the strategy alignment literature stream have shown that managerial performance is improved when the manager's focus is strategy aligned.

The second type of performance measure, the use of operational tactics in the form of performance measures, represents strategy surrogation. Strategy surrogation occurs when managers cannot grasp the strategic construct *represented* by their performance measures through operational tactics; subsequently, the managers act as though their 'surrogated' performance measures are the actual construct of interest, in place of the strategy construct (Choi et al., 2013, 2012). Attribution substitution theory explains why strategy surrogation occurs; however, it does not denote whether the surrogation is a positive or negative phenomenon in the organizational setting. The results from study one show preliminary results that strategy surrogation in the lower levels of an organization can be positive; and, in fact, some managers intentionally create strategy surrogated performance measures for the dashboards utilized within their large multi-national organizations.

Strategy surrogation occurs in both the higher levels of an organization as well as the lower levels in the organization. The results of prior research have found strategy surrogation to be a negative influence at the higher levels of the organization (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004); however, no study has examined strategy surrogation at the lower levels of the organization. This study posits that both strategy alignment and strategy surrogation will have positive impacts on the managerial decision environment at the lower levels of the organization. Consequently, this study defines the concept of strategy alignment to include both the performance measures directly attached to the strategic objectives (classic strategy alignment) and the operational tactics not discernibly linked directly to strategy, but nonetheless indirectly representative of the strategic objectives. Therefore, strategic alignment proxies both the classic view of strategic alignment from prior literature (Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004) and strategy surrogation (Choi et al., 2012, 2013) as they both are designed to accomplish the strategic goals of the organization at the lower levels.

Prior research in the area of strategy alignment/surrogation in a context that does not include a strategic outcome is limited. Recent research found that the MCS helped to communicate the strategic agenda throughout the organization (Kober et al., 2007). As organizations build the capacity to communicate strategy to the lower levels of the organization through the use of operational tactics contained in dashboards, this study posits that higher quality decisions will result from the delivery of this consistent and relevant information throughout the organization. Therefore, this study hypothesizes that strategy alignment is also important antecedent that positively impacts the decision environment of managers.

H7: Strategic alignment is positively associated with the managerial decision environment.

Moderation of Quality Dimensions and Decision Quality

The initial set of hypotheses in this study posits that the dimensions of dashboard quality (system and information) are positively associated with the managerial decision environment. Prior research in the area of strategy alignment has shown that strategy alignment results in higher levels of consistency and managerial performance (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004). Although the prior strategy research does not directly measure the decision environment, the higher levels of performance are accomplished through more effective decision-making (Chong, 1996); therefore, this study posits that when a dashboards' performance measures are strategy aligned, all of the positive associations between each dashboard dimension (system and information) will become stronger in the presence of strategy alignment except for the flexibility dimension. The results from study one reveal that the relationship between flexibility and strategy is negative based on managements' intentional reduction of system flexibility to ensure that managers' maintain the strategy aligned KPI's presented on their dashboards. Conversely, higher levels of dashboard system flexibility are associated with PI's. Therefore, the following set of hypotheses is set forth:

H8a: The higher the level of strategy alignment, the stronger the positive association between accessibility and the managerial decision environment.

H8b: The higher the level of strategy alignment, the stronger the positive association between integration and the managerial decision environment.

H8c: The higher the level of strategy alignment, the weaker the positive association between flexibility and the managerial decision environment.

H8d: The higher the level of strategy alignment, the stronger the positive association between completeness and the managerial decision environment.

H8e: The higher the level of strategy alignment, the stronger the positive association between currency and the managerial decision environment.

H8f: The higher the level of strategy alignment, the stronger the positive association between accuracy and the managerial decision environment.

Performance

The IS Success model shows the net benefits of success may positively impact both managerial performance and organizational performance. These two constructs are examined in this study to understand how the innovations in dashboard qualities (system and information) impacts both personal and organizational performance through the managerial decision environment (DM, 1992, 2003).

Managerial Personal Performance

Managerial performance is an important 'net benefit' of the utilization of dashboards for decision-making. Prior research examines the association between managerial performance and the dimensions of systems quality and information quality. Integration, in the context of a single database, is investigated as an antecedent to MCS and managerial performance through the lens of enabling and coercive bureaucracy (Chapman and Kihn, 2009). The results show that the integration of IS is associated with enabling bureaucracy and higher levels of managerial performance. The currency of information and overall information quality are associated with managerial performance through the construct of task technology fit (Goodhue and Thompson, 1995). Additional research in the area of strategy alignment examines managerial performance and the utilization of strategic 'key' performance measures. Results show that when performance measures are strategy aligned and organizational justice is high, managerial performance improves (Burney et al., 2009).

Overall, this study posits that as dashboard utilization increases to assist with a manager's decision-environment, the organizational information processing capacity will increase and offset the ever increasing uncertainties faced in today's organizations. IPT predicts that as the needs for more information processing are met through the use of IS (dashboard), the manager and the organization will achieve a higher level of performance (Ismail and King, 2005; Premkumar et al., 2005). Therefore, this study posits that a high level of managerial decision environment will result in higher levels of managerial performance.

H9: The managerial decision environment is positively associated with managerial performance.

Organizational Performance

Organizational performance is examined as a 'net benefit' of the managerial decision environment in the IS Success model. Early research in this area found that the antecedent of integration is associated with higher levels of organizational performance through the managerial decision environment (Teo and Wong, 1998). Further research in the area of IS integration investigated the association of integration with information utilized for either coordination or control, and the results indicate that integration is a strong antecedent to both types of information utilization and also organizational performance (through the construct of trust) (Nicolaou et al., 2011). Additionally, when performance measures are decision facilitating, managerial use of these measures is positively associated with the organizational strategic capabilities and organizational performance. When the performance measures are not decision facilitating, the managers are less likely to use the measures to manage performance (Grafton et al., 2010). In a recent survey with 3,000 business executives from around the world, the use of analytics (performance measures) and organizational performance is investigated. The research

reveals that the organizations with the highest levels of performance utilized analytics and performance measures to formulate strategies, develop insights to manage the day-to-day operations, and to conduct rigorous analysis to aid in decision-making (LaValle et al., 2011).

Based on IPT, as organizations make higher levels of investment in dashboards that convey relevant performance measures and managers throughout the organization utilize those dashboards to facilitate decision making, the organization should achieve a higher level of performance (Ismail and King, 2005; Premkumar et al., 2005). Therefore, this study posits that higher levels of decision quality will be associated with higher levels of organizational performance. Additionally, since improved managerial performance should enhance the performance of the organization, this study posits that higher levels of managerial performance will be associated organizational performance.

H10: The managerial decision environment is positively associated with organizational performance.
H11: Managerial performance is positively associated with organizational performance.

Research Methods

This study examines the antecedent and consequences of the managerial decision environment and how strategy alignment may moderate the relationship between dashboard qualities (system and information) and managerial decision environment. The data are collected over a four-day period. The subsequent subsections present respondent demographics, instrument development, and data analysis and results.

Respondents

Based on the diffusion of dashboards throughout the organization, this study investigates

how innovations in dashboard system quality and dashboard information quality impact the managerial decision environment, and subsequently, both managerial and organizational performance. Consequently, the respondents sought for this study needed to meet the following screening criteria to best understand the impact of this diffusion: (1) utilize dashboards in their daily or weekly work life, (2) hold a middle level to upper level management position, (3) work in a functional area of the organization that is operational and not IT oriented, and (4) located in the United States to avoid any cultural effects. The study focuses on middle to upper level management since they are next in line to receive dashboards that are dispersed throughout the organization and they are considered key decision makers in the organization.

To reach this target population of dashboard users, the assistance of a national survey firm was utilized. The firm sent 26,000 e-mail solicitations to potential respondents. From the 26,000 solicited to participate, 3,087 responded. Of the 3,087, only 694 met the screening criteria and were passed to the survey. In order to provide assurance that each respondent understood each question and was actively engaged, three 'disqualification' questions were inserted in the survey (one at about the 25 percent complete point, one at the 50 percent complete point, and one at the 75 percent complete point). These questions read "Please select 'no basis for responding' (or 'disagree') as your answer to this question". If the respondent did not mark the proper response, they were disqualified from completing the survey. These three questions eliminated 294 respondents, leaving 400 valid responses.[7] An additional 9 respondents were subsequently removed from the sample due to their excessive selection of the 'no basis for answering'. The 9 responses were removed because the respondent selected 'no basis for answering' (1) for more than 10 percent of their answers or (2) for more than 2 item measures for

[7]The goal was to collect 400 responses; therefore the survey was closed once 400 responses were received. As a result, calculation of response rates is not meaningful.

each construct.[8] After removing these 9 respondents, the final sample contained 391 respondents. The average time to complete the survey is 14:50 minutes and the median time for completion is 12:30 minutes.[9]

The demographic data is shown in Table 3. These data show that the average age of the respondent is 37.90 years, and 269 (68.8 percent) of the 391 respondents are male. The majority (n=289; 73.9 percent) of the respondents had achieved an education level of a four year college degree or higher. The respondents from three different functional areas in the operational side of businesses represent the largest set of respondents: manufacturing (n=99, 25.3 percent), operations management (n=123, 31.5 percent), and project management (n=34, 8.7 percent). The respondents' years of experience with their current organization averaged 5 to 10 years for 46.8 percent of the respondents (n=183). The majority of the respondents had experience utilizing dashboards in excess of 1 year, but less than 5 years (n=244, 62.4 percent); and came from mid-size organizations with annual revenue between $10 million and $500 million (n=284, 72.6 percent) as well as less than 5,000 employees (n=329. 84.1 percent). Lastly, the industry representation included chemical (1.0 percent) finance (13.0%), healthcare (11.0 percent), manufacturing (35.3 percent), service (5.6 percent), technology (8.4 percent), transportation (6.1 percent) utilities (3.3 percent) wholesale/retail (12.0 percent), and other (4.1 percent).

[8] Another 35 respondents selected 'no basis for answering' infrequently either once or twice throughout the entire survey; therefore, mean replacement is deemed appropriate and is utilized 45 times to replace the 'no basis for answering' reply.

[9] Respondents who took less than six minutes to complete the survey were also disqualified, and their responses were not recorded.

Table 3: Demographic Data – Study Two

Variable	n	%
Average age in years	37.9	
Gender		
Male	269	68.8%
Female	122	31.2%
Highest Education		
Some High School	0	0.0%
High school graduate/diploma	15	3.8%
Some college courses or technical school courses	44	11.3%
2 year College Degree	43	11.0%
4 year College Degree	215	55.0%
Master's Degree or higher	74	18.9%
Functional Area		
Accounting	13	3.3%
Financial Services	38	9.7%
Healthcare Management	34	8.7%
Manufacturing/Production	99	25.3%
Operations Management	123	31.5%
Project Management	34	8.7%
Purchasing	9	2.3%
Sales/Marketing	41	10.5%
Years of Experience with Current Organization		
2 Year or Less	21	5.4%
2 Year up to 5 Years	82	21.0%
5 Year up to 10 Years	183	46.8%
10 Year up to 20 Years	88	22.5%
Greater than 20 Years	17	4.3%
Years of Dashboard Utilization		
1 Year or Less	20	5.1%
1 Year up to 3 Years	108	27.6%
3 Year up to 5 Years	136	34.8%
5 Year up to 7 Years	87	22.3%
Greater than 7 Years	40	10.2%
Organizational Size by Number of Employees		
250 up to 1,000	175	44.8%
1,000 up to 5,000	154	39.4%
5,001 up to 10,000	33	8.4%
More than 10,000	29	7.4%
Organizational Size by Annual Revenue		
Less than $10 million	47	12.0%
$10 million up to $100 million	144	36.8%
$100 million up to $500 million	140	35.8%
Greater than $500 Million	60	15.3%
Industry		
Chemical	4	1.0%
Finance	51	13.0%
Health care	43	11.0%
Manufacturing	138	35.3%
Service	22	5.6%
Technology	33	8.4%
Transportation	24	6.1%
Utilities	13	3.3%
Wholesale/Retail	47	12.0%
Other	16	4.1%

Total Sample: n =391

Survey Development

As Figure 7 shows, this study examines the relationships of the following theoretical constructs: accessibility, integration, flexibility, completeness, currency, accuracy, strategy alignment, decision environment, managerial performance, and organizational performance. The constructs for this study were measured utilizing multi-item scales. With the exception of strategy alignment, all of the measures for the theoretical constructs were adapted from validated instruments. The item measures used for strategy alignment were developed for this study. All of the item measures were considered to be reflective measures of each respective theoretical construct and these item measures are listed in Table 4. The complete survey is contained in the Appendix. Each construct, except organizational performance, was measured utilizing 5 point Likert scales where 1 represented the positive response for 'agree', 5 represented the negative response for 'disagree', and 6 represented "no basis for answering". Organizational performance was measured utilizing a 5 point Likert scale anchored by well above average (1), to well below average (5), and no basis for answering (6).

Table 4: Item Measure Descriptions - Study Two

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
Accessibility - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which a system can be accessed with relatively low effort.				
My dashboard system is accessible to me from anywhere (home, office, during meetings, while traveling, etc.).	A8_1	1.813	2.000	1.078
My dashboard system can be retrieved using different types of technology.*	A8_2	1.719	1.000	0.999
My dashboard system can be retrieved from locations outside my office.	A8_3	1.693	1.000	1.037
My dashboard system has a high level of mobility.	A8_4	1.734	1.000	0.937
My dashboard system is accessible during business meetings*	A8_5	1.501	1.000	0.777
My dashboard system is accessible during staff meetings.*	A8_6	1.517	1.000	0.841

*Dropped

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
Integration - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which a system facilitates the combination of information from various sources.				
My dashboard system integrates data from different areas within my company.	INT9_1	1.575	1.000	0.784
My dashboard system pulls together data from different departments in my company.	INT9_2	1.632	1.000	0.834
My dashboard system combines information from various departments in my company.	INT9_3	1.601	1.000	0.838
My dashboard system's data combines data from various computer systems within our company.*	INT9_4	1.596	1.000	0.906
My dashboard system integrates data from all of our databases.*	INT9_5	1.788	2.000	0.994
My dashboard system is based on a common database.*	INT9_6	1.683	1.000	0.907
Flexibility - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which a system can adapt to a variety of user needs and to changing conditions.				
My dashboard system can be adapted to meet a variety of my needs.	FLEX10_1	1.729	2.000	0.913
My dashboard system can be adjusted to any new requirements.*	FLEX10_2	1.788	2.000	0.952
My dashboard system is versatile in addressing my new desires as they arise.	FLEX10_3	1.788	2.000	0.916
My dashboard system can be organized to meet my personal needs.	FLEX10_4	1.749	1.000	0.986
I can customize my dashboard system.	FLEX10_5	1.762	1.000	1.016
My dashboard system can accommodate changes in the business environment quickly.*	FLEX10_6	1.801	2.000	0.964
Completeness - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which all possible states relevant to user population are represented in the stored information.				
My dashboard includes a complete set of information relevant to my work.*	COMP11_1	1.573	1.000	0.767
My dashboard contains a comprehensive set of information applicable to my job.*	COMP11_2	1.568	1.000	0.734
My dashboard includes the extent of information that is appropriate for my tasks.*	COMP11_3	1.560	1.000	0.752
My dashboard contains all of the relevant information for my job.*	COMP11_4	1.706	1.000	0.899
My dashboard contains the range of information important in my job.*	COMP11_5	1.465	1.000	0.670

*Dropped

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
Currency - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which the information precisely reflects the current state of the world that it represents.				
My dashboard shows the most recent information available.	CURR12_1	1.632	1.000	0.773
My dashboard displays the most current information in the system.	CURR12_2	1.639	1.000	0.863
The information reported on my dashboard is up to date.	CURR12_3	1.568	1.000	0.761
There is no delay between the occurrence of an event and my dashboard displaying the information.	CURR12_4	2.036	2.000	1.113
The information displayed by my dashboard is updated immediately as new information enters the system.	CURR12_5	1.783	2.000	0.948
Accuracy - item measures adapted from existing instruments (Nelson et al., 2005)				
The degree to which information is correct, unambiguous, meaningful, believable, and consistent.				
The information reported on my dashboard is accurate.*	ACCUR13_1	1.598	1.000	0.765
The information displayed on my dashboard is error free.*	ACCUR13_2	2.110	2.000	1.098
I am satisfied with the accuracy of my dashboard information.*	ACCUR13_3	1.627	1.000	0.747
The information presented on my dashboard is believable.*	ACCUR13_4	1.494	1.000	0.683
The information reported on my dashboard is reliable.*	ACCUR13_5	1.527	1.000	0.701
The information my dashboard displays is correct.*	ACCUR13_6	1.645	1.000	0.781
Quality of Decision-Making - item measures adapted from existing instruments (Wieder et al., 2012; Jiang and Klein, 1999)				
The quality of decision-making based on the utilization of the dashboard system.				
My dashboard has improved the effectiveness of my decisions.	QDM23_1	1.629	1.000	0.815
My dashboard has enhanced the accuracy of my decisions.	QDM23_2	1.668	2.000	0.808
My dashboard has improved the speed of my decision making.	QDM23_3	1.678	2.000	0.855
My dashboard has improved the outcomes of my decisions.	QDM23_4	1.673	1.000	0.823
My dashboard has increased the range of alternatives available to me for my decision-making.	QDM23_5	1.703	2.000	0.847
My dashboard has enhanced my level of confidence in my decisions.	QDM23_6	1.647	1.000	0.828

*Dropped

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
In-Role Performance - item measures adapted from existing instruments (Grafton et al., 2010; Burney et al, 2009 AOS; Williams and Anderson, 1991)				
Managerial performance in comparison to their performance measurement system and as described in job descriptions.				
I complete my assigned duties.	IRP24_1	1.327	1.000	0.599
I fulfill the responsibilities specified in my job description.	IRP24_2	1.330	1.000	0.569
I perform the tasks that are expected of me.*	IRP24_3	1.335	1.000	0.593
I meet the formal performance requirements of my job.	IRP24_4	1.386	1.000	0.692
I engage in the activities that directly affect my performance evaluation.*	IRP24_5	1.463	1.000	0.725
I perform the aspects of my job that I am obligated to perform.	IRP24_6	1.338	1.000	0.589
I perform the essential duties.	IRP24_7	1.350	1.000	0.654
Organizational Performance - item measures adapted from existing instruments (Yen-Chun et al.,2012; Grafton et al., 2010) **				
The perceived financial performance of the organizations.				
Relative to your business unit's stated objectives, how is your business unit performing in sales growth?	OP25_1	1.893	2.000	0.834
Relative to your major competitors in the industry, how is your business unit performing in sales growth?*	OP25_2	2.003	2.000	0.809
Relative to your business unit's stated objectives, how is your business unit performing in profitability?	OP25_3	2.000	2.000	0.853
Relative to your major competitors in the industry, how is your business unit performing in profitability?*	OP25_5	2.054	2.000	0.774
Relative to your business units expectations, how is your business unit performing?	OP25_6	1.954	2.000	0.834
Relative to your major competitors in the industry, how is your business unit's overall financial performance?	OP25_7	1.990	2.000	0.781
Overall performance of your business unit relative to expectations.	OP25_8	1.882	2.000	0.706
Strategy Alignment - item measures adapted from literature and study one.				
The extent that performance measures displayed on dashboard are tied to the strategy of the organization.				
My dashboard contains performance measures that directly represent the overall strategy of my organization.*	SA28_1	1.688	2.000	0.841
My dashboard includes performance measures that are directly associated with our corporate strategy.	SA28_2	1.696	2.000	0.872
My dashboard contains performance measures used to execute the overall strategic objectives in my organization.	SA28_3	1.639	1.000	0.817
My dashboard includes performance measures that show our organizational strategy.	SA28_4	1.624	1.000	0.807
My dashboard contains strategic performance measures developed by the corporate office.	SA28_5	1.719	1.000	0.930

*Dropped

**Item measure 4 (not shown here) was removed from the survey prior to distribution to respondents.

In order to assist with the development of the instrument, several experts were engaged, including two accounting professors and three managers from the target population, to review a draft of the survey instrument.[10] The accounting professors provided feedback regarding grammar choice and potential validity issues. Each of the three managers completed the survey in approximately 20 minutes and suggested minimal grammatical changes. Based on comments or questions raised during this review process, the instrument was revised to increase the face validity of the theoretical constructs and their associated item measures.

Measurement of Variables

In order to measure the constructs that comprise both dashboard system quality and dashboard information quality, the item measures were primarily adapted from Nelson et al. (2005). While Nelson et al. (2005) examined systems quality and information quality in the context of data warehousing, the results are applicable to a wider context of modern technologies including dashboards Following a comprehensive literature review, Nelson et al. aggregates the large number of quality attributes into six dimensions representing system quality and information quality (Wieder et al., 2013; Nelson et al., 2005). However, the actual analysis of the data in Nelson et al. (2005) only shows three item measures for each construct in their model. When utilizing path modeling to analyze data, prior research has indicated that more item measures per construct is recommended over less item measures, and more measures may lead to fewer improper solutions (Marsh et al., 1998; McDonald, 1996). Therefore, additional item measures were developed from the literature and the results of study one for each of the dashboard system quality and dashboard information quality dimensions. The remaining

[10] The managers that reviewed the initial instrument are not included in the either the pilots study samples of the sample for the analysis of the main theoretical model.

constructs, managerial decision environment, managerial performance, and organizational performance were adapted from existing validated instruments. No validated instrument was available measuring strategy alignment; therefore, the item measures were constructed based on existing literature in the areas of performance measurement/measures, strategy, and the data from study one. Additionally, the data collected in study one was utilized to help adapt all of the item measures into the context of dashboards. Each of the constructs and their associated item measures are discussed below.

Accessibility. A six-item scale was adapted from Nelson et al. (2005) to measure the degree to which the dashboard system can be accessed with a low level of effort.

Integration. A six-item scale was adapted from Nelson et al. (2005) and Barua et al, (2004) to measure the extent to which the dashboard system enables the combination of information from various sources to aid in managerial decision-making.

Flexibility the six-item scale was adapted from Nelson et al. (2005) to measure the degree a dashboard system can adapt to changing business conditions and a variety of user needs or preferences.

Completeness. A five-item scale was adapted from Nelson et al. (2005) to measure the extent that all possible states pertinent to the dashboard system users are represented in the available information.

Currency. A five-item scale was adapted from Nelson et al. (2005), Chenhall and Morris (1986), and Agbejule (2005) to measure the degree to which the information contained in the dashboard faithfully reflects the current state of the environment that is represented.

Accuracy. A six-item scale was adapted from Nelson et al. (2005) to measure the extent the information displayed on the dashboard is correct, unambiguous, meaningful, believable, and consistent.

Managerial Decision Environment. This construct was operationalized though the variable of quality of decision-making. The six-item scale for quality of decision-making was adapted from Wieder et al. (2013) and Yong-Tae (2006) to measure the effect dashboard utilization has on the quality of the managerial decision-making.

Managerial Performance. A seven-item scale was adapted from Burney et al. (2009) and Williams and Anderson (1991) to measure managerial performance in comparison to their performance measurement system and as described in job descriptions.

Organizational Performance. A seven-item scale was developed from Yen-Chen et al. (2012) and Grafton et al. (2010) to measure the perceived financial performance of the organizations.

Strategy Alignment. A five-item scale was developed specifically for this study since there were no validated scales in the literature that measures how well the performance measures contained in a dashboard system align to the organization's strategy. Items were developed based on past literature identifying the need to tie performance measures to the strategy of the organization (e.g. Kaplan and Norton, 2004, Ittner and Larker, 2003). The item measures were designed to elicit the extent that the performance measures displayed on a dashboard are linked to the strategy of the organization, either directly or through operational tactics.

Control Variable

One control variable was included in the theoretical model with a direct effect on the managerial decision environment. The measure for years working with dashboards was included as a control because a more extensive level of experience with dashboards may affect decision-making. This measure is categorical (1) 1 year or less; (2) 1 year up to 3 years; (3) 3 year up to 5 years; (4) 5 year up to 7 years; and (5) greater than 7 years.

Pilot Tests

Once the instrument was finalized, it was pilot tested (Dillman, 2009) with 51mid-level managers obtained from the national survey company. Four of the responses were dropped due to the time to complete being less than one standard deviation away from the mean (mean = 12:32 minutes; SD = 6:13 minutes). A preliminary principal components analysis (PCA) was conducted that revealed a high level of cross loadings and the individual constructs loaded on more than one factor with eigenvalues exceeding 1.0 for each factor. Revisions were made to the instrument to correct these issues and the updated instrument was reviewed again by an accounting professor. Based on the feedback received, the instrument was further revised for grammar and any validity concerns. The updated instrument was pilot tested a second time with 47 new respondents. The results for the PCA with the second pilot test data showed more convergent validity in all of the measures except for the construct of accessibility. Final adjustments were made to the instrument based on this PCA before the final data collection was begun.

Moderator Variables

In order to construct the moderator variables, the product indicator method is utilized (Chin et al., 1996, 2003; Henseler and Fassott, 2010). In this method, the moderator variable is constructed utilizing the product of each of the indicators for the independent latent variable and each indicator of the moderator variable. The resulting product indicators are the indicators for the latent moderator (interaction) construct. In order to help control for multi-collinearity when moderator variables are utilized in structural equation modeling techniques, the literature recommends that the predictor and moderator variables are mean-centered; consequently, the predictor and moderator variables for this study are mean centered (Chin et al., 1996, 2003; Little et al, 2006; Henseler and Fassett, 2010). Additionally, there is no reason to mean center the endogenous variables; therefore, the endogenous variables in this study are not mean-centered (Henseler and Fassott, 2010).[11]

Data Analysis and Results

Partial least squares (PLS), a components based structural equation modeling, is utilized to analyze the data for this study. PLS is appropriate for this study since it is used in situations that are predictive in nature and when the model is examined more on the basis of exploration than confirmation. Further, it is effective for non-normal data sets (Hair et al., 2010). The minimum sample size for analyzing the theoretical model shown in Figure 7 can be calculated utilizing 10 times the largest number of item measures associated with a latent construct in the

[11] In addition to mean centering, Little et al., (2006) recommends a method where residuals are utilized instead of product indicators to reduce the correlation between the moderator variable and the independent variables. This residual method may be utilized when mean centering is not achieving a large enough reduction in the correlations of the variables. This residual method is undertaken for this study; however, the correlations and the results did not improve the model results beyond mean centering; therefore, this study utilized the mean centering method and not the residual method.

model (Chin, 1998). The construct for managerial decision environment is measured utilizing 6 item measures; therefore, the minimum sample size for this study is 60. Based on the actual sample of 391 respondents, the sample size is ample to analyze the theoretical model.

Tests of data normality are conducted utilizing both the Kolmogorov-Smirnov and the Shapiro-Wilks normality tests. They reveal that the data for this study is not normally distributed ($p < 0.001$). Cassel et al. (1999) examined the impact of non-normal data utilized in the PLS method of analyzing theoretical models and found that results are reasonably robust to the deviations typically found in most data sets. Cassel et al.'s study found that biases are observed in the large inner structure coefficient only when there distributions are extremely skewed distributions. However, such extremely skewed distributions are rarely encountered (Cassel et al., 1999), and the level of skewness (average 1.376) and kurtosis (average 2.171) found in the data for this study is not extreme (Cameron, 2004). Therefore, this study posits that the departures from normality shown in the data can be justifiably disregarded.

Individual Item Quality

Since the scales utilized in this study are either adapted from prior research studies or developed specifically for this study, an exploratory factor analysis is conducted in SPSS statistical software determine item quality for the factors. Principal components factoring with promax rotation is utilized to identify eight factors with eigenvalues in excess of 1. The results of the PCA show that the constructs for both currency and accuracy formed one factor. The data from study one indicated that the level of accuracy is not a large concern for today's dashboard users. In contrast, the currency of dashboards is shown to have higher variability as a high percentage of the dashboards utilized by the managers are not provided in real-time (Study One).

Therefore, the currency construct appears to be more predictive of the managerial decision environment and is retained in the model while the construct of accuracy is removed from the model. The factor loadings for the completeness construct are all found to be below 0.40, so this construct is also removed from the theoretical model.

Several item measures are eliminated based on low factor loadings and/or high cross loading. The elimination of these item measures does not impact the constructs theoretical significance. The item measures that are retained exhibit factor loadings in excess of 0.50 with no cross-loading in excess of 0.30 (Hair et al., 2010). The eight factors produced by the PCA account for 63.4 percent of the total variance. Table 5 displays the rotated factor solution.

Table 5: PCA Factor Loadings – Study Two

Item Measures	FACTOR							
	1	2	3	4	5	6	7	8
Accessibility 1	-.156	.117	-.050	-.044	.002	.175	-.032	**.812**
Accessibility 3	.153	-.080	.038	-.131	.014	-.088	.038	**.874**
Accessibility 4	-.046	.009	.017	.229	-.002	.177	-.016	**.570**
Integration 1	-.095	.040	.061	-.013	-.005	.070	**.812**	.000
Integration 2	-.073	.056	.045	.018	-.034	.007	**.783**	.063
Integration 3	.061	.114	-.045	.037	.006	.004	**.741**	-.066
Flexibility 1	.246	-.213	.026	-.004	-.006	**.626**	.136	.114
Flexibility 3	.066	.041	-.058	.124	.034	**.598**	.070	.034
Flexibility 4	-.017	.112	-.013	.009	-.031	**.781**	-.044	.097
Flexibility 5	-.006	-.026	.022	-.059	-.001	**.901**	.007	-.021
Currency 1	-.022	.028	.107	**.848**	-.088	-.050	-.031	.014
Currency 2	.111	-.106	.032	**.731**	.033	-.078	.174	-.038
Currency 3	.033	.042	.070	**.807**	.040	-.128	-.045	-.002
Currency 4	-.016	.034	-.230	**.640**	.053	.172	.021	-.054
Currency 5	.044	-.060	-.011	**.637**	.023	.282	-.060	-.085
Strategy Alignment 1	**.765**	.020	.010	.011	.025	-.049	.012	.061
Strategy Alignment 2	**.807**	-.094	-.012	.073	-.037	-.031	.083	.000
Strategy Alignment 3	**.671**	.099	-.009	-.008	-.005	.080	-.047	-.027
Strategy Alignment 4	**.752**	.039	-.069	.037	.063	.012	-.043	-.082
Strategy Alignment 5	**.667**	.173	.086	.006	-.042	.126	-.172	-.079
Quality Decision-making 1	**.701**	.014	.072	-.009	-.045	.047	-.030	.107
Quality Decision-making 2	-.049	.206	**.727**	.124	-.039	-.065	-.101	.047
Quality Decision-making 3	-.010	-.025	**.721**	.063	-.023	-.104	.128	.023
Quality Decision-making 4	-.064	.024	**.769**	-.058	.106	.059	.050	-.064
Quality Decision-making 5	.121	-.051	**.786**	-.101	-.035	.111	.003	-.090
Quality Decision-making 6	.040	-.102	**.704**	.058	.083	-.022	-.019	.096
In-Role Performance 1	-.108	.142	-.040	.144	**.637**	.044	-.129	.043
In-Role Performance 2	-.090	-.067	.068	-.021	**.733**	.267	-.018	-.101
In-Role Performance 4	-.003	-.021	.102	.006	**.783**	-.068	.034	-.042
In-Role Performance 6	-.029	.008	.096	-.060	**.754**	.064	-.007	.001
In-Role Performance 7	.217	-.018	-.172	-.013	**.748**	-.297	.063	.150
Organizational Performance 1	.048	**.750**	.040	.021	-.035	-.040	.058	.044
Organizational Performance 3	-.018	**.807**	-.018	.157	-.055	-.157	.042	.049
Organizational Performance 6	.043	**.787**	.027	-.092	.045	.090	-.007	.017
Organizational Performance 7	.118	**.641**	-.091	-.127	.075	.134	.167	-.134
Organizational Performance 8	.005	**.845**	.037	-.034	.015	-.011	-.010	.013

*See Table 4 for item descriptions

Measurement Model

The measurement model is examined next to assess the convergent validity, discriminant validity, internal consistency reliability, and indicator reliability of the eight reflective constructs and the four moderator latent variables. Convergent validity evaluates the degree to which the construct captures the variance in the item measures (Hair et al., 2011). Convergent validity is assessed through each construct's average variance extracted (AVE), which measures the variance captured by the construct, The AVE should exceed 0.50 for each construct (Hair et al., 2011; Chin 1998) and each of the eight constructs has an AVE greater than 0.50 as shown in Table 6; however, the latent product indicator variable for the currency/strategy alignment moderation has an AVE of .41, which shows low convergent validity for this product indicator variable.

Discriminant validity shows the degree that measures of the constructs are empirically separate (Hair et al., 2010). Discriminant validity is analyzed in two manners: The square root of the AVE for each reflective construct should higher than the highest correlation of each construct (Hair et al., 2011; Fornell and Larcker, 1981) and the factor loading for a construct should be higher than any of the cross-loadings (Hair et al., 2011). Table 6 shows that the square root of each construct's AVE is larger than the construct's correlations. Additionally, the factor loadings are higher than cross-loadings associated with the other constructs (see Table 7). These results support the convergent and discriminant validity of the latent constructs (Hair et al., 2011; Chin, 1998; Fornell and Larker, 1981). However, there is a high level of correlation between the product indicator variable created for the moderation that mean centering is not able to fully correct. These high levels of correlation between the moderator variables may be causing multi-collinearity issues, which are further discussed in the structural model results section.

Table 6: Discriminant Validity – Study Two

		AVE	CR	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Accessibility	0.65	0.85	**0.81**												
2	Accessibility*SA	0.55	0.95	0.14	**0.74**											
3	Currency	0.59	0.88	0.42	0.03	**0.77**										
4	Currency*SA	0.41	0.95	0.02	0.40	0.10	**0.64**									
5	Flexibility	0.68	0.89	0.51	0.22	0.58	0.09	**0.82**								
6	Flexibility*SA	0.70	0.98	0.18	0.73	0.05	0.42	0.33	**0.84**							
7	Integration	0.68	0.87	0.31	0.24	0.30	0.11	0.41	0.39	**0.83**						
8	Integration*SA	0.71	0.97	0.17	0.54	0.07	0.13	0.34	0.77	0.47	**0.84**					
9	Organizational Performance	0.55	0.86	0.32	0.09	0.48	0.10	0.45	0.07	0.19	0.10	**0.74**				
10	Managerial Performance	0.58	0.87	0.20	0.00	0.18	0.05	0.16	-0.01	0.35	0.03	0.22	**0.74**			
11	Quality of Decision Making	0.59	0.90	0.42	0.13	0.60	0.18	0.61	0.16	0.42	0.22	0.48	0.36	**0.77**		
12	Strategy Alignment	0.67	0.91	0.38	0.45	0.38	0.31	0.49	0.51	0.57	0.49	0.42	0.36	0.57	**0.82**	
13	Years with Dashboard	N/A	N/A	0.00	0.04	0.02	0.05	0.03	0.06	0.04	0.07	0.00	-0.11	0.04	-0.02	**N/A**

Notes:

AVE = average variance extracted

CR = composite reliability

SA = strategy alignment

Table 7: Measurement Model Cross Loadings - Study Two

Measure	Access	Int	Flex	Curr	QDM	IRP	OP	SA
A8_1	**0.796**	0.246	0.403	0.285	0.273	0.095	0.243	0.310
A8_3	**0.795**	0.243	0.302	0.231	0.316	0.193	0.203	0.254
A8_4	**0.825**	0.257	0.506	0.453	0.395	0.164	0.319	0.338
INT9_1	0.245	**0.823**	0.327	0.216	0.312	0.334	0.138	0.450
INT9_2	0.271	**0.809**	0.321	0.221	0.317	0.297	0.126	0.451
INT9_3	0.254	**0.850**	0.362	0.293	0.392	0.272	0.193	0.507
FLEX10_1	0.439	0.356	**0.818**	0.484	0.542	0.188	0.346	0.360
FLEX10_3	0.417	0.346	**0.825**	0.514	0.518	0.107	0.407	0.440
FLEX10_4	0.451	0.327	**0.830**	0.469	0.490	0.121	0.368	0.447
FLEX10_5	0.369	0.312	**0.820**	0.420	0.457	0.110	0.352	0.369
CURR12_1	0.321	0.239	0.403	**0.766**	0.450	0.196	0.319	0.279
CURR12_2	0.331	0.305	0.424	**0.778**	0.500	0.197	0.367	0.306
CURR12_3	0.311	0.221	0.400	**0.771**	0.472	0.202	0.395	0.303
CURR12_4	0.305	0.184	0.473	**0.735**	0.405	-0.049	0.363	0.286
CURR12_5	0.328	0.189	0.520	**0.798**	0.477	0.104	0.387	0.299
QDM23_1	0.349	0.363	0.474	0.472	**0.799**	0.314	0.395	0.453
QDM23_2	0.320	0.337	0.470	0.487	**0.780**	0.271	0.342	0.399
QDM23_3	0.310	0.314	0.463	0.440	**0.743**	0.244	0.365	0.443
QDM23_4	0.282	0.275	0.455	0.475	**0.755**	0.218	0.395	0.425
QDM23_5	0.283	0.294	0.465	0.456	**0.758**	0.302	0.368	0.466
QDM23_6	0.372	0.329	0.492	0.439	**0.770**	0.302	0.355	0.428
IRP24_1	0.179	0.283	0.151	0.176	0.304	**0.767**	0.187	0.334
IRP24_2	0.145	0.288	0.073	0.106	0.229	**0.723**	0.113	0.256
IRP24_4	0.116	0.290	0.112	0.106	0.253	**0.759**	0.191	0.288
IRP24_6	0.099	0.263	0.118	0.087	0.283	**0.771**	0.125	0.256
IRP24_7	0.216	0.232	0.152	0.182	0.282	**0.736**	0.203	0.237
OP25_1	0.258	0.110	0.381	0.392	0.346	0.109	**0.737**	0.322
OP25_3	0.219	0.139	0.378	0.380	0.350	0.152	**0.745**	0.294
OP25_6	0.196	0.157	0.297	0.328	0.355	0.233	**0.748**	0.305
OP25_7	0.257	0.154	0.333	0.343	0.365	0.209	**0.757**	0.339
OP25_8	0.270	0.136	0.282	0.331	0.375	0.089	**0.734**	0.293
SA28_1	0.335	0.483	0.391	0.322	0.469	0.336	0.322	**0.815**
SA28_3	0.298	0.431	0.364	0.332	0.419	0.277	0.298	**0.784**
SA28_3	0.335	0.472	0.440	0.320	0.495	0.329	0.384	**0.853**
SA28_4	0.257	0.484	0.429	0.298	0.470	0.233	0.349	**0.795**
SA28_5	0.308	0.453	0.377	0.295	0.461	0.313	0.346	**0.837**

Access = Accessibility
Int = Integration
Flex = Flexibility
Curr = Currency
QDM = Quality of Decision
IRP = In-Role Performance
OP = Organizational Performance
SA = Strategy Alignment

The internal consistency reliability is examined through a construct's measure of composite reliability, which should exceed 0.70 (Hair et al., 2011). The constructs showed composite reliabilities ranging from 0.847 to 0.979. For the indicator reliability, the factors loadings are reviewed and should be in excess of 0.70. The factor loadings on all eight constructs range from 0.723 to 0.850.

Structural Model Results

The results of the structural model analysis are presented in Figure 8. All t-values and outer-item loadings are obtained from a bootstrap sample of 1000 iterations. The model reveals an R^2 for each of the endogenous construct, which indicates the predictive power of the models endogenous constructs. The R^2 for managerial decision environment is 56.6 percent, for managerial performance is 12.8 percent, and for organizational performance is 23.2 percent of the variance.

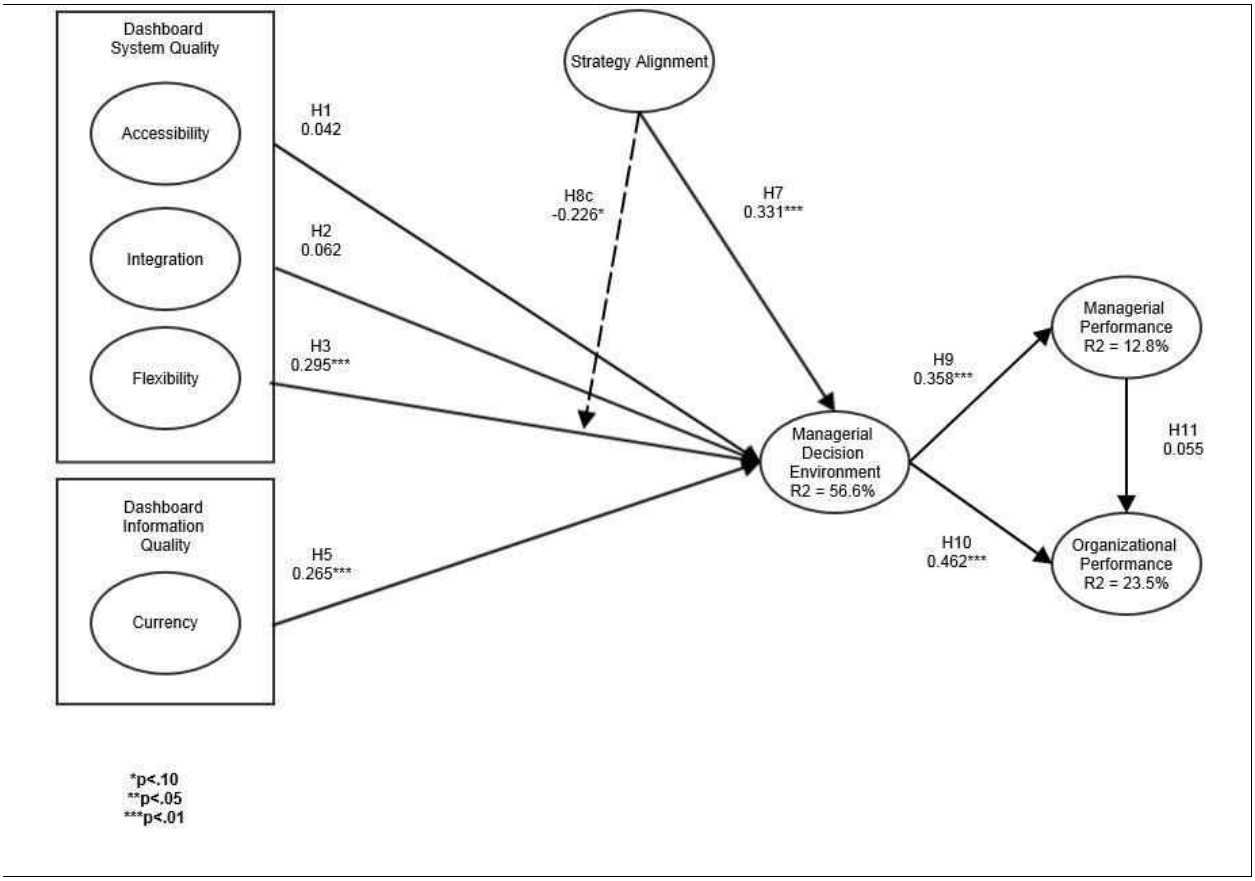

Figure 8: Model Results - Study Two

Hypothesis 1 predicts that dashboard system accessibility is positively associated with the managerial decision environment. Analysis of the model indicates an insignificant ($p > .05$) association between dashboard system accessibility and the managerial decision environment. This result indicates that increased levels of accessibility are not significantly associated with the managerial decision environment and hypothesis 1 is not supported.

Hypothesis 2 predicts that dashboard system integration is positively associated with the managerial decision environment. The model results indicate an insignificant ($p > .05$) association between dashboard system integration and the managerial decision environment.

This result indicates that increased levels of integration are not significantly associated with the managerial decision environment and hypothesis 2 is not supported.

Hypothesis 3 predicts that dashboard system flexibility is positively associated with the managerial decision environment. Analysis of the model indicates a significant association between dashboard system flexibility and the managerial decision environment ($\beta = 0.295$, $p < .01$, one tailed); therefore hypothesis 3 is supported.

Hypothesis 4 predicts that dashboard information completeness is positively associated with the managerial decision environment. Since the construct of completeness is removed from the model during the PCA, hypothesis 4 is not tested.

Hypothesis 5 predicts that dashboard system currency is positively associated with the managerial decision environment. The model results indicate a significant ($\beta = 0.265$, $p < .01$) association between dashboard system currency and the managerial decision environment. This result indicates that increased levels of currency lead to increases in the managerial decision environment and hypothesis 5 is supported.

Hypothesis 6 predicts that dashboard information accuracy is positively associated with the managerial decision environment. Since the construct of accuracy is removed from the model during the PCA, hypothesis 6 is not tested.

Hypothesis 7 predicts that strategy alignment is positively associated with the managerial decision environment. The model results indicate a significant ($\beta = 0.331$, $p < .01$) association between strategy alignment and the managerial decision environment. This result indicates that increased levels of strategy alignment lead to increases in the quality of the managerial decision environment and hypothesis 7 is supported.

Hypotheses 8a through 8f predicts that strategy alignment will moderate the relationships between the managerial decision environment and each dimension of dashboard system quality and dashboard information quality. The only dashboard quality dimension showing a moderately significant interaction relationship with strategy alignment is flexibility. The interaction between flexibility and strategy alignment is negatively associated with the managerial decision environment for managers. The hypothesis predicted that the moderation will weaken the previous direct positive association between flexibility and the managerial decision environment. The beta for the direct association is ($\beta = 0.331$, $p < .01$, one tailed) and the beta for the moderated relationship is flexibility ($\beta = -0.226$, $p < .10$, one tailed), which is weaker than the beta for the direct relationship; therefore, hypothesis 8c is supported. The negative association for the interaction variable is expected and is interpreted based on the results of study one, which found that when a dashboard contains strategy aligned performance measures, then the dashboard system exhibited a lower level of flexibility. This result occurs based on strategy objectives being developed at the top levels of an organization then diffused to the lower levels of the organization through the aid of dashboards; consequently, users are not afforded the flexibility to select or change the strategic or tactical key performance measures. When the dashboard system flexibility is high and managers can select their own performance measures, the performance measures are not associated with a high level of strategy alignment. These 'performance measures' selected under high levels of flexibility may be considered PI's or operational measures that are not linked to strategy. Overall, for all of the interaction hypotheses (8a through 8f), only H8c is supported. The lack of results associated with these hypotheses may have resulted from the higher levels of correlation between the moderator variables, specifically the correlations involving the flexibility/strategy alignment moderator.

Hypothesis 9 predicts that the managerial decision environment will be positively associated with managerial performance. Analysis of the model indicates a significant association between the managerial decision environment and the managerial performance ($\beta = 0.358$, $p < .01$, one tailed). Hypothesis 10 predicts that the managerial decision environment will be positively associated with organizational performance. Analysis of the model indicates a significant association between the managerial decision environment and organizational performance ($\beta = 0.482$, $p < .01$, one tailed). Both hypotheses 9 and 10 are supported.

Hypothesis 11 predicts that managerial performance is positively associated with organizational performance. The model results indicate an insignificant ($p > .05$) association between managerial performance and organizational performance. This result indicates that increased levels of managerial performance are not significantly associated with the organizational performance and hypothesis 11 is not supported. Lastly, the control variable of the number of years a manager has utilized dashboards is not significantly associated with the managerial decision environment.[12]

Conclusion

This study examined the antecedents and consequences of dashboards utilized in the managerial decision environment. Survey data is collected and the theoretical model is tested utilizing PLS. The results of this study reveal that the dimensions of dashboard system quality (accessibility, integration, and flexibility) and dashboard information quality (completeness, currency, and accuracy) are not strong antecedents for the managerial decision environment except for dimensions of flexibility and currency. The model shows that dashboard system

[12] For sake of clarity in the model, the statistically insignificant control variable is not shown.

flexibility and dashboard information currency is positively associated with the managerial decision environment. Further, the model examined if the dashboards qualities association with the managerial decision environment are moderated by strategic alignment of the dashboard. The only dimension that is moderated by strategy alignment is dashboard system flexibility. The hypothesis for this moderation predicts that the direct positive association will be weakened through the moderation by strategy alignment. The results show moderate support for this hypothesis and the positive beta coefficient in the direct relationship became negative for the interaction term. This result indicates that when the level of strategy alignment is high, then dashboard system flexibility is low. Conversely, when the dashboards performance measures are not highly strategy aligned, a higher level of dashboard system flexibility is associated with the managerial decision environment. Although the only significant paths are the antecedents to the managerial decision environment are limited to flexibility and currency and the moderation between flexibility and strategy alignment, the model explained more than 56.6 percent of the variance within the managerial decision environment. The managerial decision environment is positively associated with both managerial performance and organizational performance.

This study makes contributions to the both the dashboards literature and the strategy literature. This study is the first study to report the effects of recent innovations in the antecedents of dashboard system quality and dashboard information quality has on the managerial decision environment. A primary contribution is the examination of the strategy alignment at the lower levels of an organization and the results showing strategy alignment is negatively associated with system flexibility. Additionally, the study expands our understanding of the interaction between MCS (dashboards) and strategy through the examination of this phenomenon in the context of operational outcomes (the decision environment at the lower level

of the organization) away from prior research that has only viewed this relationship at the highest strategic levels (Choi et al., 2012, 2013; Cheng and Humphreys, 2012; Humphreys and Trotman, 2011; Banker et al., 2011; Tayler, 2010; Banker et al., 2004).

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STUDY THREE
THE EXAMINATION OF DASHBOARD UTILIZATION BASED ON THE ANTECEDENTS OF INFORMATION CONTENT AND TASK UNCERTAINTY AND THE CONSEQUENCES OF USER SATISFACTION AND PERFORMANCE

Introduction

A digital dashboard (also known as a 'dashboard') is a visual digital display that contains key information or measures necessary to the achievement of managerial and/or organizational level objectives and it is designed to be viewed at a glance (Few, 2005). Managers utilize dashboards in their daily work-life to accomplish an array of tasks and activities; and prior information system (IS) research indicates that the level of utilization is dependent upon the users belief that their utilization will improve their performance (Bokhari, 2005). As shown in study one, managers utilize dashboards for one, some, or all of the following different types of activities: making decision, verifying prior decisions, guiding activities, monitoring personal performance, managing overall work, achieving the goals and objectives of the organization, managing subordinates, informing superiors, analyzing trends, and getting feedback on new initiatives. Prior research examining IS has linked utilization to user satisfaction (Teo and Wong, 1998; Goodhue and Thompson, 1995) and user satisfaction to managerial/organizational performance (Hou, 2012).

When using various types of IS, user satisfaction is conditioned upon the usefulness of the information. As technology provides managers with the information useful to complete their tasks, managerial performance improves through higher levels of utilization and user satisfaction (Frezatti et al., 2006; Chang et al., 2003). For information to be useful to managers, the information does not need to be provided to managers in large quantities. On the contrary, when managers receive large quantities of information, lower levels of utilization and performance

may result (McKinnon and Bruns, 1992). The usefulness of information provided through dashboards is dependent upon the 'content' of the information versus the quantity of information. As the practice related literature reveals, providing managers with information content that contain just a few key measures that are relevant to personal and organizational objectives has a greater impact on the extent of utilization versus just providing volumes of information (Miller and Cioffi, 2004; Clark et al., 2006; LaPointe, 2008).

The selection of these relevant key measures that constitute useful information content does not occur automatically. In fact, designing dashboards that contain the necessary information content is a very deliberate undertaking since dashboard designers have access to an extraordinary amount of information content that can be placed on a dashboard for managers to access and utilize to complete their portfolio of tasks. BI software, typically the platform for operating dashboards, can contain up to 500 pre-programmed key performance indicators (KPI's) measurements, 200 reports, and 2,900 analytics attempting to solve vital business questions and issues (Elbashir et al., 2011). Condensing the information content to only the vital information that matches the tasks being performed is imperative in order to increase the utilization of the information so that managers effectively perform their work (Ittner and Larcker, 2003).

The purpose of this study is to examine how the fit between dashboard information content and task uncertainty impacts managers' utilization of digital dashboards, and subsequently, user satisfaction and performance. This level of 'fit' is examined through the lens of task-technology fit (TTF) theory, which predicts that a high level of fit between technology and tasks leads to higher levels of utilization, user satisfaction, and performance (Goodhue and Thompson, 1995; Lim and Benbasat, 2000). Prior research has used the interaction of technology

and task to measure TTF (Dishaw and Strong, 1998, 2003), and this study is consistent with prior research by using the interaction of dashboard information content and task uncertainty to determine TTF.

This study is important to the emerging line of dashboard research since more managers throughout organizations utilize dashboards on a daily basis. The utilization of the dashboard is changing how managers receive their information, and academics and practitioners need to understand the antecedents and consequences of this utilization. Additionally, empirical research that examines the managerial utilization of dashboard is limited (Yigitbasioglu and Velcu, 2012). Prior literature concentrating on dashboards is primarily practice oriented and has concentrated on dashboard design, dashboard implementations, and the presentation format of the information (Yigitbasioglu and Velcu, 2012; Ballou et al., 2010; LaPointe, 2008; Few, 2005, 2006; Clark et al., 2006; Wind, 2005; Brath and Peter, 2005; Miller and Coiffi, 2004; DeBusk et al., 2003). Therefore, this study will fill a gap in the literature by providing empirical evidence of dashboard utilization as well as the associated antecedents and consequences.

A theoretical model is developed based on TTF and analyzed using components based structural equation modeling. Since dashboards are becoming more diffused throughout organizations (Study One), how the higher level decision-makers are utilizing dashboards is important to understand; therefore, this study focuses on dashboard users who are in middle to upper management. The data for the theoretical model is collected from 391 middle to upper level managers who utilize dashboards in their weekly work life. A survey is used to collect the data from these managers regarding the following information about themselves and their dashboard utilization: dashboard utilization, dashboard information content (information scope and KPI's), tasks (task difficulty and task variability), user satisfaction, and managerial

performance. The results from the analysis of the theoretical model show that the relationships of dashboard information content (information scope and KPI's) and task uncertainty (task difficulty and task variability) are both directly and positively associated with the extent of dashboard utilization. However, the interaction between the dimensions of dashboard information content and task uncertainty, which are the measures of the level of TTF, are not significantly associated with the extent of dashboard utilization. This lack of statistical significance may be related to poor estimation of the interaction variables due to high levels of correlation and low convergent validity. The consequences of user satisfaction and managerial performance are both positively associated with the extent of dashboard utilization.

A second model is constructed in the additional analysis section that examines the level of TTF as measured through the mediation of dashboard information content and task uncertainty as opposed to the interaction of the variables. The new model that predicts the extent of dashboard utilization directly from dashboard information content and this relationship is governed (mediated) by the level of task uncertainty associated with the portfolio of task performed by managers. This additional analysis model also shows the consequences of dashboard utilization are user satisfaction and managerial performance. The results indicate strong support for TTF operationalized as tasks mediating the relationship between dashboard information content and the extent of utilization.

The primary contribution of this study is empirically showing that higher levels of dashboard utilization based on the antecedent of TTF increase managerial satisfaction and managerial performance. This study is the first to empirically report on the antecedents and consequences of managerial utilization of dashboards. Additionally, this study extends research in the area of TTF to include the construct of information 'content' and this research adds to

limited research in the area of the behavioral effects of business intelligence (BI) enabled software. Lastly, this research empirically confirms the practice related literature that shows higher levels of performance associated with dashboard information content linked to organizational goals and objectives.

The remainder of this paper is organized as follows: Section 2 discusses the background, theory, and hypotheses development. Section 3 provides research methods. Section 4 shows the data analysis and results. Section 5 provides a summary and concludes the paper.

Background, Theory & Hypotheses

The information content of today's dashboard content can be customized to match the manager's organizational role and level of task uncertainties. However, dashboard designers may not be properly trained in the subtleties of dashboard design, which can result in a dashboard that does not provide a fit between the dashboard's information content and the level of task uncertainty associated with the portfolio of tasks performed by managers. For technology to have a positive effect on the extent of utilization, the technology needs to fit with the portfolio of tasks performed (Lim and Benbasat, 2000; Goodhue, 1998). TTF is an individual level theory that concentrates on the user of information that is provided through the technology to support decision-making; therefore, the positive consequence of a high level of TTF is the prediction of user satisfaction and manager performance (Goodhue et al., 1997, 2000). TTF is an appropriate lens to use to understand dashboards based on prior research showing that middle to upper level managers exhibit higher levels of TTF when their reporting systems provided regularly scheduled reports (Vlahos et al., 2004).

The theory of TTF is comprised of five primary constructs and their relationships. These five constructs include the following: technology, task, utilization, user satisfaction, and individual performance (Cane and McCarthy, 2009). This study examines all five of the primary constructs denoted by the theory of TTF. Technology is the tool utilized to perform tasks. For this study, the dashboard's information content is examined as the enabling technology for managers. Tasks are viewed as the actions taken by managers during the transformation of inputs into outputs. TTF assesses the portfolio of tasks performed by managers based on whether the tasks are routine or non-routine (Goodhue and Thompson, 1995). Non-routine tasks are viewed as unfamiliar, unexpected, and/or ill-defined; and the non-routine tasks result in a variety of contexts for managers' completing their portfolio of tasks. The task construct defined in TTF is equivalent to the task uncertainty construct examined in the managerial budgeting literature (Brownell and Dunk, 1991); therefore, the examination of the task construct for TTF through the lens of level of task uncertainty associated with the portfolio of tasks completed by managers is appropriate.

Utilization signifies the action of the manager performing their portfolio of tasks with the technology, while user satisfaction is the user evaluation of the system and indicates how satisfied users are with the technology. Individual performance is the resulting improvements in efficiency, effectiveness, or quality of the tasks performed (Goodhue and Thompson, 1995; Cane and McCarthy, 2009). Each of these theoretical constructs are examined in this study and reviewed below. Figure 9 shows the theoretical model depicting the theoretical constructs and their relationships.

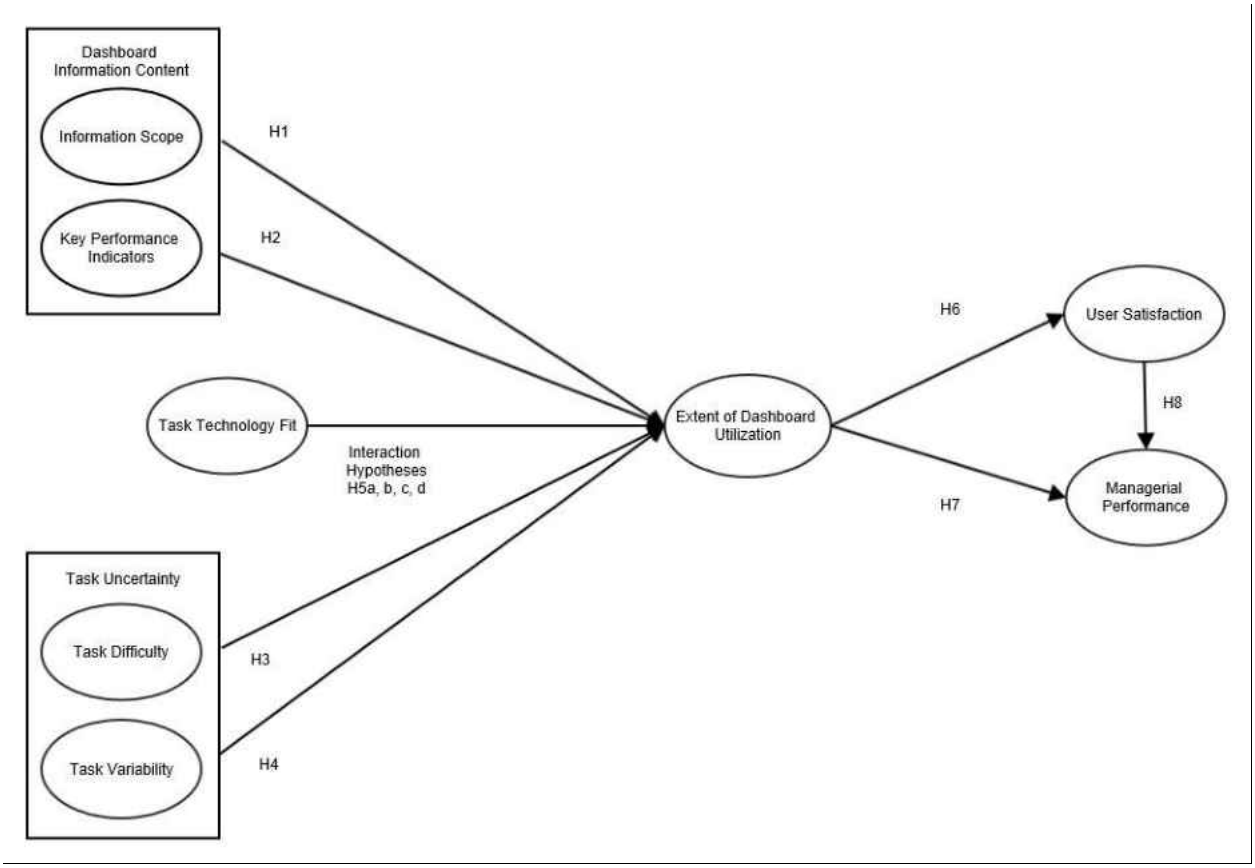

Figure 9: Theoretical Model – Study Three

Extent of Dashboard Utilization

The primary construct of interest in this study is the utilization of dashboards based on the antecedent of fit between the dashboard information content and task uncertainty. Therefore, the extent of dashboard utilization is reviewed first, since the other constructs act as antecedents and consequences to utilization. Dashboard utilization is the managerial "behavior of employing the technology in completing tasks" (Goodhue and Thompson, 1995: 218). Based on TTF, dashboard utilization is predicated upon the managers' beliefs about the consequences of utilizing the dashboard (Goodhue and Thompson, 1995). If managers believe that dashboard utilization will improve their performance, then their dashboard utilization will increase,

otherwise, they may avoid the utilizing the dashboard (Bokhari, 2005). As shown in study one, dashboard utilization is typically a voluntary choice made by the individual manager. According to Rom and Rohde (2007), managers receive training and instruction on how to use technology (dashboards); however, the managers' behavior as well as the extent they utilize the full functionality of the technology is at their own discretion. For this study, the choice of utilization is posited to be contingent upon the antecedent of TTF between the dashboard's information content and the level of task uncertainty exhibited by the managerial tasks.

The majority of prior TTF research simply measures usage, without digging deeper into how extensively a system is utilized. The association between the usage of IT and individual benefits has been a constant critique of the utilization variable in the literature (DeLone and McLean, 2003). A call for a more considered implementation of the utilization construct has been issued, which includes the nature and extent of the utilization of the dashboard system (DeLone and McLean, 2003). The results for the research presented in study one show that managers can utilize dashboards for a multitude of tasks and activities; therefore, this study examines of the extent of dashboard utilization based on the range of activities and tasks managers use dashboards to support. Overall, this construct of the extent of dashboard utilization is posited to be the primary construct in this study, which is impacted by the antecedent of TTF, and utilization leads to the consequences of user satisfaction and managerial performance.

Dashboard Information Content

Over 30 years ago, research suggested that management accounting systems needed to provide managers with information content that is dynamic and externally focused (Amey, 1979). Innovations in integrated information systems (IIS), specifically through dashboards, have

changed the range of information content that managers can access and utilize for task completion. Dashboards are currently capable of displaying management accounting information (MAI) content that is differentiated by the following two characteristics: information scope and KPI's.

Information Scope

The scope of information provided through dashboards is comprised of the following three dimensions: quantification (financial and/or non-financial), focus (internal and/or external), and time horizon (historical and/or future oriented). The level of information scope is measured as being either broad or narrow based on which dimensions are represented in the information (Chenhall and Morris, 1986). Narrow scope information content relies upon internal financial information that is historical in nature (Chenhall and Morris, 1986). Broader scope MAI provides information that contains the narrow scope dimension as well as the following dimensions: external focus, non-financial quantification, a time horizon that is oriented to the future, and a larger range of possible solutions for consideration (Chenhall and Morris, 1986; Bouwens & Abernethy, 2000). Since IIS is capable of capturing, analyzing, and presenting the full spectrum of MAI scope through dashboards, managers can receive information content that contains both financial and non-financial information (DeBusk et al., 2003), both short-term and long-term information (Clark et al., 2006), as well as internal and external information. Prior research examining 'information scope' as a single construct (instead of the separate dimensions of focus, quantification, and time horizon) has identified positive associations with both utilization and performance (Chong, 1996; Hoque, 2005; Lau and Moser, 2008). The results for the cross-sectional field study conducted in study one revealed that dashboards contain few external

measures, and a low level of forward looking information (i.e. future trends and probabilities of events occurring based on the real-time analysis of current data, which does not includes items such as projected budget numbers for the upcoming year), resulting in dashboards that primarily contain both financial and non-financial information that is internally focused and historical in nature.

Financial and non-financial information is the first dimension of information scope. The provision of non-financial information for the management of the day-to-day operations of an organization has been the subject of extensive research over the last two decades (Johnson and Kaplan, 1987; McKinnon and Bruns, 1992; Kaplan and Norton, 1992; Vaivio, 1999; Ittner and Larcker, 2003, 2004; Cardinaels and van Veen-Dirks, 2010; Ndlovu, 2010). Non-financial information is needed for the shorter term operational activities such guiding daily actions and make decisions concerning, while financial information is needed for longer-term actions and decisions (Bruns and McKinnon, 1993). The majority of prior research in the area of non-financial information concentrates on how non-financial performance measures impact individual performance evaluations/incentives (Cardinaels and van Veen-Dirks, 2010; Ndlovu, 2010; Baiman & Baldenius, 2009; Campbell, 2008), which is unrelated to this study. Research examining non-financial performance measures in association with organizational performance only provides limited support for a link between non-financial performance measures and organizational performance (Banker & Mashruwala, 2007; Ittner and Larcker, 1998; Perera et al., 1997).

The second dimension of information scope is the internal and external focus of the information content. The MAI presented on dashboards can be internal, external, or a combination of both. Innovations in IIS, such as cloud computing, now offer organizations the

ability to cultivate and provide external information for managers automatically; therefore, the dashboards have the capability to report external economic (such as gross national product, total market sales, and a company's share of that market) or noneconomic (such as demographic factors, consumer tastes, competitors' actions, inter-firm comparison, and technological advances) information (Mendelson and Pillai, 1999; Tambe et al., 2011). Organizational use of externally focused information is not a new phenomenon; however, ISs have changed the manner in which this type of information can be automatically gathered, processed, and presented. As early as 30 years ago, the importance of delivering external information through the IS is recognized by Ewusi-Mensah, (1981: 302):

> An organization's information system, which has as its main responsibilities the selective gathering, memorization, processing and communication of information for decision-making purposes, must necessarily reflect the total picture presented by the organization and its surrounding environment.

Prior research has shown that externally focused organizations are associated with higher levels of performance (Mendelson and Pillai, 1999; Tambe et al., 2011). However, no research in the dashboard literature has examined information focus; therefore, based on TTF and these related studies, this study posits that dashboards that include both internal and external information will be better able to assist managers to cope with the level of task uncertainty leading to a higher extent of dashboard utilization.

The third dimension of information scope is time horizon. According to McKinnon and Bruns, managerial "information wants change based on the time horizon" of the tasks performed (1992: 19). No research has specifically examined information time horizon in relation to utilization of either the information or system providing the information content; however, this study posits that as managers receive more forward looking information on their dashboards, their task performance will increase leading to improved levels of dashboard utilization.

Based on the theory of TTF, the technology provisioned to managers must be aligned (fit) with the level of task uncertainty associated with the portfolio of tasks managers need to perform to achieve a high level of dashboard utilization (Goodhue and Thompson, 1995). This study posits that dashboards that contain broad scope information are more capable of providing the support managers need based on the level of task uncertainty associated with their tasks, and will thus achieve a higher level of utilization:

H1: Information scope is positively associated with the extent of dashboard utilization.

Key Performance Indicators

KPI's are indicators that are linked or mapped to organizational goals and objectives. Performance indicators (PI) are aggregated summary measures displayed on dashboards utilized to support the operations of the organization in isolation of the organizational goals or objectives (Cokins, 2010). The difference between KPI's and PI's is that the former are linked to organization goals and objectives, whereas, the latter are merely summary metrics of activities that are not mapped to these goals or objectives (Cokins. 2010). The importance of the mapping of the KPI's (also known as creating a causal chain) is the highlighting of the cause and effect relationships between the organizational objectives and the actual activities or processes that drive the objectives (Ittner and Larcker, 2003; Tayler, 2010; Cheng and Humphreys 2012). The primary function for a dashboard is to present KPI's linked to operational tactics or organizational objectives (La Pointe, 2008; Wind 2005; Miller and Cioffi, 2004).

Study one shows that the dashboards utilized by managers contain one of three types of indicators: 1.) KPI's linked directly to organizational objectives; 2.) KPI's indirectly linked to the organizational objectives through operational tactics; and 3.) PI's not linked to organizational

objectives. The results of the study in study one show that when KPI's (type 1 and type 2 as defined above) included on dashboards are part of the organization's interactive management control system, the extent of dashboard utilization improves. Additional research links KPI's to higher levels of performance. Organizations that have instituted KPI's in their organization show a 2.95 percent higher return on assets and a 5.14 percent return on equity (Gartner, 2011), although less than 30 percent of the organizations actually link KPI's to objectives and goals (Ittner and Larcker, 2003). Prior research has noted that one of the primary causes of dashboard failures is the lack of relevancy of the indicators contained on the dashboard and/or not including KPI's (LaPointe, 2008).

Dashboards are a great platform for organizations to consistently keep managers informed of the status of relevant KPI's in an easy to access and understandable format. However, the practice oriented literature shows that designing and implementing effective dashboards containing properly linked performance indicators (KPI's) requires substantial time and effort on the part of top management (Miller and Cioffi, 2004; Clark et al., 2006; LaPointe, 2008). The payoff for developing important and relevant KPI's for dashboards is a higher level of managerial utilization. TTF predicts that technology must match the level of task uncertainty exhibited by the portfolio of tasks performed by managers in order to increase utilization of the technology (Goodhue and Thompson, 1995). This study posits that when a dashboard contains indicators that are associated with the organizational goals or objectives that managers will be more effective managing the level of task uncertainty associated with their portfolio of tasks through higher levels of dashboard utilization:

H2: KPI's are positively associated with extent of dashboard utilization.

Task Uncertainty

The 'uncertainty' aspect of task uncertainty' is related to the absence of information that causes managers to search for additional information to complete their tasks (Guo, 2011). Higher levels of uncertainty may result in the inability to accurately predict the outcome of a decision (Karimi et al., 2004; Tushman and Tushman 1978). In order for organizations to be effective, uncertainty must be tolerated and managed (Karimi et al., 2004). Prior TTF research has included uncertainty reduction as a dimension of TTF (D'Ambra and Wilson, 2004a, 2004b). The dimension of uncertainty reduction is positively associated with perceived performance (D'Ambra and Wilson, 2004b). Further, today's organizations experience less market stability based on shortened product design and life cycles, technological innovations, and frequent entry by unexpected outsiders, which causes the level of uncertainty to continually escalate to higher levels (D'Aveni, 1994).

When uncertainty is viewed through the tasks completed by managers, it is defined as the "degree of experienced indeterminability of task process and outcomes" (Guo, 2011: 138). Based on the need for fit between technology and tasks as modeled in TTF theory, the level of task uncertainty in the portfolio of managerial tasks should moderate how the dashboard information content impacts the extent of dashboard utilization (Dishaw and Strong, 1998, 2003). This study posits that the provision of information through dashboards helps to offset the increased task uncertainties experienced by managers.

Task uncertainty is comprised of two distinct dimensions: task variability and task difficulty (Perrow, 1967; Van de Ven and Delbecq, 1974; Brownell and Dunk, 1991). Task difficulty is the analyzability of the work and the degree to which procedures have been developed that define the steps required to complete a task (Van de Ven and Delbecq, 1974;

Gelderman, 2002). According to Perrow (1967), task difficulty includes the level of complexity involved in the search process undertaken to perform a task, the extent of time spent solving business related problems, and amount of available knowledge that can be easily accessed to support the performance of tasks. Task variability concerns the number of exceptional situations that require different procedures or routines for completing the task (Van de Ven and Delbecq, 1977). Highly variable tasks may encompass a wide variety of problems and types of decisions; therefore, the content of the information captured and processed is required to have a broader scope and less uniformity (Ghani, 1992).

Prior research examining task uncertainty has operationalized task uncertainty using two methods: 1.) a composite measure for task uncertainty or 2.) through the two dimensions of task variability and task difficulty separately. Earlier studies posited that these two dimensions should not be combined into a single composite measure for task uncertainty since the two dimensions are clearly independent and have differing theoretical outcomes (Van de Ven and Delbecq, 1974; Brownell and Dunk, 1991). In Brownell and Dunk's study, the distinct theoretical roles of task variability and task difficulty are investigated separately to understand how the results of their prior research differed when these two dimensions are used instead of a composite measure. Although the results showed differences between the composite measure and the two individual measures of the task difficulty and task variability dimensions, the authors "stopped short of any clear statement of advocacy for one or another measure of task uncertainty" (Brownell and Dunk, 1991: 702). The task uncertainty measurement conflict remains unresolved in the literature today; therefore, this study will take a conservative approach and utilize the two dimensions separately to operationalize task uncertainty in the theoretical model in order to understand how each dimension may interact differently with information content.

In the context of high levels of uncertainty, the TTF literature stream has generally indicated that information content is positively associated with utilization and performance. (Daft and Macintosh, 1981; Gordon and Naranyan 1984; Govindarajan 1984; Govindarajan and Gupta 1985; Chenhall and Morris, 1986; Gul, 1991; Mia, 1993; Gul and Chia, 1994; Chong, 1996; Abemethy and Brownell 1997; Agbejule, 2005). In a study examining management support systems (MSS), the results reveal that when task difficulty is high, users are less satisfied with their MSS. The author posits that these results may have occurred because managers still lack the information content they need to perform their work (Gelderman, 2002); however, dashboards should solve this issue. In another study examining task variability and broad scope information, the results show that highly variable tasks completed with broad scope information content are positively associated with user satisfaction in the accounting information system (Chang et al., 2003). Additionally, when the level of task uncertainty is high, the search for information by managers is broader and deeper as well as more reliant upon external sources of information (Guo, 2011). This study posits that when managers work in an environment where their portfolio of tasks contain higher levels of uncertainty, then managers will rely on their dashboard more heavily through more extensively utilization to compensate for the level of uncertainty. Therefore, this study hypothesizes that both task difficulty and task variability will be positively associated with the extent of dashboard utilization.

H3: Task Difficulty is positively associated with extent of dashboard utilization.
H4: Task Variability is positively associated with extent of dashboard utilization.

Measurement of TTF – Interaction between Dashboard Information Content and Task Uncertainty

The initial four hypotheses in this study posit that the two dimensions of dashboard information content and the two dimensions of task uncertainty are positively associated with the

extent of dashboard utilization. In order to examine the level of TTF for this study, Dishaw and Strong's (1998, 2003) approach to measuring TTF is utilized. Dishaw and Strong measure TTF as the interaction between technology and task to predict utilization.[13] Therefore, according to TTF, this study posits that the interactions between the dimensions of dashboard information content (scope of information and KPI) and the extent of dashboard utilization will be moderated by task uncertainty (task difficulty and task variability). Although the results for previous research discussed above are not specific to dashboards, they are relevant to the consequences of TTF (utilization, user satisfaction, and performance) and may drive the interaction of dashboard information content and task uncertainty. Therefore, this study posits that the level TTF experienced by managers as measured by the interaction between task uncertainty and dashboard information content determines the extent of dashboard utilization. Therefore, the following hypotheses are set forth:

H5a: The higher the level of task difficulty, the stronger the positive association between the scope of information and the extent of dashboard utilization.

H5b: The higher the level of task difficulty, the stronger the positive association between KPI's and the extent of dashboard utilization.

H5c: The higher the level of task variability, the stronger the positive association between the scope of information and the extent of dashboard utilization.

H5d: The higher the level of task variability, the stronger the positive association between KPI's and the extent of dashboard utilization.

User Satisfaction

User satisfaction is defined as "an affective attitude towards a specific computer application by someone who interacts with the application directly" (Doll and Torkzadeh, 1988,

[13] Although the terminology of 'interaction' is used in prior literature to describe the new variable that measures TTF, in this study, the interaction variable is labeled in the theoretical model as the moderator variable. The moderator variable is comprised of the interaction between task uncertainty and dashboard information content.

p. 261). As viewed through the lens of TTF, the fit between dashboard information content and task uncertainty is an antecedent to user satisfaction based on a manager's utilization of the dashboard to obtain their information (Goodhue, 1998). User satisfaction has been studied extensively in prior research and it is one of the predominate measures in DeLone and McLean's (1992, 2003) IS Success Model. According to Bokhari (2005), prior research in this literature stream examining the relationship between utilization of systems and user satisfaction has revealed results that are mixed and inconclusive; however, in the author's meta-analysis conducted almost a decade ago, a significant positive relationship between utilization and user satisfaction is indicated. Prior literature acknowledges the close, interrelated nature of the relationship between utilization and user satisfaction. When these two constructs are examined in a process model, utilization precedes user satisfaction (DeLone and McLean, 2003); therefore, this study views user satisfaction as a consequence of the extent of dashboard utilization in the TTF model.

Prior research in the area of end user satisfaction is extensive; however, research in the area that focuses on dashboards, dashboard information content, and/or task uncertainty is limited. Research has indicated that high levels of user satisfaction are achieved through the provision of high quality information content in uncertain environments (Chang et al., 2003). A high level of user satisfaction is experienced by managers when they utilize a MAI system that allows them to obtain useful information content (Frezatti et al., 2006). Another study in the BI context examined system utilization and user satisfaction and found that system utilization is positively associated with user satisfaction, which leads to higher levels of managerial performance (Hou, 2012). Subsequent research examined the scope of information and the impact of utilization on user satisfaction. Interestingly, user satisfaction is found to be negatively

associated with utilization in a BI context (Wieder et al., 2013). Overall, based on TTF theory, this study posits that user satisfaction will be positively affected by the extent of dashboard utilization. Therefore, the following hypothesis is proposed:

H6: User satisfaction is positively associated with the extent of dashboard utilization.

Managerial Personal Performance

The underlying premise of TTF theory predicts improved managerial performance based on the utilization of technology, which is predicated upon the antecedent of fit between the technologies meeting the task needs of the manager (Goodhue et al., 1997). If dashboards provide information content that is useful to managers, higher levels of managerial performance through dashboard utilization and user satisfaction will result. Prior research in the dashboard/BI stream of literature has linked system utilization to user satisfaction and performance (Hou, 2012; Wieder, 2013).

Research examining information content (information scope and KPI's) and the task uncertainty constructs in relation to managerial performance generally show a positive association between information content and task uncertainty leading to higher levels of performance. In a study investigating impacts to managerial performance through the scope of information utilized under differing levels of task uncertainty, the results indicate that broad scope information is positively associated with managerial performance under higher levels of task uncertainty (Chong, 1996; Hoque, 2005). Non-financial performance measures indirectly impact managerial performance through procedural fairness and organizational commitment (Lau and Moser, 2008). The use of KPI's in organizations is associated with higher level of organizational performance (Ittner and Larker, 2003, 2004). The utilization of KPI's is

associated with managerial performance indirectly through organizational justice (Burney et al., 2009).

Prior research has also shown a direct link between user satisfaction and managerial performance. In a study examining the impact of IT on the individual user, the results indicate that user satisfaction has the strongest direct effect on managerial performance (Igbaria and Tan, 1997) and user satisfaction leads to managerial performance (Tarafdar & Ragu-Nathan, 2010). Overall, TTF is viewed as the antecedent to utilization, user satisfaction, and performance to assist managers meet their information needs (Goodhue, 1998). Based on TTF theory, this study posits that both dashboard utilization and user satisfaction improves managerial performance. Therefore, the following hypotheses are proposed:

H7: Managerial performance is positively associated with the extent of dashboard utilization.

H8: Managerial performance is positively associated with user satisfaction.

Research Methods

This study examines the extent of dashboard utilization by middle to upper level managers based on the antecedent of the TTF of dashboard information content and task uncertainty, and the resulting consequence of user satisfaction and managerial performance. Data collection is accomplished over a four consecutive day period. The subsequent subsections show the respondent demographics, instrument development, data analysis, and results.

Respondents

In order to study the phenomenon of dashboard utilization by middle to upper level managers, the respondents needed to meet the following criteria: utilize dashboards in their daily

or weekly work life; be in upper to middle level management positions; work in a functional area of the organization that is operational and not IT oriented, and finally, their office needed to be located in the United States to eliminate any possible cultural effects. A national survey firm was utilized to reach the target population of managers for this study. E-mail solicitations were transmitted to 26,000 potential respondents through the survey firm. From the 26,000 asked to take the survey, 3,087 responds were received. Of the 3,087, 694 respondents passed the screening criteria and were allowed to take the survey.

Three 'disqualification' questions were placed in the survey in order to ensure that the respondents were actively engaged and understand the survey questions. One was placed at about the 25 percent complete point, one at about the 50 percent complete point, and one at about the 75 percent complete point. The disqualification questions were worded as "Please select 'no basis for responding' (or 'disagree') as your answer to this question". If the respondent marked the incorrect response, they were not allowed to complete the survey. The 'disqualification' questions eliminated another 294 respondents, which left 400 respondents.[14] An additional 9 respondents were eliminated for excessively selecting the 'no basis for answering' response. Respondents were removed from this study if this response comprised more than 10 percent of their total answers or if this response is selected for more than 2 item measures in a construct.[15] The final sample consisted of 391 respondents. The average completion time for the survey is 14:50 minutes and the median time to complete is 12:30 minutes.[16]

Table 8 shows the data for the respondents' demographics. The average age for the

[14]The target for data collection was to 400 responses. Consequently, when 400 responses were received, the survey was closed. Therefore, the calculation of a response rate is meaningless.
[15] Another 35 respondents selected 'no basis for answering' either once or twice throughout the completion of their survey; consequently, mean replacement is utilized 45 times to replace the 'no basis for answering' reply.
[16] Respondents who completed the survey in less than six minutes were also disqualified, and their answers were not recorded.

respondents is 37.9 years, and 269 (68.8 percent) out of the 391 respondents are male. A large portion of the respondents (n=289; 73.9 percent) earned a four year college degree or higher. The largest set of respondents work in functional areas from the operational side of the business: manufacturing (n=99, 25.3 percent), operations management (n=123, 31.5 percent), and project management (n=34, 8.7 percent). The years of experience with the current organization averaged 5 to 10 years (n=183, 46.8 percent). Most of the respondents show experience with dashboards in excess of 1 year, but less than 5 years (n=244, 62.4 percent); and they work for mid-size organizations with annual revenues of $10 million through $500 million (n=284, 72.6 percent) as well as less than 5,000 employees (n=329. 84.1 percent). Lastly, the respondents are drawn from a diverse set of industries, including chemical (1.0 percent) finance (13.0%), healthcare (11.0 percent), manufacturing (35.3 percent), service (5.6 percent), technology (8.4 percent), transportation (6.1 percent) utilities (3.3 percent) wholesale/retail (12.0 percent), and other (4.1 percent).

Table 8: Demographic Data - Study Three

Variable	n	%
Average age in years	37.9	
Gender		
Male	269	68.8%
Female	122	31.2%
Highest Education		
Some High School	0	0.0%
High school graduate/diploma	15	3.8%
Some college courses or technical school courses	44	11.3%
2 year College Degree	43	11.0%
4 year College Degree	215	55.0%
Master's Degree or higher	74	18.9%
Functional Area		
Accounting	13	3.3%
Financial Services	38	9.7%
Healthcare Management	34	8.7%
Manufacturing/Production	99	25.3%
Operations Management	123	31.5%
Project Management	34	8.7%
Purchasing	9	2.3%
Sales/Marketing	41	10.5%
Years of Experience with Current Organization		
2 Year or Less	21	5.4%
2 Year up to 5 Years	82	21.0%
5 Year up to 10 Years	183	46.8%
10 Year up to 20 Years	88	22.5%
Greater than 20 Years	17	4.3%
Years of Dashboard Utilization		
1 Year or Less	20	5.1%
1 Year up to 3 Years	108	27.6%
3 Year up to 5 Years	136	34.8%
5 Year up to 7 Years	87	22.3%
Greater than 7 Years	40	10.2%
Organizational Size by Number of Employees		
250 up to 1,000	175	44.8%
1,000 up to 5,000	154	39.4%
5,001 up to 10,000	33	8.4%
More than 10,000	29	7.4%
Organizational Size by Annual Revenue		
Less than $10 million	47	12.0%
$10 million up to $100 million	144	36.8%
$100 million up to $500 million	140	35.8%
Greater than $500 Million	60	15.3%
Industry		
Chemical	4	1.0%
Finance	51	13.0%
Health care	43	11.0%
Manufacturing	138	35.3%
Service	22	5.6%
Technology	33	8.4%
Transportation	24	6.1%
Utilities	13	3.3%
Wholesale/Retail	47	12.0%
Other	16	4.1%

Total Sample: n =391

Survey Development

As shown in Figure 9, this study investigates the following theoretical constructs: dashboard information content, task uncertainty, extent of dashboard utilization, user satisfaction, and managerial performance. This study measures the theoretical constructs using multi-item scales adapted from prior studies. All of the scales utilized were adapted from validated instruments except for the item measures for the two constructs of KPI and extent of dashboard utilization constructs, since no prior validated instrument was available. The development of the item measures for these two constructs was based on the review of prior literature and the results of the study in study one. The item measures for all of the constructs were reflective and they were detailed in Table 9. The complete instrument is included in the Appendix. Five point Likert scales were utilized to collect the respondent's response for each item measure. All of the theoretical constructs except organizational performance were measured based on the scale where 1 is the positive response for 'agree' through 5 for the negative response of 'disagree'. Additionally, all questions allowed for the option of number 6, which represents "no basis for answering". The item measures for organizational performance were anchored by (1) well above average through (5) well below average as well as (6) no basis for answering.

Table 9: Item Measure Descriptions - Study Three

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
Information Scope (Chenhall and Morris, 1986; Chong, 2004; Gilbert and Reid, 2009)				
Comprised of the level of quantification, (financial/non-financial), time horizon (short-term/long-term), and focus (internal/external)				
My dashboard reports information that relates to possible future events such as potential trends in sales, profits, expenses, cash flow etc.	S14_1	1.895	2.000	1.133
My dashboard shows information that quantifies the likelihood of future events occurring (e.g., probability estimates).	S14_2	2.018	2.000	1.140
My dashboard presents non-economic information, such as customer preferences, employee attitudes, competitive threats, etc.	S14_3	2.192	2.000	1.303
My dashboard displays information that is external to my organization, such as economic conditions, market data, competitor data, customer information, etc.	S14_4	2.064	2.000	1.252
My dashboard presents information that is non-financial that relates to internal processes (e.g., sales process, production/manufacturing process, patient care quality measures, etc.).*	S14_5	1.752	2.000	0.946
My dashboard shows information that is non-financial that relates to market information such as market size, market share, etc.	S14_6	2.097	2.000	1.249
Key Performance Indicators - No pre-validated instrument				
Aggregated summary measures displayed on dashboards linked to the organizational goals and objectives.				
My dashboard contains performance measures that directly represent the overall strategy of my organization.	KPI28_1	1.688	2.000	0.841
My dashboard includes performance measures that are directly associated with our corporate strategy.	KPI28_2	1.696	2.000	0.872
My dashboard contains performance measures used to execute the overall strategic objectives in my organization.	KPI28_3	1.639	1.000	0.817
My dashboard includes performance measures that show our organizational strategy.	KPI28_4	1.624	1.000	0.807
My dashboard contains strategic performance measures developed by the corporate office.	KPI28_5	1.719	1.000	0.930

* Dropped

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
Task Difficulty (Chong, 2004; Chang et al., 2003; Van de Ven & Delbecq, 1974) - **				
Work analyzability and the degree that procedures have been developed to define the steps to complete a task.				
There is a clearly known way to do the majority of my work.	TD26_1	4.205	4.000	0.963
I can rely on established procedures to do my work.	TD26_2	4.279	4.000	0.863
There is an understandable sequence of steps for carrying out my work.*	TD26_3	4.358	5.000	0.877
There is a clearly defined body of information that can guide my work.	TD26_4	4.261	4.000	0.922
I rarely encounter problems in my work that I do not know how to solve immediately.*	TD26_5	4.102	4.000	0.928
I can go to someone else for assistance if I do not know the answer to a problem.*	TD26_6	4.297	4.000	0.841
I am sure of the eventual outcome for the majority of my tasks.*	TD26_7	4.332	5.000	0.824
Task Variability. (Chong, 2004; Chang et at., 2003; Williams and Seaman, 2002) **				
The number of exceptional situations that require different procedures or routines for completing the task.				
The tasks I perform are the same from day to day.	TV27_1	3.749	4.000	1.189
I do the same job in the same way most of the time.	TV27_2	3.880	4.000	1.113
The daily tasks I perform are routine.	TV27_3	3.934	4.000	1.112
I perform repetitive activities in doing my job.	TV27_4	3.972	4.000	1.034
I complete my work the same way most of the time.	TV27_5	3.992	4.000	1.039
Extent of Utilization - No pre-validated instrument				
The types of tasks accomplished with the dashboard.				
I depend on my dashboard for decision-making.	EU21_1	1.959	2.000	0.963
I depend on my dashboard for verification of prior decisions.	EU21_2	1.752	2.000	0.867
I depend on my dashboard to guide my activities.	EU21_3	1.877	2.000	0.982
I depend on my dashboard to monitor my personal performance.	EU21_4	1.962	2.000	1.070
I depend on my dashboard to achieve the goals and objectives of the organization.*	EU21_5	1.627	1.000	0.760
I depend on my dashboard to manage my work.	EU21_6	1.829	2.000	0.981
I depend on my dashboard to manage my subordinates.*	EU21_7	1.905	2.000	1.020
I depend on my dashboard to let my superiors know how I am performing.*	EU21_8	1.767	2.000	0.936
I depend on my dashboard to perform trend analysis of the data.*	EU21_9	1.601	1.000	0.797
I depend on my dashboard to provide feedback for new initiatives.	EU21_10	1.737	2.000	0.841

* Dropped

** Reverse Coded

Scale Item	Item Measure Name	Mean	Median	Standard Deviation
User Satisfaction (Hsieh et al., 2012 MISQ; Au et al., 2008 MISQ; Wixom and Todd, 2005)* **				
The level of satisfaction users have with their dashboards.				
I am very pleased with my dashboard.	US22_2	1.529	1.000	0.697
I am very contented with my dashboard.	US22_3	1.586	1.000	0.773
I feel delighted with my dashboard.	US22_4	1.701	1.000	0.853
Overall, I am very satisfied with my dashboard.	US22_5	1.512	1.000	0.705
Managerial Performance (Burney et al, 2009 AOS; Williams and Anderson, 1991)				
Managerial performance in comparison to performance measurement system and as described in job descriptions.				
I complete my assigned duties.	MP24_1	1.327	1.000	0.599
I fulfill the responsibilities specified in my job description.	MP24_2	1.330	1.000	0.569
I perform the tasks that are expected of me.*	MP24_3	1.335	1.000	0.593
I meet the formal performance requirements of my job.	MP24_4	1.386	1.000	0.692
I engage in the activities that directly affect my performance evaluation.*	MP24_5	1.463	1.000	0.725
I perform the aspects of my job that I am obligated to perform.	MP24_6	1.338	1.000	0.589
I perform the essential duties.	MP24_7	1.350	1.000	0.654

*Dropped

***Item US22_1 was removed from the survey before data collection.

The instrument was developed with the assistance of several experts in academia and practice. Three managers who utilize dashboards daily and two accounting professors were each asked to review and comment upon the preliminary survey instrument. The feedback received from the managers in the field indicated that the items measures were understandable to managers who utilize dashboards, and the managers commented on minor grammatical issues. The feedback from the accounting professors consisted of potential issues with validity and grammar. Based on all of this feedback received during this review process, the instrument was revised prior to collecting data.

Measurement of Variables

The constructs of the information scope, task uncertainty, user satisfaction, and managerial performance were adapted from prior validated instruments. There were no existing scales for the constructs of the extent of dashboard utilization and KPI's; therefore, related literature and the data collected from study one were utilized to develop the item measure these two constructs. Each of the constructs is discussed below.

Information Scope. –A six-item scale was adapted from Chenhall and Morris (1986), Chong (2004), and Gilbert and Reid (2009) to measure the extent the information displayed on the dashboard includes both financial and non-financial quantification, both short-term and long-term time horizons, and both an internal and external focus. A high level of agreement with the item measures for this construct indicates a broader scope of dashboard information content, while a high level of disagreement indicates a more narrow scope of dashboard information content.

Key Performance Indicators. –A five-item scale was constructed for this study since no validated scales exist in prior research measuring how well performance measures are linked to organizational objectives and goals (LaPointe, 2008; Kaplan and Norton, 2004, Ittner and Larker, 2003). The item measures were designed to elicit the degree a dashboard's performance indicators were associated with the objectives, goals, and strategy of the organization.

Task Uncertainty. The construct of task uncertainty was operationalized through the two separate and distinct constructs of task difficulty and task variability (Brownell and Dunk, 1991). These two constructs were reverse coded.

Task Difficulty. A seven-item scale was adapted from Chong (2004), Chang et al. (2003), and Van de Ven & Delbecq (1974) to measure the work analyzability and the degree that procedures have been developed to define the steps to complete a task.

Task Variability. A six-item scale was adapted from Chong (2004), Chang et al. (2003), Williams and Seaman (2002), and Whithey et al. (1983) to measure the number of exceptional situations that require different procedures or routines for completing the task.

Extent of Dashboard Utilization. A ten-item scale was adapted from Goodhue and Thompson, (1995) and the data collected in study one. The instrument asks the respondents about their level of dependence of their dashboard for differing task and activities. Gauging the extent of dashboard utilization through 'dependence' was adapted from Goodhue and Thompson (1995) who used this method of dependence on technology to ascertain the extent of utilization in their seminal study that established the theory of TTF. For the current study, the extent of dashboard utilization was operationalized by asking managers how dependent they are on several different ways managers utilize dashboards based on the data collected in study one.

User satisfaction. A four-item scale was adapted from Hsieh et al. (2012), Au et al. (2008), and Wieder at al. (2013) to measure the level of satisfaction managers associate with their dashboard utilization.

Managerial Performance. A seven-item scale was adapted from Burney et al. (2009) and Williams and Anderson (1991) to measure managerial performance in comparison to their performance measurement system as described in job descriptions.

Control Variable

A control variable was added to the theoretical model with a proposed direct effect on the extent of dashboard utilization. The manifest variable of years working with dashboards was included since higher levels of dashboard experience may impact the extent managers choose to utilize their dashboard. This item was measured through the selection of one of the following responses: (1) 1 year or less; (2) 1 year up to 3 years; (3) 3 year up to 5 years; (4) 5 year up to 7 years; and (5) greater than 7 years.

Pilot Tests

The instrument was pilot tested with a hold-out sample of 51 mid-level managers obtained from the same survey firm that collected the main data for the study (Dillman, 2009). A preliminary principal components analysis (PCA) was conducted to ensure that the item measures are adapted in a manner consistent with dashboards as well as to assess discriminant validity and indicator reliability of the latent constructs. The PCA showed a high level of cross loadings between the item measures and multiple constructs loaded on one factor. Consequently, the instrument was revised to correct these issues. A second pilot test was conducted with a second set of 47 hold-out respondents. After the data was collected for the second pilot study; a second PCA was conducted, which resulted in better discriminant validity and indicator reliability. Final adjustments to the instrument are made prior to the primary data collection.

Interaction Variables

The product indicator method of building interaction variables is used in this study. (Chin et al., 1996, 2003; Henseler and Fassott, 2010). Based on the product indicator method, the

interaction variable is created through the interaction of the predictor variable and the moderator variable by obtaining the product terms of all of the individual indicators from the two variables. The product indicators then become the indicators for the latent interaction variable added to the theoretical model. To control for potential multi-collinearity between the predictor variable, the moderator variables, and the product term interaction variable, the literature recommends mean centering the predictor variables and the moderator variables (Chin et al., 1996, 2003; Little et al, 2006; Henseler and Fassott, 2010). Accordingly, the dashboard information content dimensions and the task uncertainty dimensions for this study are mean centered prior to building the interaction latent variable in the model.[17]

Data Analysis and Results

This study utilizes partial least squares (PLS), a components based structural equation modeling technique, to test the theoretical model. The appropriate analysis technique for the initial research in the area of dashboards is PLS based on the predictive nature of PLS. Additionally, PLS is effective for non-normal data sets (Hair et al., 2010). The minimum sample size for this study is calculated based on 10 times the highest quantity of item measures on an individual construct in the theoretical model (Chin, 1998). The construct for the extent of dashboard utilization contains 6 item measures; therefore, the sample size needs to be at least 60 for this study. Since 391 respondents are included in the actual sample, the sample size is sufficient to test the theoretical model in PLS.

[17] Little et al., (2006) offers another method to reduce the multi-collinearity, in addition to mean centering, where the residuals of the product terms are used to build the interaction term. This residual method is analyzed in this study; however, there is no significant improvement in the correlations and model results. Therefore, the mean centering method is chosen as the best method for this study.

A data normality test is performed using both the Kolmogorov-Smirnov and the Shapiro-Wilks normality tests. The results show that the data for this study is not distributed normally ($p < 0.001$). The impact of non-normal data in a PLS environment is examined by Cassel et al. (1999) and they show that the results of non-normal data found in most data sets are reasonably robust. When extremely skewed distributions are used in PLS, biases are encountered in the large inner structure coefficient; however, extremely skewed data sets are rarely encountered (Cassel et al., 1999), and the level of skewness (average 1.351) and kurtosis (average 1.788) exhibited by the data in this study is not severe (Cameron, 2004). Consequently, the departures from normality exhibited by the data set for this study can justifiably be disregarded.

Individual Item Quality

The scales used in this study are adapted from validated instruments or developed specifically for this study when no validated instrument is available. A PCA is performed in the SPSS statistical software to determine the quality of the item measures for each of the factors. Principal component factoring with promax rotation is used and 7 factors are identified with eigenvalues larger than 1. Some of the item measures are dropped from the theoretical model due to low factor loadings and/or high levels of cross-loading. Since the item measures are reflective, the removal of some the item measures does not affect the theoretical significance of the constructs (Nicolaou et al., 2011). The retained item measures all demonstrated factor loadings of 0.50 or higher with cross-loadings lower than 0.30 (Hair et al., 2010). The 7 factors shown in the PCA explained 63.83 percent of the total variance. Table 10 shows the 7 factors produced by the PCA.

Table 10: PCA Factor Loadings - Study Three

Item Measures	FACTOR						
	1	2	3	4	5	6	7
Scope of Information 1	-.047	-.051	-.053	**.909**	.046	-.001	-.062
Scope of Information 2	.053	.081	.044	**.596**	-.032	.129	-.022
Scope of Information 3	-.086	.080	.111	**.645**	-.138	-.105	.201
Scope of Information 4	.009	-.040	-.055	**.898**	.037	.007	-.077
Scope of Information 6	.092	.136	-.033	**.722**	-.030	-.004	-.056
Key Performance Indicators 1	.040	**.779**	.001	-.034	.072	.150	-.134
Key Performance Indicators 2	.019	**.772**	-.111	.132	.060	-.033	-.005
Key Performance Indicators 3	.042	**.754**	-.033	.048	.051	.055	.046
Key Performance Indicators 4	-.087	**.765**	.149	-.043	-.078	.045	-.018
Key Performance Indicators 5	-.051	**.836**	.020	-.007	.036	-.136	.147
Task Difficulty 1	.108	.016	-.165	.012	-.033	-.037	.839
Task Difficulty 2	.047	.067	-.039	-.116	.046	.069	.759
Task Difficulty 4	-.080	-.049	.140	-.014	-.032	.120	.740
Task Variability 1	**.799**	-.005	.024	.059	-.092	-.043	.046
Task Variability 2	**.851**	-.133	-.002	.033	-.001	.059	.030
Task Variability 3	**.831**	.018	-.030	-.021	-.003	-.060	.098
Task Variability 4	**.763**	.162	.072	-.137	-.030	.013	-.118
Task Variability 5	**.760**	-.097	.053	.086	.156	.007	.038
Extent of Use 1	.012	-.005	**.908**	-.047	.022	-.075	-.106
Extent of Use 2	-.093	-.088	**.580**	.153	.096	.184	-.032
Extent of Use 3	.064	.122	**.755**	-.121	-.075	.039	.029
Extent of Use 4	.014	.154	**.591**	.183	-.075	-.105	.041
Extent of Use 6	.075	-.033	**.841**	-.118	-.042	.055	-.075
Extent of Use 10	-.003	-.119	**.513**	.184	.227	-.046	.142
User Satisfaction 2	-.089	-.068	.005	.078	.096	**.729**	.155
User Satisfaction 3	-.010	-.024	.114	-.103	-.052	**.811**	.052
User Satisfaction 4	.081	.099	-.025	.183	-.133	**.687**	-.066
User Satisfaction 5	.008	.060	-.076	-.039	.049	**.840**	-.014
Managerial Performance 1	-.025	.162	.000	-.043	**.696**	-.032	.032
Managerial Performance 2	.051	.030	-.123	-.038	**.755**	.125	-.046
Managerial Performance 4	-.010	.088	.048	-.040	**.744**	-.119	.057
Managerial Performance 6	.007	-.020	.016	-.010	**.797**	.020	-.036
Managerial Performance 7	-.017	-.097	.079	.087	**.753**	-.015	-.025

*See Table 9 for item descriptions

Measurement Model

The measurement model is examined next to assess the level of convergent validity, discriminant validity, internal consistency reliability, and indicator reliability for the 7 reflective factors contained in the theoretical model. Convergent validity shows the extent that a construct captures the item measure's variance (Hair et al., 2011). Convergent validity is examined by looking at the average variance extracted (AVE) for each construct and the value should exceed 0.50 (Hair et al., 2011; Chin 1998). The AVE for the 7 constructs is in excess of 0.50 as shown in Table 11; however, the AVE's for the interaction variables are all below 0.50. The low level of convergent validity exhibited by the moderator (interaction) variables may explain the poor results attained in the model for the moderator hypotheses (3a – 3d) as discussed in the next section.

Discriminant validity demonstrates the extent the items measures for each construct are empirically separate (Hair et al., 2010). Discriminant validity is measured using two methods. First, the square root of a construct AVE is compared against the correlations with all the other constructs, and the correlations should be lower than the square root of the AVE (Hair et al., 2011; Fornell and Larcker, 1981). Second, the factor loadings for each factor needs to be higher than any of the cross-loadings (Hair et al., 2011). Table 11 reveals that the square root of the AVE is higher than the correlations for each of the 7 constructs and the moderator variables. Each factor loadings is larger than cross-loadings for each construct (see Table 12). Based on these results, the data exhibits a high level of convergent and discriminant validity for the 7 main constructs (Hair et al., 2011; Chin, 1998; Fornell and Larker, 1981).

Table 11: Discriminant Validity - Study Three

		AVE	CR	1	2	3	4	5	6	7	8	9	10	11	12
1	Extent of Use	0.55	0.88	**0.74**											
2	KPI	0.67	0.91	0.52	**0.82**										
3	KPI * Task Difficulty	0.42	0.95	0.16	0.22	**0.65**									
4	KPI * Task Variability	0.44	0.92	0.20	0.45	0.50	**0.66**								
5	Managerial Performance	0.58	0.87	0.26	0.36	0.09	0.14	**0.76**							
6	Satisfaction	0.66	0.88	0.54	0.50	0.18	0.22	0.26	**0.81**						
7	Scope	0.62	0.89	0.58	0.57	0.12	0.19	0.04	0.56	**0.79**					
8	Scope * Task Difficulty	0.47	0.96	0.16	0.10	0.58	0.21	-0.01	0.21	0.24	**0.68**				
9	Scope * Task Variability	0.38	0.90	0.19	0.18	0.28	0.41	-0.03	0.25	0.24	0.42	**0.61**			
10	Task Difficulty	0.64	0.84	0.49	0.45	0.10	0.19	0.27	0.51	0.43	0.18	0.38	**0.80**		
11	Task Variability	0.67	0.91	0.39	0.25	-0.02	0.08	0.06	0.34	0.33	0.22	0.19	0.45	**0.82**	
12	Years with Dashboard	n/a	n/a	0.03	-0.02	-0.03	0.02	-0.11	-0.01	0.02	0.03	0.06	0.05	-0.01	n/a

Notes:

AVE = Average Variance Extracted

CR = Composite Reliability

KPI = Key Performance Indicator

Diagonal elements (in bold) are the square root of the AVE estimate for each of the constructs (numbers 1 - 12).

Off-diagonal elements are the correlation between the constructs.

Table 12: Measurement Model Cross Loadings - Study Three

	SI	KPI	TD	TV	EU	US	MP
S14_1	**0.779**	0.406	0.297	0.190	0.420	0.422	0.030
S14_2	**0.782**	0.476	0.368	0.304	0.494	0.494	0.069
S14_3	**0.784**	0.454	0.385	0.244	0.492	0.407	-0.013
S14_4	**0.804**	0.418	0.299	0.233	0.422	0.431	0.028
S14_6	**0.786**	0.479	0.327	0.303	0.457	0.456	0.039
KPI28_1	0.439	**0.812**	0.328	0.209	0.418	0.442	0.329
KPI28_2	0.468	**0.783**	0.324	0.198	0.382	0.387	0.280
KPI28_3	0.500	**0.855**	0.420	0.266	0.466	0.468	0.316
KPI28_4	0.472	**0.794**	0.342	0.155	0.431	0.402	0.231
KPI28_5	0.446	**0.838**	0.410	0.191	0.429	0.358	0.321
TD26_1	0.303	0.315	**0.757**	0.396	0.307	0.323	0.149
TD26_2	0.300	0.374	**0.790**	0.364	0.377	0.401	0.265
TD26_4	0.409	0.380	**0.847**	0.339	0.468	0.469	0.216
TV27_1	0.302	0.198	0.359	**0.828**	0.325	0.266	-0.034
TV27_2	0.263	0.148	0.362	**0.858**	0.305	0.289	0.006
TV27_3	0.240	0.202	0.386	**0.831**	0.289	0.246	0.045
TV27_4	0.210	0.219	0.300	**0.724**	0.275	0.223	0.053
TV27_5	0.303	0.248	0.417	**0.838**	0.381	0.336	0.165
EU21_1	0.374	0.347	0.307	0.266	**0.753**	0.332	0.188
EU21_2	0.450	0.376	0.343	0.216	**0.738**	0.466	0.225
EU21_3	0.442	0.430	0.411	0.350	**0.781**	0.426	0.170
EU21_4	0.529	0.468	0.380	0.314	**0.757**	0.406	0.125
EU21_6	0.380	0.315	0.337	0.314	**0.719**	0.365	0.152
EU21_10	0.412	0.373	0.399	0.279	**0.709**	0.396	0.300
US22_2	0.461	0.413	0.463	0.245	0.460	**0.836**	0.294
US22_3	0.418	0.370	0.418	0.277	0.442	**0.804**	0.200
US22_4	0.549	0.447	0.384	0.328	0.457	**0.803**	0.085
US22_5	0.397	0.407	0.373	0.249	0.388	**0.800**	0.257
MP24_1	0.054	0.334	0.223	0.051	0.225	0.222	**0.777**
MP24_2	0.003	0.256	0.179	0.051	0.139	0.206	**0.733**
MP24_4	0.025	0.288	0.220	0.048	0.203	0.162	**0.770**
MP24_6	0.001	0.256	0.187	0.037	0.201	0.184	**0.777**
MP24_7	0.057	0.238	0.200	0.052	0.214	0.210	**0.751**

SI = Scope of Information
KPI = Key Performance Indicator
TD = Task Difficulty
TV = Task Variability
EU = Extent of Use
US = User Satisfaction
MP = Managerial Performance

Internal consistency reliability for each construct is measured by the composite reliability score, which should be higher than 0.70 (Hair et al., 2011). The composite reliability scores for the constructs range from 0.841 to 0.956. To examine the indicator reliability, the factors loadings for each item measure should exceed 0.70 (Hair et al., 2010). The item measure factor loadings for each the 7 constructs range from 0.709 to 0.858.

Structural Model Results

The structural model analysis results are shown in Figure 10. The model t-values and outer-item loadings are produced through a 1,000 iteration bootstrap sample. The variance explained in the endogenous variables shown in the model, revealed through the measure of $R^{2,}$ shows the predictive power of the variable (Wieder et al., 2013). The level of explained variance for the endogenous variables ranged from small (8.9 percent - managerial performance), to medium (29.1 percent - user satisfaction), to large (46.4 percent - the extent of dashboard utilization).

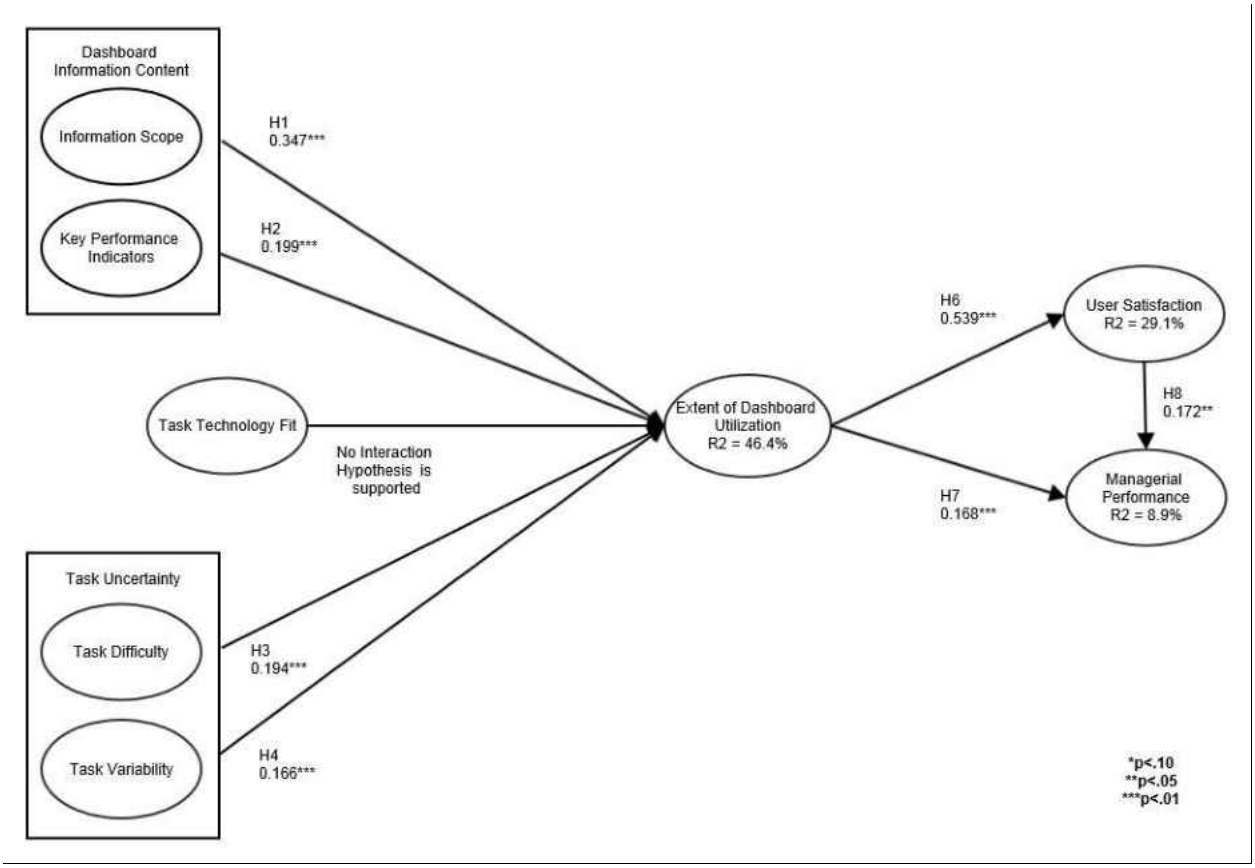

Figure 10: Model Results - Study Three

Hypothesis 1 predicts that information scope is positively associated with the extent of dashboard utilization. Analysis of the model indicates a significant association between information scope and the extent of dashboard utilization ($\beta = 0.347$, $p < .01$, one tailed); therefore hypothesis 1 is supported.

Hypothesis 2 predicts that KPI's are positively associated with extent of dashboard utilization. Analysis of the model indicates a significant association between KPI's and the extent of dashboard utilization ($\beta = 0.199$, $p < .01$, one tailed); therefore hypothesis 2 is supported.

Hypothesis 3 predicts that task difficulty is positively associated with extent of dashboard utilization. Analysis of the model indicates a significant association between task difficulty and

the extent of dashboard utilization ($\beta = 0.194$, $p < .01$, one tailed); therefore hypothesis 3 is supported.

Hypothesis 4 predicts that task variability is positively associated with extent of dashboard utilization. Analysis of the model indicates a significant association between task variability and the extent of dashboard utilization ($\beta = 0.166$, $p < .01$, one tailed); therefore hypothesis 4 is supported.

Hypotheses 5a through 5d predicts that the interaction between task uncertainty (as operationalized through task difficulty and task variability) and dashboard content (information scope and KPI's) will and the extent of dashboard utilization. The direct effects for both task difficulty ($\beta = 0.194$, $p < .01$, one tailed) and task variability ($\beta = 0.166$, $p < .01$, one tailed) are significant. However, the only moderation hypotheses that is significant is H3b ($\beta = 0.133$, $p < .10$, one tailed). Although the association becomes weaker instead of stronger as predicted in H5b. Overall, none of the moderation hypotheses (5a – 5d) are supported. The poor results for the moderation effect of task uncertainty may have resulted from the low level of convergent validity exhibited by AVE's < 0.50 for these product indicator variables.

Hypothesis 6 predicts that user satisfaction is positively associated with the extent of dashboard utilization. The analysis of the model indicates a significant association between user satisfaction and the extent of dashboard utilization ($\beta = 0.539$, $p < .01$, one tailed); therefore, hypothesis 6 is supported.

Hypothesis 7 predicts that managerial performance is positively associated with the extent of dashboard utilization. Analysis of the model indicates a significant association between the managerial performance and the extent of dashboard utilization ($\beta = 0.168$, $p < .01$, one tailed); therefore, hypothesis 7 is supported.

Hypothesis 8 predicts that managerial performance is positively associated with user satisfaction. Analysis of the model indicates a significant association between the managerial performance and user satisfaction ($\beta = 0.172$, $p < .05$, one tailed); therefore, hypothesis 8 is supported. Lastly, the control variable measuring the years a manager has utilized dashboards is not significantly associated with the managerial decision environment.[18]

Additional Analysis – TTF Operationalized Through Mediation

The original theoretical model is based on TTF being operationalized through the interaction of dashboard information content and task uncertainty to predict the extent of dashboard utilization. However, due to the lack of convergent validity in the moderator variables and/or improper specification of TTF as a moderator variable the results do not provide support for TTF operationalized through the interaction of task uncertainty and dashboard information content. When TTF is evaluated through moderation, the relationship between dashboard information content and the extent of dashboard utilization is posited to either strengthened or weakened through the level of task uncertainty. When task uncertainty impacts the strength of the relationship between dashboard information content and the extent of utilization, the level of fit between the technology and task is not really assessed. Therefore, additional analysis is conducted to examine if TTF is better operationalized through task uncertainty acting as a mediator to dashboard information content and the extent of dashboard utilization. Mediation occurs when a third variable, such task uncertainty, exerts influence in the relationship of the independent and dependent variable. This influence is exerted on the dependent variable of utilization in this study based on the level of fit between dashboard information content and task

[18] For sake of clarity in the model, control variables are not shown.

uncertainty. Since there is a direct relationship between dashboard information content and task uncertainty in a mediation model where task uncertainty actually governs the level of utilization, the level of fit is better operationalized through this mediation.

A new model is developed that shows task uncertainty mediating the relationship between dashboard information content and the extent of dashboard utilization. TTF, as the theoretical basis for this model is not changing, the only change in the model is how TTF is operationalization through mediation to predict the extent of dashboard utilization. The measurement model for the additional analysis model shows high levels of convergent validity (all AVE's > 0.50), discriminant validity (all correlations lower than the square root of the AVE and no excessive cross-loadings), internal consistency reliability (all composite reliabilities > 0.70), and indicator reliability (factor loadings for all of the indicators > 0.70). See Table 13 below.

Table 13: Discriminate Validity - Additional Analysis Study Three

		AVE	CR	1	2	3	4	5	6	7	8
1	Extent of Use	0.58	0.88	**0.76**							
2	KPI	0.60	0.82	0.53	**0.78**						
3	Managerial Performance	0.58	0.87	0.22	0.39	**0.76**					
4	Scope of Information	0.65	0.88	0.55	0.44	0.02	**0.81**				
5	Task Difficulty	0.64	0.84	0.47	0.47	0.26	0.41	**0.80**			
6	Task Variability	0.67	0.91	0.38	0.29	0.06	0.30	0.45	**0.82**		
7	User Satisfaction	0.66	0.88	0.53	0.53	0.26	0.53	0.51	0.34	**0.81**	
8	Years with Dashboard	n/a	n/a	0.04	0.00	-0.11	0.04	0.05	-0.01	-0.02	**n/a**

Notes:

AVE = Average Variance Extracted

CR = Composite Reliability

KPI = Key Performance Indicator

Diagonal elements (in bold) are the square root of the AVE estimate for each of the constructs (numbers 1 - 7).

Off-diagonal elements are the correlation between the constructs.

This updated model is shown in Figure 11. All of the relationships shown in the model are significant ($p < .01$) except for the relationship between the extent of dashboard utilization and managerial performance, which is significant at the 0.05 level.

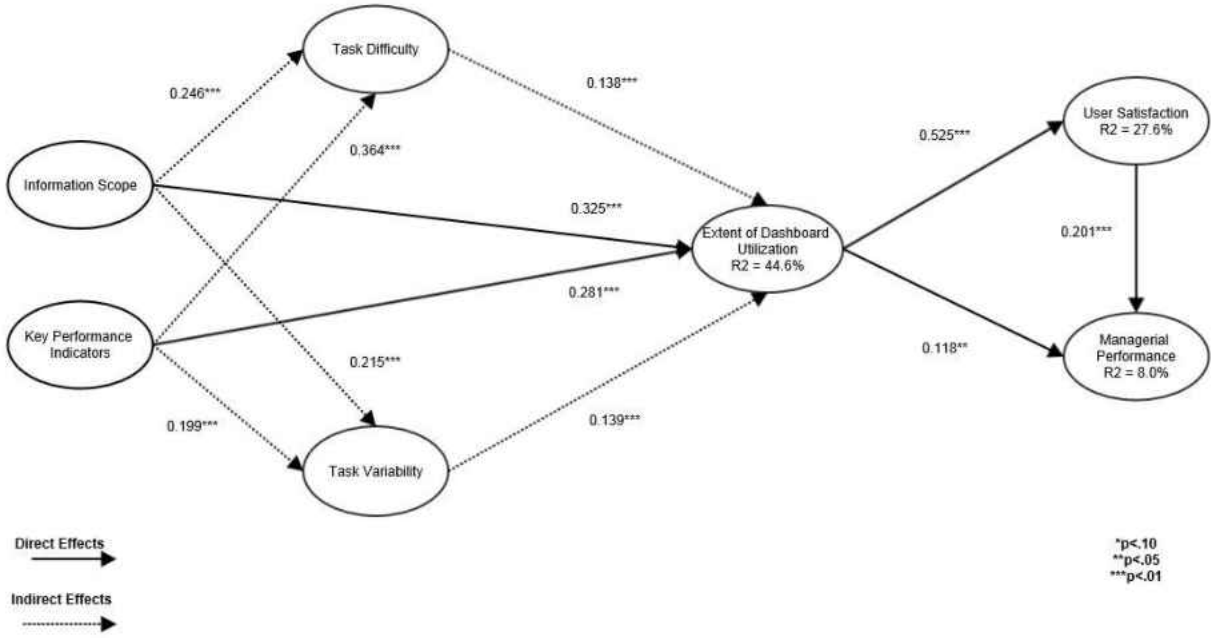

Figure 11: Additional Analysis Results - Study Three

When TTF is operationalized based on task uncertainty mediating dashboard information content, the total effects between information scope and the extent of dashboard utilization increases from 0.325 direct effects to 0.389 total effects, which includes the indirect effects through task difficulty 0.034 (.246*.138) plus the indirect effects through task variability 0.030 (.215*.139), for a total of 0.064 attributable to the indirect effects. The total effects between KPI's and the extent of dashboard utilization increase from 0.281 for the direct effects to 0.359 for the total effects, which includes the indirect effects through task difficulty 0.050 (.364*.138) plus the indirect effects through task variability 0.028 (.199*.139), for a total of 0.078 attributable to the indirect effects. These results support the achievement of TTF through the

partial mediation of the relationship between dashboard information content and the extent of dashboard utilization by task uncertainty. The results for the remainder of the model (β weight, R^2, & t-statistics for the constructs of the extent of dashboard utilization, user satisfaction, and managerial performance) are similar to the results shown in the main study. Overall, this model better matches the relationships exhibited in these theoretical constructs.

Conclusion

This study examines the utilization of dashboards by middle to upper level managers based on the antecedents of dashboard information content and task uncertainty, and subsequently, the consequences of user satisfaction and performance. The results of this study indicate that both dashboard information content (information scope and KPI's) and task uncertainty (task difficulty and task variability) are viewed as antecedents to dashboard utilization as they are positively associated with the extent of dashboard utilization. However, the measurement of TTF based on the moderation (interaction) variable formed from these two constructs does not significantly impact the extent of dashboard utilization. TTF's lack of impact on utilization may have resulted from high levels of correlation and lack of convergent validity for the moderating variables. The results further indicate that the consequences of user satisfaction and managerial performance are both positively associated with the extent of dashboard utilization. Since the operationalization of TTF in the original model is not successful, additional analysis is conducted to see if TTF is better understood through mediation. The development of a new model predicts that the direct relationship between dashboard information content and the extent of dashboard utilization is affected through the indirect relationship of task uncertainty. The analysis of this mediation model finds strong support for dashboard TTF when

task uncertainty mediates the relationship between dashboard information content and the extent of dashboard utilization.

A key contribution from this study is the empirical examination of the extent of dashboard utilization by middle to upper level managers. The results show that TTF, as measured through task uncertainty mediating dashboard information content, has a large effect (R^2 = .446) on the extent of dashboard utilization. Both dimensions of dashboard information content affect the extent of utilization almost equally (total effect of scope of information is .389 and the total effect of KPI is .359). The higher extent of dashboard utilization explained more variance in the user satisfaction (R^2 = .276) than for the construct of managerial performance (R^2 = .080). Consequently, there is a high level of importance for dashboard designers to ensure that the scope of information contained on the dashboard matches the level of uncertainty associated with managerial positions to ensure higher levels of utilization. Equally as important, but more difficult to achieve, is the linking of the dashboard content to the organizational goals and objectives. This study empirically confirms the practice related literature that calls for the measures contained on dashboards to be linked to organizational objectives and goals (Miller and Cioffi, 2004; Clark et al., 2006; LaPointe, 2008). Therefore, when dashboards are being developed for the manager ranks in organizations, attention should be placed equally on the scope of information given to managers as well as making sure that the information is linked to organizational goals and objectives. This study also extends TTF theory through the examination of information content as the construct for technology. Prior research has examined the technology system, while this study examined the fit between the output of the technology and the impact on the extent of utilization. Overall, this research adds to limited research in the area of the behavioral effects of managerial dashboards.

Although this study only examined managerial performance through TTF theory, future research may consider the impact of the dashboard information content on the organizational performance. The results from Chapter 3 reveals that more variance in the model is explained through organizational performance (R^2 = .232) than managerial performance (R^2 = .128) through the dashboards impact on the managerial decision environment.

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GENERAL CONCLUSIONS

These three studies examine the phenomena of the diffusion of dashboards to the lower levels of the organization to explain why the utilization of technology has become so widespread. As organizations invest substantial resources into providing their managers with access to dashboards, both practitioners and academics need to have a better understanding of the antecedents, and especially the consequences of dashboard utilization. Empirical research in the area of dashboards is very limited, particularly considering the widespread utilization of this technology over the last ten years. Therefore, these three studies present the first substantive empirical evidence regarding why dashboards are extensively utilized and the net benefits of this dashboard utilization.

The three studies completed for this dissertation each offer a separate, but related investigation of the factors that have impacted or been impacted by the diffusion of dashboards. Since empirical evidence is limited regarding most aspects of the dashboard as it exists in the field, the initial source of inquiry for this dissertation is selected to be a cross-sectional field study to gain a better understanding and definition of the constructs involved with the diffusion of dashboards throughout an organization. According to Kaplan (1986), the practice of management accounting is best understood in the context of existing active organizations; consequently, the initial empirical work undertaken for this dissertation took place within organizations in the field. Based on interviews with 27 managers, the dashboard related constructs are identified and defined; and, a framework is developed to show the preliminary relationships between these constructs. Next, the constructs that emerged from study one that are related to the diffusion of dashboards are incorporated into two separate theoretical models and tested in the second and third studies. The primary function of a dashboard posited by the

practice related literature is to focus managements' attention on the key performance indicators that direct managerial action and support decision-making (Few, 2005; Colbert, 2009; Pauwels et al., 2009) and the primacy of this dashboard function is verified through study one. Consequently, the main focus of study two is on the managerial decision environment in the context of dashboards and the associated antecedents and consequences. Utilization also emerged as an important category in study one since diffusion of technologies can only occur through higher levels of utilization. However, the number of dashboards being implemented as the technology is diffused may trigger unintended consequences, such as dashboard content not matching the task performed by managers, which may ultimately impact the extent of dashboard utilization. This fit between the dashboard information content and managerial tasks is examined in study three. Together, these three studies provide an integrated sequence to this research in explaining why dashboards have been diffused as well as the antecedents and consequences.

The cross-sectional field study for study one utilizes data collected from 27 managers from 24 different organizations operating in 10 industrial sectors. Initially, prior literature indicated that the increasing utilization of dashboards may have resulted from innovations in IS that made it possible for managers to receive management accounting information from dashboards that is accurate, complete, current in real-time, and flexible (Vasarhelyi and Alles 2008). However, the results that emerged from the iterative data collection and analysis process in study one reveal that strategic alignment and interactive management control aspects of dashboards has had the greatest impact on utilization, and subsequently diffusion. Furthermore, the data indicates that higher levels of dashboard accessibility, dashboard viewpoint integration, information completeness, and information currency are not directly responsible for higher levels of utilization; rather, they mediate the direct relationship between interactive management

control dashboards and the extent of dashboard utilization. While these innovations to dashboard qualities play an important role in the increased utilization of dashboards, they are not the primary reason why dashboards have become so pervasive. The diffusion of dashboards throughout today's organizations is directly attributable to the strategic alignment of dashboards operating as the organization's interactive management control.

The main contribution of study one is the explanation of why dashboards have been diffused throughout today's organizations. These results position dashboards in the MCS and strategy area of research; whereas, prior practice related literature viewed dashboards as an isolated system (Cokins, 2010). Prior strategy research investigated strategic outcomes at the highest levels of the organization, and this study extends this literature to include the execution of operational strategy at the lower levels of the organization through strategy surrogation. Additionally, prior research has associated negative outcomes with strategy surrogation (Choi et al, 2012, 2013), and this research shows that strategy surrogation is positive when attributed to the lower levels of the organization. Lastly, the study provides preliminary evidence of the net benefits of dashboard utilization through managerial performance and organizational performance.

Study two extends the first study by examining the managerial decision environment, which emerges as an important construct in study one. Study two examines dashboard qualities as antecedents to the quality of the managerial decision environment, and the consequences of managerial and organizational performance. A theoretical model is developed and analyzed utilizing PLS. The results show that there is not strong support for the dimensions of dashboard system quality (accessibility and integration) and dashboard information quality (completeness) acting as antecedents to the managerial decision environment. Only dashboard system flexibility

and dashboard information currency are positively associated with the managerial decision environment. These results are posited to have occurred based on providing managers or the information technology (IT) function the flexibility to adjust and align dashboards to new tasks or meet a changing business environment to continue to make effective decisions. Additionally, managers cannot make effective decisions with outdated information; consequently, the currency of the information is an important antecedent to the decision environment.

Further, this study investigates the impact of the level of strategy alignment associated with dashboards on the managerial decision environment through the moderation hypotheses. The results show that flexibility is the only dimension moderated by strategy alignment, which indicates that high levels of strategy alignment are better matched with lower levels of dashboard flexibility to ensure that managers cannot change the strategy aligned measures contained on the dashboard. Lastly, the results support the links between high quality managerial decision environments and improved managerial performance and organizational performance.

Study two extends both the dashboard and strategy literatures, and this is the first study to empirically examine the managerial decision environment in the context of dashboards. A primary contribution for the strategy literature is the finding that high levels of dashboard flexibility in strategy aligned settings lead to lower quality decision environments. This study also provides evidence that a higher quality decision environment in the dashboard context is linked to improved managerial performance and organizational performance.

The third study continues to build upon study one by focusing on dashboard utilization and the antecedent of task-technology fit (TTF). The theoretical model shows that dashboard information content and task uncertainty are strong antecedents to dashboard utilization as separate constructs. However, the model findings do not support the impact of TTF on the extent

of dashboard utilization when TTF is measured as the interaction between dashboard information content and task uncertainty. However, TTF's lack of effect on dashboard utilization may have resulted from a lack of convergent validity in the moderating variables. Similar to the first two studies, the results show strong support for the net benefits through higher levels of user satisfaction and managerial performance. Additional analysis is conducted that measures TTF as task uncertainty functioning as a mediator variable to dashboard information content to predict the extent of dashboard utilization. The mediation model of TTF is strongly supported.

This study extends the dashboard and TTF literature through the findings that show that TTF is an important antecedent to more extensive dashboard utilization. As a result, dashboard designers need to match the information contained on dashboards to the tasks manager's performance to ensure continued dashboard utilization. The dashboard literature is again extended to include the empirical results showing that the net benefits received through dashboard utilization are user satisfaction and managerial performance. This study provides empirical evidence confirming the practice literature that recommends linking the dashboard to organizational objectives and goals to increase performance. Lastly, the TTF literature is extended through the inclusion of information content as a construct for technology.

Although the three studies that comprise this dissertation provide substantial empirical evidence concerning the diffusion of dashboards, more research is still needed to continue the development of a more comprehensive understanding of the impact of dashboards in today's organizations. Future research could empirically test the framework developed in study one as a method of triangulating research methods to increase the reliability of these results showing the importance of strategy alignment and interactive management control. Since organizations continue to invest substantial resources into their IT, such as dashboards, understanding the link

between dashboard utilization and organizational performance would be of benefit to this stream of literature. Finally, future research could examine the impact of specialized dashboards utilized in certain industries that track compliance with regulatory requirements in government contracting contexts or in the healthcare industry.

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APPENDIX A: STUDY ONE CASE STUDY PROTOCOL

Purpose

The purpose of this study is to examine how the technological advances of user control, accessibility, and continuous real-time information have impacted how manager's utilize digital dashboard to support decision-making.

Research Question

How have digital dashboards impacted the decision environments of today's' organizations? Secondary research question: What organizational variables lead to a higher level of digital dashboard utilization?

Theory

The field work for these studies is motivated by three separate theories: IPT (Galbraith, 1973) and Cognitive Fit Theory (Vessey, 1991), and attribute substitution theory (Kahneman and Frederick, 2002). Galbraith's (1973) IPT posits that the information processing capacity of an organization must match the needs for information in the organization. If the organization's processing capacity is lower than the level of need, performance will suffer as a result. According to IPT, the level of task uncertainty is positively associated with the level of information needed by an organization. Galbraith (1973) provides four design strategies to assist with the increased levels of task uncertainty by reducing the information processing needs (items 1 and 2) or increasing the organization's capabilities (items 3 and 4). These strategies include: 1) Creation of Slack Resources, 2) Self-contained tasks, 3) Vertical integration, and 4) Horizontal integration. If one or more of these strategies are not adopted or expanded upon when facing higher levels of uncertainty, performance will be affected negatively (Galbraith, 1974).

The IIS is the primary platform which has allowed for a higher level of vertical and horizontal organization integration accomplished by the creation of single organizational real-time databases.[19] The increase to information processing capacity is achieved through IIS applications, such as business intelligence (BI), which arranges the extensive data contained in the data warehouse, analyzes this data to uncover new relationships, and presents this information through digital dashboards to managers to support their decision-making (Seddon et al., 2010; Gartner, 2011). The creation of new information through BI and the effective flow of all information to managers have been responsible for increasing the levels of information processing capacity in the organizations (Chang et al., 2003).

The theory of cognitive fit (Vessey, 1991) is based on the fit between problem representations and the task to be performed. Empirical research has shown that a higher level of cognitive fit is associated with higher levels of performance. This study seeks to understand how the fit between the information content provided by through digital dashboard technology and

[19] An IIS may also support applications which link the access of several separate databases, so that it appears that all of the data is stored on one large database. Additionally, IIS's are capable of capturing and storing broad types of internally generated and externally generated data which previously could not be captured automatically.

task variability impacts the dashboard's capability to provide support for managerial decision-making.

Attribute substitution occurs when the target attribute is assessed by mapping the value of some other attribute (heuristic attribute) on the target attribute" (Kahneman and Frederick, 2002: 54). The heuristic attribute is more easily accessed by the individual than the complex attribute substitution. Attribute substitution can occur when three conditions are satisfied: 1.) the target attribute is relatively inaccessible; 2.) a semantically and associatively related attribute is highly accessible; and 3.) the substitution of the heuristic attribute for the target attribute cannot be consciously rejected (Kahneman and Frederick, 2002: 54; Choi et al., 2012; Choi et al., 2013). In the context of dashboards used for the diffusion of strategy throughout an organization, the first of these conditions satisfied due to the conceptual, ill-defined, and complex nature of strategic constructs. The second and third conditions are typically met at the lower levels of the organization when tactics are substituted for the strategic objectives.

Key Features of the Case Study

Type of Case Study

The study will be an exploratory cross-sectional field study

Propositions

The propositions for this study are designed to direct attention to issues that will be examined within the scope of the study (Yin, 1984).[20]

- Proposition 1: Dashboard system quality will be positively associated with dashboard utilization.
- Proposition 2: Dashboard information quality will be positively associated with dashboard utilization.
- Proposition 3: The match between the interactive information content and task uncertainty will be positively associated with dashboard utilization.
- Proposition 4: The match between broad scope information content and task uncertainty will be positively associated with dashboard utilization.
- Proposition 5: The match between the KPI metrics and task uncertainty will be positively associated with dashboard utilization.
- Proposition 6: Dashboard utilization will be positively associated with support for decision-making.

After the initial data collection and analysis, the following propositions are added to the protocol as a result of the explanation building process. This set of propositions is

[20] Propositions 1, 2, and 6 will be used to motivate the Study in Chapter 3. Propositions 3, 4, 5, and 6 are used to motivate the Study in Chapter 4.

investigated utilizing a second set of semi-structured interview question to conduct the remaining interviews. The second set of semi-structured interview questions are included at the end of the protocol. All of the propositions are utilized throughout the study to drive inquiry and help guide the explanation building process (Yin, 2009).

- Proposition 7: The relationship between dashboard quality and utilization will be moderated by strategy alignment/surrogation.
- Proposition 8: Strategy surrogated dashboards will be positively associated with personal performance.
- Proposition 9: Strategy surrogated dashboards will be positively associated with organizational performance.
- Proposition 10: Based on IPT, dashboards will increase information processing through interactive use. The interactive use will be associated with strategy surrogation.
- Proposition 11: Dashboard system accessibility is positively associated with interactive use.

Unit of Analysis

The overall unit of analysis is at the individual level. The digital dashboard and moderators are at the organizational level.

Variables

1. Endogenous variables
    a. Utilization
    b. Decision support
        i. Decision-making
        ii. Verification of prior decisions
2. Exogenous variables
    a. Dashboard Quality
        i. Accessibility
        ii. Response time
        iii. Flexibility
    b. Dashboard Information Quality
        i. Accuracy
        ii. Completeness
        iii. Currency
        iv. Format
    c. Dashboard Information Content
        i. Scope of information
        ii. Performance Drivers
        iii. Interactive information
    d. Task Uncertainty
3. Moderators

a. Learning Curve
b. Training
c. Managerial performance evaluation measures.

Procedures

1. Sample selection
    a. Organizational participants
        i. The main sample for this study will be drawn from financial, retail, and manufacturing organizations that have higher levels of decentralization and environmental uncertainty. Since this study is exploratory in nature, other firms may be included for contrast and comparative analysis of the data found in the primary organizations.
    b. Individual participants from the target organizations
        i. The primary sample for the individuals to interview will concentrate on mid-level managers who have authority over operational aspects in their organizations.
        ii. Other mid-level managers may be interviewed to broaden the understanding of how dashboards are utilized to manage day-to-day operations. These managers may work in areas such as IT, sales, accounting, or finance.
        iii. Consultants that work in the area of BI or information reporting may also be interviewed to gain additional perspectives.

Initial Scheduling of Field Visits

1. Semi-structured Interview Questionnaire pilot testing – July/August 2012
2. Full study – Fall 2012

Sources of Information

1. Sources of data
    a. Interviews
    b. Documents
        i. Snap shots of actual dashboard.
        ii. Field notes specifying design of dashboard.
        iii. Reports generated by manager through the dashboard.
        iv. Reports received by manager otherwise.

Analysis Plan and Case Study Reports

The analysis of the data will take place in the following manner:

1. The coding of the data will be completed by the researcher as well as computerized coding through NVIVO (or similar software).
2. The analysis will rely on all the relevant evidence and include any major rival interpretations of the analysis.
3. The analysis may utilize the researcher's prior, expert knowledge to further the analysis.
4. Additional resources coding and analysis may include Malina and Selto (2001) and the Miles and Huberman (1994) matrix.

Protocol Questions

The semi-structured questionnaire is forwarded to the interviewees prior to the interview to help them organize their thoughts and provide more thorough answers.

Initial set of semi-structured interview questions

Background of respondent and organization

1. What is your exact position at present?
2. How long have you been in this position?
3. Please summarize your job description.
4. What was your job title in the position you held immediately prior to this one?
5. How many years did you hold that position?
6. What are the estimated total annual sales for your organization?
7. What is the estimated total number of employees in your organization?
8. Who is the provider of your BI software and digital dashboard?

Dashboard

1. What are two to three of the most important tasks or activities you use your dashboard to complete?
2. What do you like best (features) about your dashboard?
3. What is the ONE thing you would change about your dashboard?
4. Who uses dashboards in your organization?

Dashboard Quality

1. Accessibility
    a. What is the level of effort required to retrieve information from your dashboard on a scale of 1 to 5, with 1 being easiest and 5 being the most difficult.
    b. At what locations (i.e., office, home, coffee shop, traveling) do you access the dashboard? Why?
    c. How do you access your dashboard at these various locations?
    d. Is the dashboard user friendly?
2. Response time
    a. Does your dashboard offer drill-down capabilities? (Drill down capabilities allow you to double click on a summary measure to reveal more detailed information about the measure)

b. How important is the drill-down feature to you?
c. Why do you use drill down capabilities?

3. Flexibility
    a. Can you set up your own dashboard? (i.e., select metrics to display or the format – tabular or graphs). Why or why, not?
    b. Who set up your dashboard? If you did not, which department of the company is in charge of the dashboard implementation?
    c. What types of presentation formats do you use to display your data on your dashboard? For example, is the data numerical, graphical, both, or something different?
    d. How do you decide what information to present on the dashboard?
4. Integration
    a. What is the source of your data?

Dashboard Information Quality

1. Accuracy
    a. On a scale from 1 to 5 (1 being the lowest and 5 being the highest), what is the level of accuracy and consistency of the data received from your dashboard?
    b. Why did you select this number for accuracy?
2. Completeness
    a. On a scale from 1 to 5 (1 being the lowest and 5 being the highest), what is the level of completeness of the data received from your dashboard?
    b. Why did you select this number for completeness?
3. Currency
    a. On a scale from 1 to 5 (1 being the lowest and 5 being the highest), what is the level of currency or timeliness of the information from the dashboard?
    b. Why did you select this number for currency?
4. Format
    a. Does the format of the information presented on the dashboard match the tasks you perform?
        i. Why or why not?

Utilization - Intensity

1. What is your level of utilization of the dashboard?
    a. How often do you use your dashboard?
    b. How much of the functionality do you actually utilize?
2. Why do you use your dashboard?

Decision Support

1. Do you use the dashboard to make new decisions; verify prior decisions; or both?
    a. Give me some examples.

Task Variability

1. On a scale from 1 to 5, with 1 being the lowest and 5 being the most, to what extent do you perform repetitive activities in doing your job?

Task Difficulty

1. On a scale from 1 to 5, with 1 being the lowest and 5 being the most, to what extent is there an understandable sequence of steps than can be followed in doing your work?
2. During the course of your work, how often do you come across specific difficult problems that you don't know how to solve immediately?
3. In general, how much actual *thinking time* (in actual minutes) do you usually spend trying to solve such specific problems?

Information Content

1. Scope of information presented on dashboard
    a. Does your dashboard contain internal data, external data (supply chain, competitive, market), or both?
    b. Does your dashboard contain information presented in financial metrics, non-financial metrics, or both?
    c. What is the time horizon of the data on your dashboard? (historical, forward looking or both)
2. Performance Measures
    a. What performance indicators are contained on your dashboard?
    b. Why were these particular measures selected?
3. Quantity of Metrics
    a. How many metrics does your dashboard display?
    b. How many metrics would you like to have?

Follow-up questions

1. Are there any other items which have impacted the manner in which you utilize your dashboard that we have not discussed?
2. Are there any other items which have impacted the manner in which your dashboard supports your decision-making or prior decision verification that we have not discussed?

Other Items impacting utilization

1. Learning curve
    a. How long have you been using the dashboard?
    b. Are you comfortable with using the dashboard?
2. Ongoing Training
    a. Did you receive any training for the dashboard?
        i. When was the training received? Is the training ongoing?
3. Are the measures you show in your dashboard similar to the measures used in your personal performance evaluation?
    a. If yes, what percentage of the dashboard measures are similar to your personal performance evaluation measures?

Second set of Semi-structured Questions[21]

Background of respondent and organization

1. What is your exact position at present?
2. How long have you been with your current position and current company?
3. Please summarize your job description.
4. What are the estimated total annual sales or number of employees for your organization?
5. Who is the provider of your BI software and digital dashboard?

Dashboard

1. What are two to three of the most important tasks or activities you use your dashboard to complete?
2. What do you like best (features) about your dashboard?
3. What is the ONE thing you would change about your dashboard?
4. Who uses dashboards in your organization?

Strategy

1. Are your organizations overall goals and objectives understood by most managers in the organization?
    a. What are some examples of these goals?
2. Do you use your dashboard to meet these organizational goals? If yes, please explain.
3. Do you use your dashboard to meet personal goals? If yes, please explain.
4. Which type of goal, organizational or personal, receives the most attention from you when you use your dashboard?
5. Does your dashboard provide information that could be deemed consistent throughout your organization?
    a. How does the consistency of the information in your dashboard impact your ability to meet the overall goals of the organization?
6. Does your dashboard provide information that is transparent throughout your organization?
    a. How does the transparency of the information in your dashboard impact your ability to meet the overall goals of the organization?

Interactive

1. Does the information presented on your dashboard receive regular attention from managers at all levels in your organization.
2. Is the information presented on your dashboard a common topic with your superior? How? Why?
3. Is the information presented on your dashboard a common topic of discussion with your peers? How? Why?
4. Is the information presented on your dashboard a common topic with your subordinates? How? Why?

[21] Updated semi-structured questions aimed at strategy alignment/surrogation and interactive use of the dashboard system. This set of questions was utilized for the second phase of interviews during the explanation building process.

5. Does using your dashboard in this "interactive" manner help you meet overall organizational objectives?
6. Does using your dashboard in this "interactive" manner help you meet personal objectives?

Management Control

1. Does the dashboard enable control cause you to reorganize your resources and activities to improve your performance based on the measures contained in your dashboard?

Follow-up questions

1. Are there items which have impacted the manner in which you utilize your dashboard that we have not discussed?

APPENDIX B: SURVEY INSTRUMENT

Digital Dashboards Survey Data Collection April 2013

Q1 Do you use a digital dashboard in your role within your organization? A digital dashboard is typically a computer page which displays or allows continuous access to performance measures and/or other graphical measures that enable managers to monitor performance or inform decisions at a glance.

- I do not use a digital dashboard.
- I use a digital dashboard.
- I create or develop digital dashboards for others in my organization, but I do not use one in my role in the organization.
- I create or develop digital dashboards for other employees and I use one in my role in the organization.

Q2 Please indicate your typical level of interaction with the dashboard:

- Daily
- Weekly
- Monthly
- Quarterly
- Annually

Q3 Please indicate your present level of management within your organization:

- Executive or Senior Management (Senior Vice President and above)
- Vice President
- Division or Product Management
- Middle Management (includes Director, Sales Management, Area Management, Department Management/Head, Functional Management, Store or Location Management, etc)
- Entry Level Management
- Other

- Q4 Please indicate the departmental or functional area where you work:
- Manufacturing/Production
- Operations Management
- Sales/Marketing
- Health care
- Financial Services
- Accounting
- Other
- Information Systems or Technology
- Purchasing
- Project Management
- Business Intelligence/Analyst

Q5 What size company do you work for based on number of employees?

- Less than 100
- 101 – 250
- 251 - 1,000
- 1,001 – 5,000
- 5,001 – 10,000
- Greater than 10,000

Q6 Please indicate the country or region where your office is located:

- Asia
- Australia/Pacific
- Canada
- Europe
- South America

- United States
- Other

You are being invited to participate in a research project conducted by the University of Central Florida (UCF). Whether you take part is up to you. The purpose of this research involves a study of the effects of digital dashboards on the managerial decision environment and managerial performance. The questionnaire will take about 20 minutes of your time.

Your responses will be completely anonymous and only aggregated data will be included in any resulting publication or presentations. You must be at least 18 years of age to participate in this study. You have the right to withdraw your consent or discontinue participation at any time. Questions or complaints about research participants' rights may be directed to the UCF IRB office IRB@ucf.edu or at (407) 823-2901.

By clicking "next" below you are indicating that you understand the above and voluntarily consent to participate in the research. Thank you very much for agreeing to participate.

Q8 Please indicate your level of agreement or disagreement with the following statements about the characteristics of your dashboard system. Please provide your answers using the scale of “Agree” through "Disagree.”

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard system is accessible to me from anywhere (home, office, during meetings, while traveling, etc.).	❍	❍	❍	❍	❍	❍
My dashboard system can be retrieved using different types of technology.	❍	❍	❍	❍	❍	❍
My dashboard system can be retrieved from locations outside my office.	❍	❍	❍	❍	❍	❍
My dashboard system has a high level of mobility.	❍	❍	❍	❍	❍	❍
My dashboard system is accessible during business meetings	❍	❍	❍	❍	❍	❍
My dashboard system is accessible during staff meetings.	❍	❍	❍	❍	❍	❍

Q9

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard system integrates data from different areas within my company.	❍	❍	❍	❍	❍	❍
My dashboard system pulls together data from different departments in my company.	❍	❍	❍	❍	❍	❍
My dashboard system combines information from various departments in my company.	❍	❍	❍	❍	❍	❍
My dashboard system's data combines data from various computer systems within our company.	❍	❍	❍	❍	❍	❍
My dashboard system integrates data from all of our databases.	❍	❍	❍	❍	❍	❍
My dashboard system is based on a common database.	❍	❍	❍	❍	❍	❍

Q10

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard system can be adapted to meet a variety of my needs.	❍	❍	❍	❍	❍	❍
My dashboard system can be adjusted to any new requirements.	❍	❍	❍	❍	❍	❍
My dashboard system is versatile in addressing my new desires as they arise.	❍	❍	❍	❍	❍	❍
My dashboard system can be organized to meet my personal needs.	❍	❍	❍	❍	❍	❍
I can customize my dashboard system.	❍	❍	❍	❍	❍	❍
My dashboard system can accommodate changes in the business environment quickly.	❍	❍	❍	❍	❍	❍

Q11 Please indicate your level of agreement or disagreement with the following statements about the characteristics of your dashboard information output. Please provide your answers using the scale of “Agree” through "Disagree.”

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard includes a complete set of information relevant to my work.	❍	❍	❍	❍	❍	❍
My dashboard contains a comprehensive set of information applicable to my job.	❍	❍	❍	❍	❍	❍
My dashboard includes the extent of information that is appropriate for my tasks.	❍	❍	❍	❍	❍	❍
My dashboard contains all of the relevant information for my job.	❍	❍	❍	❍	❍	❍
My dashboard contains the range of information important in my job.	❍	❍	❍	❍	❍	❍

Q12

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard shows the most recent information available.	❍	❍	❍	❍	❍	❍
My dashboard displays the most current information in the system.	❍	❍	❍	❍	❍	❍
The information reported on my dashboard is up to date.	❍	❍	❍	❍	❍	❍
There is no delay between the occurrence of an event and my dashboard displaying the information.	❍	❍	❍	❍	❍	❍
The information displayed by my dashboard is updated immediately as new information enters the system.	❍	❍	❍	❍	❍	❍

Q13

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
The information reported on my dashboard is accurate.	❍	❍	❍	❍	❍	❍
The information displayed on my dashboard is error free.	❍	❍	❍	❍	❍	❍
I am satisfied with the accuracy of my dashboard information.	❍	❍	❍	❍	❍	❍
The information presented on my dashboard is believable.	❍	❍	❍	❍	❍	❍
The information reported on my dashboard is reliable.	❍	❍	❍	❍	❍	❍
The information my dashboard displays is correct.	❍	❍	❍	❍	❍	❍
Please select 'disagree' as your answer to this question.	❍	❍	❍	❍	❍	❍

Q14 Please indicate your level of agreement or disagreement with the following statements about the content of your dashboard information and how the information may be used. Please provide your answers using the scale of "Agree" through "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard reports information that relates to possible future events such as potential trends in sales, profits, expenses, cash flow etc.	❍	❍	❍	❍	❍	❍
My dashboard shows information that quantifies the likelihood of future events occurring (e.g., probability estimates).	❍	❍	❍	❍	❍	❍
My dashboard presents non-economic information, such as customer preferences, employee attitudes, competitive threats, etc.	❍	❍	❍	❍	❍	❍
My dashboard displays information that is external to my organization, such as economic conditions, market data, competitor data, customer information, etc.	❍	❍	❍	❍	❍	❍
My dashboard presents information that is non-financial that relates to internal processes (e.g., sales process, production/manufacturing process, patient care quality measures, etc.).	❍	❍	❍	❍	❍	❍
My dashboard shows information that is non-financial that relates to market information such as market size, market share, etc.	❍	❍	❍	❍	❍	❍

Q15

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard displays information associated with the overall organizational goals that create value for our stakeholders.	❍	❍	❍	❍	❍	❍
My dashboard displays information representative of the activities that drive organizational success.	❍	❍	❍	❍	❍	❍
My dashboard displays information that is associated with the overall objectives of the organization.	❍	❍	❍	❍	❍	❍
My dashboard shows information that is linked to organizational goals.	❍	❍	❍	❍	❍	❍
My dashboard displays information that shows me how my work fits with the overall goals of the organization.	❍	❍	❍	❍	❍	❍
My dashboard shows information that is associated with achieving overall organizational performance.	❍	❍	❍	❍	❍	❍

Q16 Please indicate your level of agreement or disagreement with the following statements about the content of your dashboard information and how the information may be used. Please provide your answers using the scale of "Agree" through "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard reports information that receives regular attention from managers at all levels in my organization.	❍	❍	❍	❍	❍	❍
My dashboard shows information that is an important source of communication with my supervisor.	❍	❍	❍	❍	❍	❍
My dashboard contains information that is an important source communication in inter-departmental meetings.	❍	❍	❍	❍	❍	❍
My dashboard displays information that is an important source of communication with my peers.	❍	❍	❍	❍	❍	❍
My dashboard shows information that is an important source of communications with my subordinates.	❍	❍	❍	❍	❍	❍
My dashboard contains information that is an important source of communication by the highest levels of management.	❍	❍	❍	❍	❍	❍

Q17

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
Information from my dashboard enables discussion in meetings with superiors, sub-ordinates, and/or peers.	❍	❍	❍	❍	❍	❍
Information from my dashboard enables continual challenge and debate of action plans, their underlying assumptions, and their underlying data.	❍	❍	❍	❍	❍	❍
Information from my dashboard provides a common view of the organization.	❍	❍	❍	❍	❍	❍
Information from my dashboard ties the organization together.	❍	❍	❍	❍	❍	❍
Information from my dashboard enables the organization to focus on common issues.	❍	❍	❍	❍	❍	❍
Information from my dashboard enables the organization to focus on critical success factors.	❍	❍	❍	❍	❍	❍
Information from my dashboard has helped to develop a common vocabulary in the organization.	❍	❍	❍	❍	❍	❍

Q18 Please indicate your level of agreement or disagreement with the following statements about the characteristics of your dashboard use. Please provide your answers using the scale of "Agree" through and "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
I use my dashboard information to decide how to best approach a problem.	❍	❍	❍	❍	❍	❍
I use my dashboard information to help me think through problems.	❍	❍	❍	❍	❍	❍
I use my dashboard information to make sure my analysis of a problem matches the data.	❍	❍	❍	❍	❍	❍
I use my dashboard 7information to check my thinking against the data.	❍	❍	❍	❍	❍	❍
I use my dashboard information to make sense out of my data.	❍	❍	❍	❍	❍	❍
I use my dashboard information to analyze why problems occur.	❍	❍	❍	❍	❍	❍

Q19

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
I use my dashboard to help me explain my decisions.	❍	❍	❍	❍	❍	❍
I use my dashboard to help me justify my decisions.	❍	❍	❍	❍	❍	❍
I use my dashboard to help me make explicit the reasons for my decisions.	❍	❍	❍	❍	❍	❍
I use my dashboard to rationalize my decisions.	❍	❍	❍	❍	❍	❍
I use my dashboard to control the decision process.	❍	❍	❍	❍	❍	❍
I use my dashboard to improve the effectiveness of the decision process.	❍	❍	❍	❍	❍	❍
I use my dashboard to improve the efficiency of the decision process.	❍	❍	❍	❍	❍	❍
I use my dashboard to make the decision process more rational.	❍	❍	❍	❍	❍	❍
Please select 'disagree' as your answer to this question.	❍	❍	❍	❍	❍	❍

Q20 Please indicate your level of agreement or disagreement with the following statements about the usefulness of your dashboard. Please provide your answers using the scale of "Agree" through and "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
Using my dashboard improves my job performance.	❍	❍	❍	❍	❍	❍
Using my dashboard enables me to perform tasks more quickly.	❍	❍	❍	❍	❍	❍
Using my dashboard enhances my effectiveness on the job.	❍	❍	❍	❍	❍	❍
Using my dashboard increases my productivity.	❍	❍	❍	❍	❍	❍
Using my dashboard makes it easier to do my job.	❍	❍	❍	❍	❍	❍
Overall, I find my dashboard system useful in my job.	❍	❍	❍	❍	❍	❍

Q21 Please indicate the level of dependence on your dashboard to facilitate the following items based on the scale ranging from "Agree" through "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
I depend on my dashboard for decision-making.	❍	❍	❍	❍	❍	❍
I depend on my dashboard for verification of prior decisions.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to guide my activities.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to monitor my personal performance.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to achieve the goals and objectives of the organization.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to manage my work.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to manage my subordinates.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to let my superiors know how I am performing.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to perform trend analysis of the data.	❍	❍	❍	❍	❍	❍
I depend on my dashboard to provide feedback for new initiatives.	❍	❍	❍	❍	❍	❍

Q22 Please indicate your level of agreement or disagreement with the following statements about your level of satisfaction with your dashboard. Please provide your answers using the scale of "Agree" through and "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
I am very pleased with my dashboard.	❍	❍	❍	❍	❍	❍
I am very contented with my dashboard.	❍	❍	❍	❍	❍	❍
I feel delighted with my dashboard.	❍	❍	❍	❍	❍	❍
Overall, I am very satisfied with my dashboard.	❍	❍	❍	❍	❍	❍

Q23 Please indicate your level of agreement or disagreement with the following statements about the impact of your dashboard on your decision-making. Please provide your answers using the scale of "Agree" through and "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard has improved the effectiveness of my decisions.	❍	❍	❍	❍	❍	❍
My dashboard has enhanced the accuracy of my decisions.	❍	❍	❍	❍	❍	❍
My dashboard has improved the speed of my decision making.	❍	❍	❍	❍	❍	❍
My dashboard has improved the outcomes of my decisions.	❍	❍	❍	❍	❍	❍
My dashboard has increased the range of alternatives available to me for my decision-making.	❍	❍	❍	❍	❍	❍
My dashboard has enhanced my level of confidence in my decisions.	❍	❍	❍	❍	❍	❍
Please select 'no basis for responding' as your answer to this question.	❍	❍	❍	❍	❍	❍

Q24 Please rate your overall performance in your job for the areas listed below based on the scale of "Agree" through "Disagree". We are interested in your own personal view of your performance, not a guess as to how others might rate you.

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
I complete my assigned duties.	❍	❍	❍	❍	❍	❍
I fulfill the responsibilities specified in my job description.	❍	❍	❍	❍	❍	❍
I perform the tasks that are expected of me.	❍	❍	❍	❍	❍	❍
I meet the formal performance requirements of my job.	❍	❍	❍	❍	❍	❍
I engage in the activities that directly affect my performance evaluation.	❍	❍	❍	❍	❍	❍
I perform the aspects of my job that I am obligated to perform.	❍	❍	❍	❍	❍	❍
I perform the essential duties.	❍	❍	❍	❍	❍	❍

Q25 Please rate your organization's performance for the areas listed below based on the scale of well above average through well below average. We are interested in your own personal view of your organization's performance, not a guess as to how others might rate the organization.

	Well Above Average	Above Average	Average	Below Average	Well Below Average	NO BASIS FOR RESPONDING
Relative to your business unit's stated objectives, how is your business unit performing in sales growth?	❍	❍	❍	❍	❍	❍
Relative to your major competitors in the industry, how is your business unit performing in sales growth?	❍	❍	❍	❍	❍	❍
Relative to your business unit's stated objectives, how is your business unit performing in profitability?	❍	❍	❍	❍	❍	❍
Relative to your major competitors in the industry, how is your business unit performing in profitability?	❍	❍	❍	❍	❍	❍
Relative to your business units expectations, how is your business unit performing?	❍	❍	❍	❍	❍	❍
Relative to your major competitors in the industry, how is your business unit’s overall financial performance?	❍	❍	❍	❍	❍	❍
Overall performance of your business unit relative to expectations.	❍	❍	❍	❍	❍	❍

Q26 These questions DO NOT relate to your dashboard usage, just your overall job responsibilities. Please indicate your level of agreement or disagreement with the following statements about the job you perform in your organization. Please provide your answers using the scale of "Agree" through and "Disagree."

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
There is a clearly known way to do the majority of my work.	❍	❍	❍	❍	❍	❍
I can rely on established procedures to do my work.	❍	❍	❍	❍	❍	❍
There is an understandable sequence of steps for carrying out my work.	❍	❍	❍	❍	❍	❍
There is a clearly defined body of information that can guide my work.	❍	❍	❍	❍	❍	❍
I rarely encounter problems in my work that I do not know how to solve immediately.	❍	❍	❍	❍	❍	❍
I can go to someone else for assistance if I do not know the answer to a problem.	❍	❍	❍	❍	❍	❍
I am sure of the eventual outcome for the majority of my tasks.	❍	❍	❍	❍	❍	❍

Q27

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
The tasks I perform are the same from day to day.	❍	❍	❍	❍	❍	❍
I do the same job in the same way most of the time.	❍	❍	❍	❍	❍	❍
The daily tasks I perform are routine.	❍	❍	❍	❍	❍	❍
I perform repetitive activities in doing my job.	❍	❍	❍	❍	❍	❍
I complete my work the same way most of the time.	❍	❍	❍	❍	❍	❍

Q28 Please indicate your level of agreement or disagreement with the following statements about the strategic objectives of your organization. Please provide your answers using the scale of “Agree” through "Disagree.”

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My dashboard contains performance measures that directly represent the overall strategy of my organization.	❍	❍	❍	❍	❍	❍
My dashboard includes performance measures that are directly associated with our corporate strategy.	❍	❍	❍	❍	❍	❍
My dashboard contains performance measures used to execute the overall strategic objectives in my organization.	❍	❍	❍	❍	❍	❍
My dashboard includes performance measures that show our organizational strategy.	❍	❍	❍	❍	❍	❍
My dashboard contains strategic performance measures developed by the corporate office.	❍	❍	❍	❍	❍	❍

Q29

	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	NO BASIS FOR RESPONDING
My organization has written strategic objectives that are known throughout the organization.	❍	❍	❍	❍	❍	❍
My organization's strategy is utilized to guide the allocation of resources throughout the organization.	❍	❍	❍	❍	❍	❍
My organization's strategy is utilized to guide the decision-making throughout the organization.	❍	❍	❍	❍	❍	❍
My organization has a shared understanding of the overall company strategic objectives.	❍	❍	❍	❍	❍	❍
There is a common language utilized in measuring our strategic objectives.	❍	❍	❍	❍	❍	❍
My departments/divisions goals are purposefully aligned with the overall strategic goals of the organization.	❍	❍	❍	❍	❍	❍

Please answer the following demographic questions about yourself, your organization, and your dashboard experience.

Q31 What is your age in years?

Q32 What is your gender?

- ❍ Male
- ❍ Female

Q33 How many years of professional work experience do you have in total?

- ❍ 2 Years or Less
- ❍ 2 Years up to 5 Years
- ❍ 5 Years up to 10 Years
- ❍ 10 Years up to 20 Years
- ❍ Greater than 20 Years

Q34 How many years have you been employed by your current organization?

- ❍ 2 Years or Less
- ❍ 2 Years up to 5 Years
- ❍ 5 Years up to 10 Years
- ❍ 10 Years up to 20 Years
- ❍ Greater than 20 Years

Q35 What is the highest level of education obtained?

- ❍ Some High School
- ❍ High school graduate/diploma
- ❍ Some college courses or technical school courses
- ❍ 2 year College Degree
- ❍ 4 year College Degree
- ❍ Master's Degree or higher
- ❍ Other _____

Q36 Please indicate the primary industry of your organization or work unit:

- ❍ Chemical
- ❍ Finance
- ❍ Health care
- ❍ Manufacturing
- ❍ Retail
- ❍ Service
- ❍ Technology
- ❍ Transportation
- ❍ Utilities
- ❍ Wholesale Distribution
- ❍ Other _____

Q37 What size company do you work for based on annual sales revenue?

- ❍ Less than $10 million
- ❍ $10 million up to $100 million
- ❍ $101 million up to $500 million
- ❍ Greater than $500 million

Q38 Is your company privately owned or publicly traded?

- ❍ Privately owned
- ❍ Publicly Traded
- ❍ I do not know

Q39 Please indicate the number of years you have utilized digital dashboard in your work life:

- ❍ 1 Year or Less
- ❍ 1 Year up to 3 Years
- ❍ 3 Year up to 5 Years
- ❍ 5 Year up to 7 Years
- ❍ Greater than 7 Years

Q40 Please indicate whether you utilize your dashboard for more short-term or long-term activities:

- ❍ More short-term (activities spanning one month or less)
- ❍ More long-term (activities spanning more than one month)
- ❍ Balanced between long-term and short-term

Q41 Please indicate the source of the software for your dashboard:

- ❍ Standard package provided by a third party software vendor
- ❍ Standard package provided by a third party software vendor that includes internal modifications
- ❍ Internally custom-developed package
- ❍ Externally custom-developed package
- ❍ I do not know
- ❍ Other _____

Q42 Please indicate if your organization uses a balanced scorecard:

- ❍ Yes
- ❍ No
- ❍ I do not know

Q43 Would you like an executive summary of the results of this research project?

- ❍ Yes
- ❍ No

Q44 Please provide any additional comments about this survey or your dashboard use that you may think are important.

APPENDIX C: IRB APPROVALS

IRB Approval for the Study One

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jeffrey F. Reinking**

Date: **August 02, 2012**

Dear Researcher:

On 8/2/2012, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	The faculty supervisor is changing from Dr. Steve Sutton to Dr. Vicky Arnold. Participant population has been modified from business owners and executives to mid-level operational managers in larger versus smaller organizations. A revised consent document has been approved for use.
Project Title:	Accounting Information Systems and Digital Dashboards
Investigator:	Jeffrey F Reinking
IRB Number:	SBE-10-06994
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 08/02/2012 01:44:11 PM EDT

IRB Coordinator

IRB Approval for the Studies Two and Three

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jeffrey F. Reinking**

Date: **March 14, 2013**

Dear Researcher:

On 3/14/2013, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	The impact of the diffusion of digital dashboard technology on the managerial decision environment and managerial performance
Investigator:	Jeffrey F Reinking
IRB Number:	SBE-13-09243
Funding Agency:	Institute of Management Accountants- Foundation for Applied Research(IMA)
Grant Title:	Foundation for Applied Research Doctoral Student Grant
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/14/2013 11:00:17 AM EST

Joanne Muratori

IRB Coordinator