9-19-2022

# A Digital Leadership Lens for a Physical World: Digital Transformation Levers of Control for Incumbent Companies

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# Digital Transformation Levers of Control for Incumbent Companies

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A Dissertation Submitted to The Graduate School at the University of Missouri – St. Louis in partial fulfillment of the requirements for the degree Doctor of Business Administration with an emphasis in Strategic Management

December 2022

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## Acknowledgements

Life's most meaningful journeys are rarely ever taken alone. This one is no exception. My efforts would be meaningless without support from the many selfless people in my network. To start, I would like to thank my CIO colleagues who provided their valuable insights which became the foundation of my research. While these CIOs provided their knowledge, the UMSL DBA staff and classmates provided support throughout the journey and somehow made it enjoyable despite the intense workload.

However, the UMSL faculty were the real beacons in this journey. Very few people in this world devote their lives to making others better. There are even fewer who selflessly provide their time and knowledge as readily as the UMSL faculty. Dr. Ekin Pellegrini belongs at the top of that list. It was her vision and program leadership which made this journey possible. Special recognition also belongs to my dissertation advisors, Dr. Doug Smith, and Dr. Joseph Rottman who readily provided their expert guidance and compassion. Most of all, Dr. Dinesh Mirchandani deserves my deepest gratitude for his gracious support and countless hours spent kindly advising me in his special way.

None of this would be possible, however, without the support of my family. My parents provided the encouragement to pursue my academic interests throughout my life and to achieve this milestone. I hope my journey serves as inspiration for my own children, Kelsey, John and Eric, to pursue their own ambitions, whatever they may be. Finally, no one invested more in this journey than Jan, my wife and partner, who patiently allowed me to devote countless hours and mental focus to achieve this goal. There is no one I would rather have by my side during life's most important moments.

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## Abstract

A new wave of advanced technologies is disrupting companies of all types and transforming business models within every industry. Long-standing industrial firms that rose to prominence in a pre-digital economy are particularly vulnerable. Prevailing views suggest these companies (hereafter referred to as incumbents) must reimagine their value propositions and transform themselves by leveraging today's advanced technologies. The opportunities provided by these advanced technologies will significantly affect incumbents whether they participate or not. The pursuit of these opportunities, commonly referred to as digital transformation (DX), is the focus of our research.

Traditional technology-enabled business endeavors creating incremental operational improvements fell within the domain of information technology organizations. DX is more profound and has become a leadership imperative for all top-level managers. The leaders of incumbent companies are facing a "moment-of-truth" with some characterizing the situation as "digital or death". With this gravity, it is not surprising that academic and business research highlights the critical role of leadership.

To address this challenge, our research leveraged prior academic views on the use of management control systems utilized to guide organizational change and employee behavior. We tested a DX control system model to identify leadership processes that are correlated to DX success. Additionally, our research highlights a new digital leadership capability required for top-level managers, which we refer to as digital acuity. Evidence suggests these leaders need high levels of digital acuity to understand new technologies, develop a digitally enabled vision for their organization, and champion digital innovation.

As such, we extend prior research with the addition of digital acuity to the DX control system framework. Finally, we provide evidence that points to a mediated model explaining how digital acuity interacts with the utilization of the process components to drive DX success.

As famed management consultant, Peter Drucker, once said “the greatest danger in times of turbulence is not the turbulence, it is to act with yesterday’s logic”. Our findings provide incremental and original insights into a new digital leadership lens for leaders of incumbent companies in their pursuit of a digitally enabled future.

## Keywords

Digital transformation, management control systems, incumbents, creative destruction, disruptive innovation, fourth industrial revolution, industry 4.0, digital intelligence, leadership 4.0

# Chapter 1: Introduction

## Unprecedented Change, Again

The business world today is caught in the vortex of transformational forces generated by technological advances. Market disruptions like these are rare but not new to the business world. Eighty years ago, renowned economist Joseph Schumpeter (1942) noted that capitalist markets are constantly changing, and economic progress is synonymous with turmoil.

In his influential book, *Capitalism, Socialism and Democracy*, Schumpeter suggested the most important market forces originate not from traditional competitors but from forces that upend markets. Those forces include the periodic introduction of new organizational types, new commodities, new methods of supply, and most important for this research, new technologies. While traditional competitive forces impact a firm's profitability, transformational forces described by Schumpeter can impact the firm's very existence.

The relevance of Schumpeter's comments eight decades later suggests disruption from technology is constant. But, while this disruption may be constant, the impact can come in waves. The most profound waves become marked in time, most notably the first, second, and third industrial revolutions. Few organizations could survive these periods without adopting new technologies and business practices.

Today, the new wave of major technological progress is so impactful that many assert the business world has entered the fourth industrial revolution (4IR) (Schwab, 2017). Warner (2019) describes the impact on businesses. First, advanced technologies such as artificial intelligence, internet-of-things, blockchain, and additive manufacturing are being deployed in ways that disrupt traditional value chains and business models. Second, these new technologies are changing customer behaviors as the customer experience is becoming increasingly digital. Lastly, competition is no longer defined by traditional cohorts. The competitive landscape now includes those from adjacent or completely different industries (Reddy, 2017) sometimes with winner-take-all outcomes (Reinartz, 2019).

**But This Time is Different**

Schwab (2017) explains how the fourth industrial revolution is different from its predecessor. Change is happening with much greater velocity than in the third industrial revolution. The 4IR is impacting every organization and every industry through a host of new technologies. These technologies create a fusion of the physical, digital, and biological worlds. The impact is more systemic than the third industrial revolution such that business models and ecosystems are being completely disrupted. It is not just a product revolution.

Especially vulnerable to these forces are long-standing industrial firms that rose to prominence in a pre-digital economy, which researchers refer to as incumbents. Schumpeter (1942) used the term creative destruction to describe the threat to these firms where innovative upstarts disrupt established firms during times of dynamic change. New technologies level the playing field by enabling smaller companies to scale more quickly and disrupt established business models. Mirroring Schumpeter's views, Christensen proposed the popular theory of "disruptive innovation" (Bower & Christensen, 1995 and Christensen, 1997). He described how incumbent companies are strong in sustaining innovation but vulnerable to disruptive innovation driven by technological advancements. Initially, the new technologies might not be valued by the customer and ignored by incumbents. But technological advancements eventually change the performance attributes at such a rapid rate that incumbents cannot catch up.

Often, the result disintermediates the value proposition of incumbent firms like General Electric (GE). The former CEO of GE, Jeffrey Immelt, cautions firms to pay attention because becoming digital is required for them to survive (Govindarajan & Immelt, 2019). Mazzone (2014) more bluntly suggests it is “digital or death”. Pursuing digital transformation is no longer an option for incumbents (Govindarajan & Immelt, 2019). Siebel (2017) likens it to periods of mass extinction in the biological world by highlighting the rapid turnover of companies listed in the Fortune 500.

A survey conducted by the Society of Information Management demonstrated this growing awareness (Kappelman, 2019). Feedback from technology leaders indicated the top three management issues continued to be cybersecurity, business alignment, and data analytics. These issues have remained at the top of the list for the last three years. However, during that time, a new priority rose to fourth on the list of most important management issues. Suddenly, digital transformation and the need to leverage the new technologies of the 4IR have become a management imperative. Approximately 90% of business leaders expect to leverage these new technologies to shape and drive their business strategies (Hess, 2016). Yet only 38% of leaders surveyed as part of research conducted by MIT Sloan business school and Capgemini Consulting believe their organizations have the necessary capabilities (Westerman, 2014) to succeed. Even fewer, 35%, believe their companies have the leadership capabilities.

Digital transformation (DX) is the prevailing term used to describe those digital strategies. The definition of DX varies in existing literature but generally follows a common theme. Vial (2019) reviewed 28 research papers with 23 unique definitions to formulate the following aggregate definition:

> **Key Definition**: Digital Transformation (DX) is "*a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.*"

Two key dimensions of Vial's definition are scope and outcome. DX involves: 1) significant changes, not just incremental improvements, and; 2) creation of new value propositions and/or digital products, not just increased revenues from existing products or decreased costs. In other words, incumbents should look and act differently than they did during their pre-digital reign.

### The Most Vulnerable

As suggested by Schwab (2017), the 4IR has widespread reach, but the impact is not felt evenly across industries and companies. Born-digital companies are built upon these technologies and have the organizational capabilities to leverage them. The same cannot be said for incumbents. Companies in industries that make physical products typically lack an understanding of digital transformation (Hanelt, 2015). Immelt goes on to suggest a digital strategy for incumbents is more difficult than managing any other enterprise transformation such as total quality management or lean management (Govindarajan & Immelt, 2019).

In his Harvard Business Review article, "The Theory of Business", Peter Drucker (1994) described a phenomenon where incumbents often do the right things, but the results stop being effective. He attributes this paradox to outdated views of market dynamics. The underlying market assumptions which drive incumbents' actions are no longer valid. The market realities for these firms changed but their core tenets did not.

Digital transformation, therefore, requires incumbents to conduct business differently (Kane, 2017). Top-level managers of these firms must think and lead differently to be successful (Govindarajan & Immelt, 2019). However, there are no recipes to follow. General Electric's infamous DX pursuit is a highly visible case study. Few would argue with GE's prior success -- success based upon institutional processes which allowed the top management team to successfully manage far-flung, diverse businesses. The formula worked well for more than one hundred years and allowed GE to become the most valuable company in the world (Noon, 2020). Inexplicably, digital transformation triggered poor decisions by an otherwise highly effective executive team (Mann, 2020) as the company's valuation plummeted. The failure of GE's management control system leads us to consider how other incumbents can avoid a similar fate.

**It Starts from the Top**

Organizational change requires strong leadership, especially in turbulent times (Kane, 2019). To be successful, the top-level managers must understand and communicate the company's vision and its motivation (Kane, 2018). Other researchers prescribe a more detailed CEO agenda which includes making DX a priority for the organization, demonstrating the desired behaviors, developing a strong transformation team, and directly engaging in the initiative (Dewer & Keller, 2006). The CEO is the only person who can ensure the right people across the organization are doing the right things.

Technology strategies do not usually require CEO attention. DX is different. It has become a mandate for CEOs (Siebel, 2017) due to the degree of change, potential for disruption, and organizational inertia which must be overcome (Danoesastro, 2017). CEOs and other top-level managers play a critical role in defining a digital future and ensuring the organization is aligned toward a common vision (Guzman, 2020). Leadership consulting firm DDI asserts the ability to drive DX will be a defining characteristic of today's top-level managers and will separate winning organizations from those that fall behind (DDI, 2021). It is not surprising then that Kane's (2018) research indicates the CEO's office is cited as the most frequent leader of DX efforts within organizations that are more successful and advanced in their journey.

Leadership style is a key success determinant during previous transformational periods. For example, Kelly's (2018) research suggests the first industrial revolution required charismatic leaders while the second industrial revolution required directive leaders. While the third industrial revolution and 4IR seem similar, Kelly goes on to suggest that leadership styles needed for the 4IR differ from their predecessors. Transactional and relational leadership styles were regarded as optimal in the third industrial revolution. But digital transformation requires a new type of leader with skills and approach to fit the challenge. Not all leaders are equipped.

The level of change brought on by 4IR and DX requires transformational leaders (Guzman, 2020). Guzman cites the need for cultural change, greater innovation, and agility as reasons for transformational behaviors. This is not a traditional technology leader. But traditional leaders must become technologically savvy. Kelly (2018) describes another leadership style required by DX called swarm leadership, a term used for the seemingly synchronized moving and shifting of large groups of animals. Swarm leadership is key in digital transformation because it creates a sense of common mission, connectivity, and the ability to overcome barriers. Collectively, these characteristics have been embodied in what many have described as Leadership 4.0, a new leadership model for the fourth industrial revolution.

While most experienced business leaders have faced inflection points throughout their careers, incumbent leaders typically ascended their organizations during a time when technology played a limited role. Consequently, pre-digital leaders are facing the DX challenge with a different cognition than their born-digital counterparts. Traditional competencies are no longer enough. Skills acquired during their ascent are not the only skills needed going forward. Leaders must enhance traditional skills with new ones to effectively lead their organization into a digital future (Kane, 2019). Digital acuity (also referred to as digital intelligence and digital literacy) is now a required capability for leaders (DDI, 2019).

Unfortunately, most leaders have very low confidence in their digital acuity. Only one out of five top-level managers surveyed by leadership consulting firm DDI feel prepared to lead digital transformation (DDI, 2021). The gap is felt more broadly across the organization as evidenced by a survey conducted by MIT Sloan and Cognizant (Church, 2020) indicating only 9% of respondents felt their leaders embodied the skills and behaviors to be successful digital transformation leaders.

Perhaps, Immelt's experience at General Electric underscores this point. He had a long and successful career at the company and valued the opportunities new technologies provided industrial companies (Gryta, 2020). He also knew transformation would be difficult. However, despite the commitment of Immelt and his team, the lack of digital intelligence within the leadership team ultimately undermined the company. We believe this dilemma is not unique to GE and requires a new digital leadership lens.

**A New Mode of Operation**

Academics and business experts paint an interesting and daunting challenge for top-level leaders seeking to drive DX within incumbent firms. First, prior research consistently highlights the important role of top-level managers – DX must start from the top. In their capacity as leaders, top-level managers must transform the organization's culture to become more agile and elevate the digital acuity of all leaders. But research also suggests decisions and activities must be delegated downward throughout the organization. Subject-matter experts must drive the execution strategies.

Historically, leaders of incumbent firms relied on mature leadership processes, practices, and routines to ensure their members are marching in the same direction.

Academic research refers to these activities as management control systems (MCS). Simons (1987) defines MCSs as:

> **Key Definition**: Management Control Systems (MCS) are "*formalized procedures and systems that use information to maintain or alter patterns in an organizational activity.*"

These organizational routines are used to control key activities across the organization including accounting, planning, new product development, and business strategy. They were built to provide top-level managers with the necessary information to make informed decisions and the means to monitor execution throughout the organization. Every company has them – formal or informal – with some models publicly branded like the Danaher Business System or the Masco Operating System, for example. Danaher (2021) describes how the DBS drives every aspect of their culture and performance. Regardless of the formality or visibility, these complex business practices can be the foundation for the firm's competitive advantage.

Resource-based view (RBV) theory considers these organizational routines as a valuable, rare, inimitable, and non-substitutable (VRIN) resource (Barney, 1991). However, their value may be eroding -- possibly becoming a competitive disadvantage -- as incumbents are faced with never-before-seen threats and opportunities. As Drucker described, these management control systems may be operating with "yesterday's logic" (Drucker, 1980).

Visionary CEOs realize the need for change and are re-envisioning their leadership playbook (Siebel, 2017). This research examines whether MCSs within incumbent companies, and the leaders who manage them, have evolved to capture market opportunities, identify nascent threats, and prescribe appropriate responses relevant to today's dynamic, digitally fueled business world.

# Chapter 2: Literature Review

Extensive research analyzes digital transformation from many perspectives with Chawla's (2021) bibliometric analysis (see appendix 1) identifying 17 major research streams on the topic. Chawla highlights several organizational research streams including the important role of leadership. Nadkarni's (2021) review of 58 DX research papers led to a simple thematic map with two high-level dimensions – technology-driven research themes and actor-driven research themes – each with several second-order themes (see appendix 2). Using this framework as a guide, the primary objective of this research is to understand the actor-driven themes. Both are important and cannot be completely decoupled. But tackling both as a whole would be beyond the scope of any single research project. Even the narrower focus of the actor elements of DX brings many important opportunities for research. To this end, this research analyzed the role top-level managers play in driving DX within incumbent organizations.

First, this research prioritized the actions top-level managers undertake to lead successful DX. These actions were operationalized through organizational processes, practices, and routines. Prior research describes these leader-led processes and practices as management control systems or MCSs. Prior research has begun to extend MCS frameworks specifically for digital endeavors. This research adds to that body of work.

The actions top-level managers take to lead DX are likely to be dependent on their personal skills. Extensive DX research has highlighted the criticality of new digital leadership skills. As such, this research relied on prior work on the digital acuity of leaders as a potential moderating variable.

### Management Control Systems

In his scathing description of General Electric's DX efforts, Mann (2020) attributes the company's failures, in part, to a lack of "well thought out processes". On the surface, this statement seems counterintuitive as GE is well known for its benchmark organizational processes. Prior research has extolled the company's prowess in six-sigma processes (Henderson, 2000), leadership development (Waters, 2009), and strategic planning (Vaghefi, 1998 and Ocasio, 2008) for example. Former CEO, Jack Welch, was even venerated as a case study in transformational leadership (Chen & Zhang, 2011). The collective value of these practices helped elevate GE to the most valuable company in the world (Noon, 2020).

Research contextualizes these leadership processes and practices within the field of management control systems (MCS). Top-level leaders use management control systems to achieve organizational goals and outcomes (Felicio, 2021). These systems are intended to ensure the alignment of decisions made by all levels of the organization with the firm's overall goals (Otley, 1980). Without this level of control, lower-level managers could make decisions based on personal goals, as prescribed by agency theory, which might differ from the broader organizational goals.

The boundaries on what constitutes a management control system can be vague. In the broadest sense, these processes can include all organizational behaviors used to drive a specific outcome or goal (Chenhall, 2003). A narrower definition describes MCSs as control mechanisms that ensure organizational actors behave consistently with organizational goals (Abernathy & Chua, 1996). Using the term "control mechanisms" suggests a very rote process. However, MCSs are comprised of a broader set of formalized routines, procedures, devices, and systems employed by leaders to maintain or alter patterns of their organization's pursuits of specific goals and objectives (Simons, 2000; Henri, 2006; Malmi, 2008).

The outcomes of an effective management control system can be equally broad. Prior research indicates firms utilize MCSs to drive organizational or management performance, although linkage to financial goals such as share price has proven difficult (Chenhall, 2003). While the absence of an MCS has been linked to business failures (Das, 2019), the linkage to positive performance can be complicated. For example, Bedford (2015) describes how specific MCS configurations provide a positive impact on firm performance in certain situations. Nonetheless, other research has shown a positive impact of a firm's MCS and key organizational capabilities such as market orientation, entrepreneurship, market responsiveness (Theriou, 2017), and product innovation (Henri & Wouters, 2020). Each of these higher-order outcomes is relevant to DX research. Other outcomes derived from the use of MCSs include:

- the ability for organizations to achieve benefits from innovation (Bisbe and Otley, 2004);
- improved innovation (Davila, 2009);
- longer CEO tenure (Davila & Foster, 2007);
- greater achievement of organizational objectives (Felicio, 2021);

- faster adaptation to the surrounding environment (Amat, 1994);
- achievement of organizational goals related to information systems (Kallunki, 2011);
- increased valuation of start-ups (Davila, 2015);
- facilitating growth (Sandelin, 2008);
- positive effect on firm performance in ambidextrous firms (Bedford, 2015 and Bedford & Malmi, 2015).

Management control systems research also suggests a strong association with business strategy. On one hand, the optimal configuration of the MCS is contingent upon the strategic orientation of a firm (Simons, 1991; Langfield-Smith, 2006). On the other, research points to the role of MCSs in the implementation and execution of business strategy. One of the influential MCS researchers, Robert Simons (1994), created a theoretical model to understand the impact of control systems on the company's strategy. Simons defined these methods as "levers of control" to achieve four key goals: 1) formalizing organizational beliefs; 2) setting boundaries on acceptable behavior aligned with the organizational strategy; 3) measuring performance variables, and; 4) stimulating interactive debate regarding dynamic market conditions. These levers are particularly useful for strategic renewal for incumbents.

Simons' framework points to the plurality of MCSs. Management control systems are not singular processes within firms and must operate with other systems (Malmi & Brown, 2008). Multiple control processes can operate independently or in conjunction with other control processes. The set of processes dependent upon one another is formally referred to as a "system". For example, a financial management control system might be comprised of the budgeting system, the long-range planning system, and the financial accounting system.

At a higher level, the aggregate of a firm's control processes has been defined as a management control "package" (Malmi & Brown, 2008). This delineation is important as Otley (1990), Chenhall (2003), and Fisher (1998) suggest research that only examines individual control processes or control systems will result in deficient models. Bedford (2020) goes on to suggest the primary aim of MCS research should be to understand how combinations of individual practices provide control for the firm. Individual control system components can be affected by the broader package (Spekle, 2020). This insight will lead to better theory (Malmi & Brown, 2008).

To this end, Malmi & Brown (2008) (referred to as M&B) developed a conceptual, theoretically based management control package typology to stimulate empirical research on management control. The typology describes five main types of control (referred to in this research as control levers) with several specific management processes in each (which we refer to as components). The framework is shown below. Detailed explanations are shown in appendix 3.

**Figure 1: Management control system as a package (Malmi & Brown, 2008)**

<table>
<tr><th colspan="7">Cultural Controls</th></tr>
<tr><td colspan="2">Clans</td><td colspan="3">Values</td><td colspan="2">Symbols</td></tr>
<tr><th colspan="2">Planning</th><th colspan="4">Cybernetic Controls</th><th rowspan="2">Reward and Compensation</th></tr>
<tr><td>Long range planning</td><td>Action planning</td><td>Budgets</td><td>Financial Measurement Systems</td><td>Non Financial Measurement Systems</td><td>Hybrid Measurement Systems</td></tr>
<tr><th colspan="7">Administrative Controls</th></tr>
<tr><td colspan="2">Governance Structure</td><td colspan="3">Organisation Structure</td><td colspan="2">Policies and Procedures</td></tr>
</table>

## Digital Transformation Control System

Prior research analyzing the relationship between technology and MCSs typically examined the supporting role information technology has on control systems. For example, business intelligence tools can be a strategic enabler for MCSs (Marx, 2012). Sharma and Bhagwat (2007) describe how the vast amounts of information provided by new technologies promote the use and effectiveness of MCSs. Information systems enhance the quality of the MCS through better insights and streamline the management-control process (Marx, 2012).

This research suggests a more important relationship between technology and MCSs. Digital transformation, in some respects, represents the potential rebirth of incumbent firms. To that extent, it is important to understand the role MCSs play in early-stage organizational development. MCS research provides mixed views on the use of MCS in start-up organizations. On one hand, the use of MCSs provides early-stage organizations with much-needed information to make critical decisions regarding the future of the organization and the lack of MCS contributes to the failure of start-ups (Greiner, 1997 and 1998). The other views suggest the use of MCS constrains the entrepreneurial orientation.

Research by Trenkle (2020) provides a unique lens on that relationship by suggesting MCSs are key to successful technology deployment, at least for game-changing technologies such as those which are part of the company's DX efforts. However, he also suggests existing control systems are not adequate for the unique nature of DX. Trenkle's novel research of eleven German companies was designed to answer the question of how small- and medium-sized businesses design and utilize MCSs to drive successful DX. The findings propose a digital transformation control system (DXCS) leveraging the original M&B framework. Trenkle's DXCS framework defines four control categories (controls variables): cultural, planning, administrative, and indicator-based controls with eleven specific components (see figure 2).

**Figure 2: Controls variables and components for the digital transformation control system (Trenkle, 2020)**

| | | | | |
|---|---|---|---|---|
| **Cultural Controls** | | | | |
| Digital Values | | Digital Symbols | | Digital Personnel |
| **Planning** | **Administrative controls** | | | |
| Digital risk management | Digital controlling procedures | Communication policy | Organization structure | Governance structure |
| **Performance-indicator-based control objects** | | | | |
| Financial objects of control | | Operational objects of control | | Web-based objects of control |

While the four high-level control levers are applicable beyond the DX context, the eleven components define specific digitally oriented leadership practices which contribute to DX success. However, Trenkle's research stops short of providing empirical evidence connecting the framework to outcome measures. Instead, it provides a starting point for additional research on digital transformation control systems.

**Incumbent Firms**

While Trenkle does not specifically call out incumbent firms, extensive research points to the unique challenges the 4IR creates for these companies. To start, the institutional experience within these firms works against them as incumbents suffer from change-resisting inertia (Warner, 2019). Existing resources operating with traditional capabilities coupled with deep-seated business practices create barriers to transformation (Vial, 2019). Teece (1997) refers to these barriers as path dependencies in suggesting a firm's future is dependent upon where it started and the path it traveled. History matters. For incumbents, that history is based upon traditional products and services delivered through conventional business models. Path dependencies create an inclination toward incremental innovation leveraging existing capabilities (exploitation) and create an internal resistance to transformational strategies (exploration) required for DX (Teece, 2007). However, to be successful, incumbents must not only leverage existing capabilities (exploitation) but also pursue strategies that explore new capabilities (exploration).

The ability to balance exploration strategies, such as those required by DX, with strategies that exploit existing capabilities is commonly referred to as strategic agility. Research suggests strategic agility is a critical organizational capability for successful transformation (Doz and Kosonen, 2010). For example, a McKinsey study found companies that demonstrate agility are almost twice as likely to have success from their DX initiatives (Bughin, 2019).

Several researchers have leveraged Teece's (1997) dynamic capability framework to propose broader organizational capabilities required in a digital economy. For example, Warner (2019) extends Teece's work in proposing a DX capability framework with three core capabilities: 1) digital sensing; 2) digital seizing, and; 3) digital transforming capabilities. Each of these core capabilities has several digitally grounded micro-foundations. Collectively, this model defines the organizational capabilities that companies need for successful DX.

Given the advanced technology driving 4IR, incumbents must also develop new technical capabilities. For example, most incumbents do not have the IT talent or technical capabilities to leverage advanced technologies such as internet-of-things (IoT), blockchain, and artificial intelligence (AI). These technologies require a new digital services platform that supports rapid innovation and response to new market opportunities (Sebastian, 2017). The requirements to build and run a digital services platform are vastly different than those required to run traditional IT environments. Sebastian's research indicated most incumbents struggle to deploy these advanced technologies and a digital service platform.

Finally, incumbents are a notable research focus because they are the organizations most at risk. Sebastian (2017) suggests incumbents face a moment of truth. Immelt (Govindarajan & Immelt, 2019) proposed that successful digital transformation is the only way incumbent manufacturers can survive.

**Digital Acuity**

It is safe to say that top-level managers of incumbent firms have demonstrated high levels of competence and intelligence as they ascended the organization. Traditional cognitive intelligence was an obvious contributor. But today's leaders need more. For example, prior research has pointed to the need for emotional intelligence (Heath, 2017). Leadership consulting firm DDI (2019) suggests leaders now also require a third level of intelligence, digital intelligence. This research adopts a synonym for digital intelligence used by other practitioners, digital acuity, as it implies a visionary component to their understanding of these advanced technologies.

Furthering this concept, Klein's (2020) literature review of 50 academic research papers explicated a new digital leadership model. The model describes 23 key leadership characteristics including many traditional competencies (see appendix 4). However, Klein adds digital intelligence to the model and goes on to suggest that digital acuity has become a necessity for leaders in today's business environment. Additional research substantiates this view for a variety of reasons including:

- Leaders with digital acuity have a more comprehensive view of their business environment and are knowledgeable about digital trends and the implications for their business (Sainger, 2018).
- Sutcliff (2019) suggests digital acuity allows leaders to know how to scale and monetize digital pilot projects.
- Digital acuity enables leaders to define a digital future (Fisk, 2002) and persuade the organization of the long-term benefits technology brings

(Sullivan, 2017). This point is critical given that lack of organizational alignment is an important contributor to DX failures (Sutcliff, 2019).

- Digital acuity enables leaders to recognize the complexities presented by new technologies and how their firms take advantage of these disruptive technologies (Christensen, 2013). This includes the ability to envision opportunities and exploit new digital-era competitive levers.
- Leaders with high digital acuity make better decisions related to digital investments and strategy (Kane, 2019).
- Digital acuity also provides awareness of the company's digital talent and digital culture (Klein, 2020) and attracts digitally oriented talent (Christensen, 2013).
- Digital acuity provides a basic understanding of IT and, more importantly, the insight to apply it for competitive advantage (Mithas and McFarlen 2017).

Most importantly, digitally capable leaders provide a positive effect on firm performance whereby organizations with high digital intelligence outperform their peers (DDI, 2018). DDI's 2018 Global Leadership Forecast indicates companies who have leaders with high digital acuity financially outperform the average by 50%. Conversely, leaders without experience driving technology strategies become barriers to digital transformation (El Sawy, 2016). Fisk (2002) suggests there is a generational element to this dilemma and goes on to describe how the CEO of ABB Corporation stepped down because he wasn't digital enough. Although not a substitute for DX success, digital acuity plays a role in a firm's success.

## Digital Champion

Organizations need more than just leaders with knowledge of new technologies. They also need digital champions. The presence of an innovation champion has a positive impact on innovation outcomes (Howell, 2005). Innovation champions are individuals who actively and enthusiastically promote innovation projects within an organization. Their contribution is driven by their ability to allocate resources and power, provide sponsorship to leaders, and foster cross-functional communication and decision-making. Carlile (2004) highlights the importance of cross-boundary communications as innovation is contingent upon bringing actors from across the company together.

Innovation champions are not a new idea. Schon (1963) boldly suggests that new ideas must find a champion or risk dying. Similarly, the concept of a technology innovation champion is also not new having been addressed as early as 1990 by Howell and Higgins. Additional research suggested technology innovation champions represent the single most important factor in technology innovation success (Beath, 1991). More recently, the concept of innovation champions has been extended to digital innovation. Digital champions are individuals who guide digital innovations (Papadonikolaki, 2018). These individuals serve as knowledge brokers across organizational boundaries while working with multiple digital innovation teams at once.

## Research Opportunity

Prior research has put forth many theoretical ideas and constructs to guide DX efforts. Common research themes describe how incumbents should leverage the new wave of technology including pursuing a digital customer experience or leveraging big data and improved data analytics in digital transformation. Similarly, research has focused on analyzing how manufacturing companies deploy smart devices powered by an internet-of-things (IoT) platform to manage and improve the performance of physical products. All told, incumbents have ample research to leverage in defining the core elements of a digital strategy.

Prior research also highlights the critical role of leadership in successful DX with a common argument that successful DX starts from the top. Like other strategic initiatives (e.g., total quality management), top-level managers are not directly responsible for formulating and executing the firm's DX strategy. But they are accountable. Leaders must ensure the organization is aligned, engaged, and empowered with adequate resources. Jeffrey Immelt's demise at General Electric is a prime example. Despite this critical role, there is limited research which prescribes how top-level managers of incumbents lead these strategies.

The lack of insights into the processes, practices, and routines of top-level leaders is a significant research gap. This research attempts to fill that gap and provide top-level managers with practical insights to successfully lead DX from the top.

***Technology-Driven vs Actor-Driven Themes***

Digital transformation is born from a new wave of advanced technology, but it is not just a technology endeavor. The human element is important as well. For example, Nadkarni (2021) highlights the two main dimensions in existing research: 1) the technology that enables it, and; 2) the actors who lead it. The underlying technologies such as internet-of-things (IoT), blockchain, and artificial intelligence (AI) are all interesting subjects and worthy of extensive research but not the focus of this research. Instead, this research focuses on the actors who drive DX within incumbents (see Nadkarni's actor-driven themes in appendix 2). This research focus is important given Nadkrani's view that technology can enable organizational transformation but not cause it to happen. To this end, Nadkrani suggests future research should include how organizations incorporate DX efforts within existing organizational structures and processes. This research seeks to explore the role of actors within incumbents to define organizational activities which are linked to successful DX.

#### *Management Control Systems*

Research has shown a positive relationship between a firm's management control systems and key organizational capabilities such as market orientation, entrepreneurship, market responsiveness (Theriou, 2017), and product innovation (Henri & Wouters, 2020). Similarly, Trenkle (2020) bridges management control systems and DX to prescribe a digital transformation control system (DXCS). Trenkle's framework provides incumbents with valuable insights into how top-level managers of incumbents lead DX. However, Trenkle acknowledges several important research gaps including:

- Lack of empirical evidence of the value of his DX control system.
- A limited sample set of DXCS.
- Lack of clarity as to whether a company should develop a dedicated control system to manage digital transformation or if DX should be managed within existing formal and informal measures already in place.
- Industry-specific research.

Trenkle's proposed DX control system serves as a strong basis for additional research. This research seeks to extend his findings to provide valuable insight for incumbents.

### *Digital Transformation in Manufacturing*

Jones (2021) studied the drivers and barriers of DT within manufacturing firms. The author leverages a Purdue University model called Strategic Doing in proposing a more effective strategic planning method for incumbent manufacturing companies. Within that research, Jones suggests future research should include how DX is integrated within organizational structures and processes within incumbent firms.

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# Chapter 3: Research Design and Methodology

## Research Questions

To address some of the many challenges associated with leading digital transformation within physical industries, this research analyzed how top-level managers of incumbent firms utilize principles from management control systems theory. Successful transformation requires leaders must operate differently. Specifically, the research findings provide a framework for the most important leadership practices, processes, and routines to effectively compete in the increasingly digital world. We do this by empirically testing an enhanced management control system framework suitable for today's digital environment; described by Trenkle (2020) as a digital transformation control system (DXCS).

Mastering these new leadership practices may not be enough. Leaders not only have to operate differently, but they must also think differently. Digital acuity is thought to be a required leadership competency. While previous research has suggested that companies with digitally savvy leaders outperform those which don't (DDI, 2018), little is known about how this is achieved. Our research integrates the cognition of digital acuity with the actions associated with a digital transformation control system to provide a more comprehensive leadership lens to drive successful DX. In doing so, this research answers the following research questions:

a) What are the components of an effective digital transformation control system?
b) Which components of the proposed framework contribute the most to successful digital transformation?

c) How does the digital acuity of top managers influence these configurations and successful digital transformation?

**Research Propositions**

This research puts forth three propositions related to the nature of the firm's management control systems and the subsequent impact on DX success. Management control systems represent organizational practices and processes to ensure alignment across the company. Organizations typically have multiple management control systems focused on different disciplines, some of which are tightly coupled with strategy execution. Successful DX requires new leadership practices to address a new set of challenges not previously encountered by incumbents. Therefore, the first proposition posits a positive relationship between digitally focused leadership practices and DX success.

**P1a**: Utilization of a digital transformation control system is positively related to the firm's digital transformation success.

Companies typically have multiple management control systems which rarely operate independently. Prior research has theorized the concept of an MCS "package" that embodies interdisciplinary activities working in unison. Malmi & Brown (2008) leverage a strategic change model proposed by Simons (1994) in conceptualizing an MCS package to drive strategic change. That framework included four levers of control based upon Simons' model and theorized 13 specific leadership processes to operationalize those levers. Trenkle (2020) utilized the M&B model to explain how companies drive successful DX. Trenkle's proposed framework identified 11 components supporting the four control levers.

Our research hypothesizes a model with four control levers as well. However, in merging the M&B model and the Trenkle mode, we propose 15 supporting processes. In addition, we add three variables to the framework in recognition of the important role of digital acuity of leaders. The impact of 18 potential components is likely not homogenous. Therefore, we analyzed the relative importance of each component to help companies prioritize their actions. As such, our second proposition recognizes the varying impact of each component on the outcome variable of DX success.

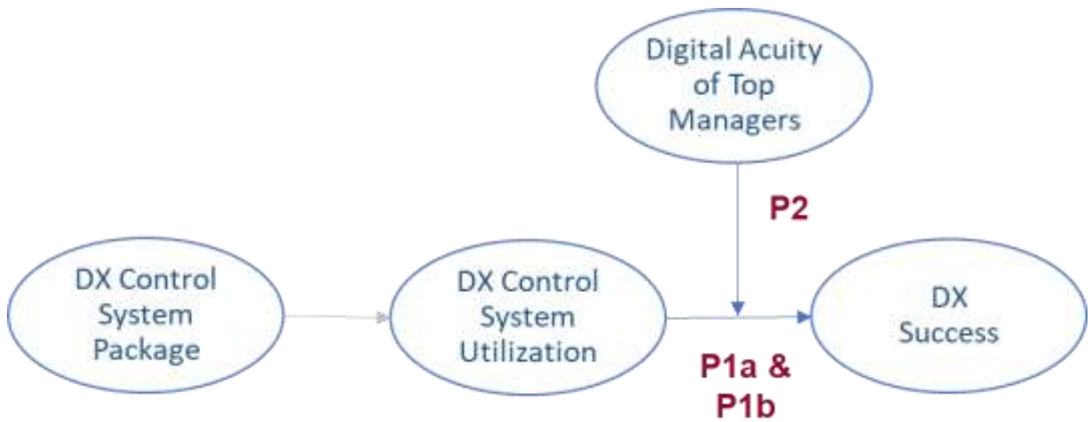
**P1b**: Components of the digital transformation control system differ in their impact on digital transformation success.

Lastly, DX strategies are defined and led from the top. While top-level managers are not expected to be technology experts, these leaders do need to understand the opportunities provided by advanced technologies, how to best leverage the opportunities provided by these technologies and be the innovation champion for those efforts. To accomplish this, academic research and business experts suggest digital acuity is now a critical skill for these top-level managers. However, research also suggests top-level managers, and others within their organizations, have low confidence in their digital acuity. This gap represents an important element of DX research and an interesting research focus. Accordingly, the third proposition suggests a moderating effect of leader digital acuity on the relationship between an organization's utilization of the DX control system processes and its DX success.

**P2**: Digital acuity of top managers moderates the relationship between an effective digital transformation control system and digital transformation success such that higher digital acuity strengthens the positive relationship.

A theoretical model representing these propositions is shown in figure 3 below.

**Figure 3: Theoretical Model**




**Hypothesized DX Control System Package**

Our hypothesized DX Control System package is derived by merging elements of the Malmi & Brown (2008) and Trenkle (2020) conceptual frameworks. The M&B model was intended to hypothesize an operational model based upon Robert Simons' Levers of Control framework (1994). The Trenkle model was an interpretation of the M&B framework based upon leadership processes observed at 11 German small- to mid-sized companies. While the M&B model was proposed as a general model to drive employee behaviors, Trenkle's version was conceptualized specifically for DX leadership. Neither model was empirically tested. Without evidence of the merits of one over the other, we kept elements as the basis for our hypothesized DX control system package.

We arrived at our model by reconciling detailed descriptions of each component in the two reference models. The two did not align exactly. In the case where one model had components not included in the other, we kept the component in our hypothesized model. For instance, Malmi & Brown proposed a **rewards and compensation** control activity. Their premise was that incentive plans motivate employee behaviors and increase performance. We viewed this as an important component for incumbents to motivate digitally oriented employees in a manner more consistent with technology companies as compared to the incumbent's traditional incentive plans. We also reconciled a few additional variations between the two reference models as follows:

- Trenkle proposed a **digital risk management component** not hypothesized in the M&B model. We believe this to be an important leadership process as the digital strategies of incumbents could be seen as riskier than strategic choices closer to their core.

- The M&B model conceptualized an **organizational design** component that is intended to create an organizational model to achieve certain types of relationships. Trenkle did not observe this in his reference companies. However, we believe this to be a potentially important leadership activity as incumbents begin building technology capabilities outside of the traditional information technology department.

- The M&B model also conceptualized governance as a key leadership component. Trenkle's model was silent on this process. Our hypothesized model includes **digital governance** as a proposed component as prior research suggests governance is an important element of technology maturity models (Teichert, 2019).

- Trenkle found that **communication** streams are important for DX success including the communication platform as well as the content. For example, Trenkle's model suggests dedicated communication meets on technology topics. This is consistent with Simons' (1995) line of reasoning that highlights the critical need for communication between top management and lower organizational levels to better align employee behavior. As a result, we kept Trenkle's communication component in our hypothesized model.

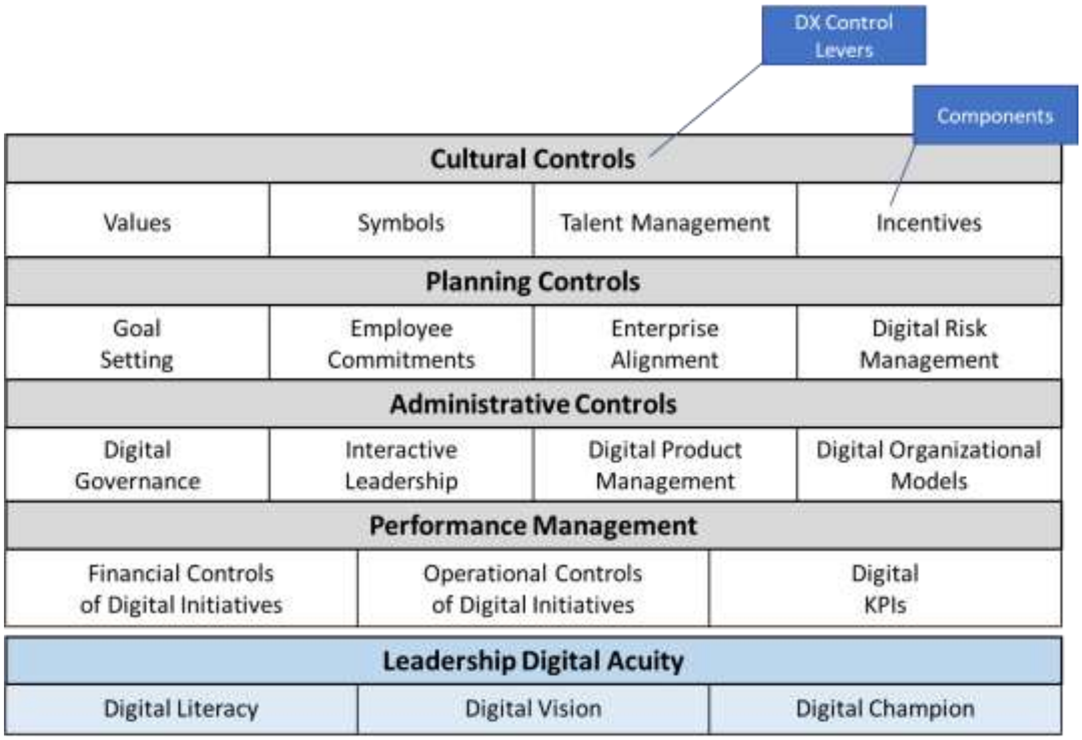
- Both models conceptualized financial and non-financial control practices as key control processes. Naturally, as a model focused on DX, Trenkle also added technology-based objects of control based on his observations. His controls were narrowly defined, only evaluating success factors of online channels such as search engine optimization. We view these as critical digital lead measures to the ultimate digital outcome measures. However, for incumbent companies, we believe **digital KPIs** need to go beyond just web-based control measures. Therefore, our hypothesized model broadens Trenkle's web-based objects of control to a more general set of digital KPIs.

This is consistent with prior research on the importance of digital KPIs (Gartner, 2017, Fitzpatrick & Strovink, 2021).

Finally, in developing our hypothesized model, we propose a new dimension not incorporated into the M&B or Trenkle models. Those models focus solely on leadership processes to drive employee behaviors. Our research proposes an extension to the process-oriented models. Specifically, we incorporate leadership capabilities as an important control lever to drive DX success. Prior research highlights leadership capabilities as a key enabler for strategy execution (Jabbar, 2017 and Schlegel, 2019). We operationalize leadership capabilities through the lens of digital intelligence (acuity) which has been demonstrated to impact DX success (DDI, 2018).

In the end, we arrived at a DX control system framework that combines elements of the M&B conceptualized model with the Trenkle observed model. We also propose an important extension to both models with the addition of digital acuity. The hypothesized model is shown in figure 4 below.

**Figure 4: Hypothesized Digital Transformation Control System**




## Research Contributions

### *Academic Research Contributions*

This research adds to the long line of valuable research on management control systems. More specifically, this research:

- Validates the M&B management control system package and Trenkle's (2020) findings on DX control systems using methods employed in other MCS research;
- Extends Malmi & Brown's and Trenkle's findings by assessing the relative importance of DX control system components;

- Integrates Malmi and Brown's and Trenkle's research with related research on digital intelligence by testing the moderating relationship between the digital acuity of top-level leaders, utilization of DX control processes, and DX success.

### *Practical Implications*

Digital transformation is a must for all firms, especially incumbent firms. Most leaders of these companies are aware of the need, but knowledge is lacking on how to proceed. By providing practical insights into ways to improve existing leadership practices, this research may help incumbent firms to be more successful in their DX journeys. In the end, this research is expected to play a small but important role in helping incumbents ensure a successful DX journey through stronger leadership practices.

## Measurement Variables

Our research utilized three high-level aggregate variables: 1) process utilization, 2) digital acuity, and; 3) DX success. Each aggregate variable was comprised of multiple components. The components of the hypothesized model are grouped into control levers. In total, there were 20 distinct variables measured in our model. Figure 5 below demonstrates the data model by control lever and component.

**Figure 5: Hypothesized Model Variables**

| | Aggregate Variable | DX Control Lever | Component |
|---|---|---|---|
| Derived from Malmi & Brown (2008) and Trenkle (2020) | Process Utilization | Cultural Controls | Digital Values |
| | | | Digital Symbols |
| | | | Digital Talent Management |
| | | | Incentives for Digital Talent |
| | | Planning Practices | Digital Goal Setting |
| | | | Employee Commitments |
| | | | Enterprise Alignment |
| | | | Digital Risk Management |
| | | Administrative Controls | Digital Governance |
| | | | Interactive Leadership |
| | | | Digital Product Management |
| | | | Digital Organizational Models |
| | | Performance Management | Financial Controls |
| | | | Operational Controls |
| | | | Digital KPIs |
| Extension | Leadership Digital Acuity | | Digital Literacy |
| | | | Digital Vision |
| | | | Digital Champion |

| | Outcome | Component |
|---|---|---|
| [illegible] | Digital Transformation Success | Competitiveness |
| | | Customer Value Proposition |

### *DX Control System Process Utilization*

The primary tenet of this proposal is that utilization of digitally focused management control processes will influence the success of an incumbent's DX efforts. We measured the degree of utilization by asking respondents to identify the extent their organization utilizes the prescribed control processes. The results are measured within a **process utilization** variable. Process utilization is measured at the individual process control component across a total of 15 components. Scores ranged from 1 through 5 derived from a 5-point Likert scale with the following response options:

1. Strongly Disagree
2. Disagree

3. Neither Agree nor Disagree
4. Agree
5. Strongly Disagree

***Digital Acuity***

Another core premise of this proposal is that most top-level managers of incumbent firms have low levels of knowledge and experience in DX technologies and opportunities. Knowledge of these technologies and the opportunities they present is captured in the variable **digital acuity**. Digital acuity has been described as one of the seven intelligence factors of a great leader (Heath, 2017). Klein (2020) describes this as digital intelligence and suggests that, without it, it is impossible to lead successful DX.

Trenkle's (2020) DXSC framework includes the concept of a technologically capable leader within his cultural controls theme. However, since Trenkle's research was qualitative, it did not propose a specific measurement method. Technologically capable leadership is widely discussed but there is no common method for measurement. Leadership consulting firms, such as DDI, are beginning to experiment with a Digital Leadership Quotient (DLQ) which, in part, includes digital acumen. However, DDI indicates that the model has not been validated enough to rely on. Without a literature-based methodology, this research focused on three key dimensions identified in prior literature: 1) knowledge of technological trends and the implications on their businesses (Sainger, 2018); 2) the ability to envision a digital future (Sutcliff, 2019; Fisk, 2002; Sullivan, 2017), and; 3) digital champions are individuals who guide digital innovations (Papadonikolaki, 2018). We conceptualized these three components as:

1. Digital Literacy - My technical knowledge of digital technologies.
2. Digital Vision - My ability to envision how best to apply digital technologies in my company.
3. Digital Champion - My ability to provide the necessary leadership to affect the digital transformation.

Like the DX process controls, we measured the degree of digital acuity at the component level using a 5-point Likert scale. Scores ranged from 1 through 5.

***DX Success***

Digital transformation is a very broad strategic topic with seemingly infinite ways for incumbents to apply it in their businesses. For example, one firm's digital strategy might drive incremental revenue from new solutions while another firm could be pursuing increased market share for existing products. A common measurement of success across incumbents may not be feasible. In addition, there is no known literature-based measurement for **DX success**.

As a result, this research followed methods used by other researchers in measuring how MCS utilization affects firm performance. For example, Frare et al (2021) studied MCS utilization in Brazilian start-up companies and the impact of utilization on firm performance. That research utilized four subjective questions to measure performance features: 1) competitiveness; 2) growth; 3) profitability, and; 4) innovativeness.

Frare's measurement method followed other MCS research including King (2010) and Crespo (2019) and, according to Frare, is widely accepted in management science literature. The use of subjective measures of firm performance has been debated in previous research (Bedford, 2015). Bedford's research references Chenhall (2003) suggesting a high correlation between subjective and objective measures of performance. Others go further in saying that neither approach is more effective (Venkatraman & Ramanujam, 1987). As a result, our research adopted this same practice as Frare (2021) but with questions applicable specifically to DX success instead of firm performance. Furthermore, content validation (discussed later) included an extensive discussion with nine subject matter experts on DX reviewing the best method to measure DX success. In the end, we settled on two measures of DX success. Each is measured by a time dimension as well as a relative measure compared to the competition. As a result, DX Success was operationalized through two variables:

1. **Increased Competitiveness** - As a result of my company's overall digital initiatives, relative to my industry peers, my company has become more/less competitive.
2. **Improved Value Proposition** - As a result of my company's overall digital initiatives, relative to my industry peers, my company's customer value proposition has become better/worse than industry peers.

## Data Collection

### *Research Participants*

This research collected data on incumbent companies within the manufacturing, distribution, and construction industries. These firms represent industries with core physical products which cannot entirely be disrupted by digital products. However, each of these companies is subject to disruption from digital innovation. Schumpeter (1942) described threats may not disrupt the actual product but will eventually change the performance attributes of the products at such a rapid rate that incumbents cannot catch up.

Incumbents were defined as firms founded in a pre-digital world and within industrial manufacturing sectors. Incumbents were specifically referenced by Schumpeter (1942) and Christensen (1995) as the type of firm most at risk. Manufacturing, distribution, and construction firms will be the specific sector focus because these entities are in a unique situation with regards to DT as their physical products cannot be directly disrupted, but their business models can.

Primary research participants were drawn from CIOs of target firms. Participants were solicited from CIO organizations such as the Society of Information Management (SIM). Participants were recruited in two phases:

1. Phase 1: Nine CIOs from companies known for their digital transformation success and DX experts to validate survey content. These subject matter experts were identified and recruited using industry expert resources with existing networks of contacts and provided input into the survey content for readability and clarity.
2. Phase 2: Forty-eight CIOs and other IT leaders were recruited through professional organizations. These technology leaders subsequently recruited 23 business leaders from within their firms.

Tables 1a and 1b provide a profile of survey participants.

**Table 1a**
**Survey Participant Roles**

| Technology Leaders | | Business Leaders | |
|---|---|---|---|
| Chief Information Officer | 34 | Chief Executive Officer | 6 |
| Chief Digital Officer | 2 | Functional Leader e.g., CFO | 16 |
| Chief Technology Officer | 6 | Business Unit Leader | 1 |
| VP Digital Transformation | 1 | | |
| Leader of Digital Transformation – Sr. Director Level | 1 | | |
| IT Director | 1 | | |
| Group IT Manager | 1 | | |
| Business Group CIO | 1 | | |
| Project Director | 1 | | |
| **Total** | **48** | | **23** |

**Table 1b**
**Participating Companies**

| Industry | Companies | Participants |
|---|---|---|
| Industrial Manufacturing | 18 | 30 |
| Consumer Manufacturing | 16 | 21 |
| Distribution Companies | 6 | 11 |
| Construction Companies | 5 | 9 |
| **Total** | **45** | **71** |

### *Survey Tool*

Data was collected through an online survey developed and distributed through Qualtrics. The use of surveys in MCS research is well supported (Spekle, 2020). All questions (except job title) were rated on a 5-point Likert scale. Technology leaders answered a long form of the survey with 20 questions while business leaders responded to a short form with 5 questions.

All respondents (n=71) were asked the following:

1. Provide their role in the organization
2. Provide a personal assessment of their digital acuity (3 questions)
3. Provide a personal assessment of their company's DX success (2 questions)

We asked the technology leaders (n=48) to assess the degree to which their companies utilize the DX control system processes. Survey questions were derived through a reconciliation process between Malmi & Brown's (2008) MCS Package Framework and Trenkle's (2020) Digital Transformation Control System as described earlier. Each component of the hypothesized model, 15 components in total, was reframed as a question and reformatted into a survey template. The survey question asked the participant the degree to which their company utilized the prescribed management control processes (see appendix 6 for questions and mean scores).

In total, 71 surveys were returned from a target list of 154 potential respondents. The response rate was 46%. The relatively high response rate was attributable to one-on-one invitations by the researcher, the collegial nature of technology leaders, and the value of professional networking groups. Invitations were sent via e-mails and LinkedIn messaging. Some responses required additional follow-up, but no participants were solicited with more than two invitations unless there were specific follow-up questions.

**Data Analysis**

This research utilized several analytical methods to answer the research questions. All analyses were conducted using SPSS v28 and Excel. The first approach used **descriptive statistics** to assess the degree to which firms claim to be utilizing the prescribed leadership processes. Although not part of the specific propositions, descriptive data was used to determine if the underlying control system packages are representative of the participant's actual DX processes. We used frequencies to identify the percentage of companies claiming to utilize the process components as well as averages to determine the relative level of utilization for each component.

We then used two statistical tools to determine the degree to which the prescribed leadership process impacted DX success to assess Proposition 1a. First, survey responses were classified into two groups, high DX success, and low DX success companies. **Independent sample t-tests** were run to identify statistically significant differences in mean scores for each component between the two groups. Secondly, **crosstabulation analysis** was utilized to determine statistically significant correlations between process utilization of each component, digital acuity, and DX success. Crosstabulations were run for various levels of the data model shown in figure 5 above. Additional crosstabulations were run on subsets of job types (role categories) and industry categories to provide additional insights.

After narrowing the list of components to those which are correlated to DX success, we conducted a **logistics regression analysis** to understand the relative impact of each process component in support of proposition 1b. We started by analyzing for multicollinearity among the 15 process control variables (Midi, Sarkar & Rana, 2010). We then conducted a correlation test for all process variables against the control lever DX Success (Pampel, 2020). Eight of the 15 process components demonstrated a statistically significant cross-correlation. Those eight variables were used as covariates in the SPSS Logistic Regression analysis. A binary value for DX success (high success/low success) was the dependent variable. We used a backward LR method to identify the process control variables with the highest predictive value.

Finally, regression analysis was used to infer the causal relationship between digital acuity, process utilization, and DX success. We utilized the Hayes (2018) PROCESS Macro to assess a moderation model using model 4. Based upon those results, we also ran a mediation model using model 1. The results of all four analyses are shown in Chapter 4. Both models utilized the highest-level aggregate variables – process utilization, digital acuity, and DX success.

# Chapter 4: Results

Prior research defined a set of management controls working in tandem to drive a wide range of strategic business objectives. We hypothesized a control system package to drive DX success which we derived from prior research. We then empirically tested leadership practices within incumbent manufacturing, distribution, and construction companies. In addition, we extended prior research to incorporate the impact of leadership digital acuity.

Our research utilized a survey to assess the degree to which companies utilize the DX control system processes and the level of digital intelligence of survey participants. Data derived from 71 survey responses were analyzed using the four analytical methods described in this chapter to answer the research questions and find support for three propositions.

## Reliability Testing

To test for reliability of the six composite DX control levers, Cronbach's alpha (α) was calculated using IBM SPSS v28. Values of 0.60 to 0.70 are considered acceptable while values of 0.7 to 0.9 are considered good (George & Mallery, 2003). Results show that survey results for all DX control levers were acceptable or good (see table 2 below).

**Table 2**
**Reliability Testing of the Control Levers**

| Control Levers | | Components | Cronbach's Alpha (α) |
|---|---|---|---|
| Process Utilization | Cultural Controls | 4 | 0.76 |
| | Planning Practices | 4 | 0.78 |

| Control Levers | | Components | Cronbach's Alpha (α) |
|---|---|---|---|
| | Administrative Controls | 4 | 0.70 |
| | Performance Management | 3 | 0.81 |
| Digital Acuity | | 3 | 0.76 |
| Digital Transformation Success | | 2 | 0.76 |

## Descriptive Statistics of Survey Results

Descriptive statistics were evaluated to understand the survey results and identify analytical opportunities. These statistics were grouped into the three high-level aggregate variables as described below.

### *Utilization of DX Control System Processes*

Table 3 below summarizes the survey results for each prescribed leadership practice. Mean and standard deviation values are shown along with the number of participants indicating whether they agree or strongly agree their company utilizes these prescribed leadership practices. Although this analysis is not included in our propositions, it is relevant to validate the extent the underlying theoretical frameworks (Malmi & Brown, 2008 and Trenkle, 2020) are used by the participating companies.

The research findings suggest all prescribed leadership practices are reportedly utilized by at least 26% and up to 96% of the participating companies. On average, participating companies agree or strongly agree they are proficient in 9 of the 15 prescribed digital leadership practices. While no company claims to use all 15 process controls, most (>50%) of participating companies utilize 12 of the 15 prescribed leadership practices comprising the hypothesized DX control system (DXCS). Processes not followed by at least 50% of participating companies are shaded in the table below. The results support the use of the underlying theoretical frameworks as the basis for this research and further analysis.

**Table 3**
**Utilization of DX Control System Components**
**Descriptive Statistics (n=48)**

| DX Control Levers | Prescribed Digital Leadership Practices (Components) | Mean | Std Dev | Utilized by Participating Company: # Agree or Strongly Agree | Utilized by Participating Company: % Agree or Strongly Agree |
|---|---|---|---|---|---|
| Digital Organizational Values | Values | 3.75 | 1.000 | 33 of 48 | 69% |
| | Symbols | 3.38 | 1.178 | 25 of 48 | 52% |
| | Talent Management | 2.98 | 1.062 | 19 of 48 | 40% |
| | Incentives | 2.54 | 1.166 | 12 of 48 | 25% (lowest) |
| Digital Planning Practices | Goal Setting | 3.85 | 1.031 | 38 of 48 | 79% |
| | Employee Commitments | 3.67 | 1.038 | 34 of 48 | 71% |
| | Enterprise Alignment | 3.42 | 1.088 | 24 of 48 | 50% |
| | Risk Management | 4.50 | 0.652 | 46 of 48 | 96% (highest) |
| Digital Administrative Controls | Digital Governance | 3.29 | 1.288 | 28 of 48 | 58% |
| | Interactive Leadership | 3.69 | 1.075 | 33 of 48 | 69% |
| | Digital Product Mgmt. | 3.44 | 1.029 | 28 of 48 | 58% |
| | Organizational Models | 3.60 | 1.106 | 31 of 48 | 65% |
| Digital Performance Management | Financial Controls | 3.35 | 1.296 | 29 of 48 | 60% |
| | Operational Controls | 3.29 | 1.202 | 25 of 48 | 52% |
| | Digital KPIs | 2.81 | 1.266 | 17 of 48 | 35% |
| ***12 of 15 Digital Leader Practices Utilized by >50% Respondents*** | | | | | |

*Shaded rows represent components used by less than half of surveyed companies.*

### *Digital Acuity*

This research sought to extend prior research with the addition of a digital acuity dimension to previous DX Control System packages. We proposed that the digital acuity of top-level leaders impacts the correlation between the utilization of prescribed leadership practices and DX success. To test this proposition, participants were asked to rate their personal digital acuity across three dimensions:

1) **Digital literacy**: knowledge of digital technologies

2) **Digital vision**: understanding how to best apply digital technologies to their companies

3) **Digital champion**: the ability to provide the necessary leadership to affect DX

The purpose of this research is not to analyze the specific digital acuity scores but rather, to understand the impact of digital acuity on DX success. This impact will be discussed in subsequent sections.

Descriptive statistics from the survey participants are shown in Table 4 below. Although the mean for all three variables and the construct are all above a score of three on a five-point Likert scale, the skewness was not statistically significant using Pearson's Coefficient of Skewness statistics. The coefficient was determined by dividing the skewness for each variable (and the aggregate variable) by the standard deviation of the skewness. In all cases, the coefficient was below the prescribed level of 1.96.

**Table 4**
**Digital Acuity Descriptive Statistics (n=71)**

| Digital Acuity Variables | Survey Response Frequency | | | | | Mean | Std. Dev. | Skewness | Std Dev of Skewness | Pearson's Coefficient of Skewness |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | | | | |
| Digital Literacy | 0 | 3 | 30 | 31 | 7 | 3.59 | 0.729 | 0.128 | 0.285 | 0.449 |
| Digital Vision | 0 | 3 | 17 | 42 | 9 | 3.80 | 0.710 | -0.437 | 0.285 | -1.533 |
| Digital Champion | 0 | 1 | 20 | 36 | 14 | 3.89 | 0.728 | -0.052 | 0.285 | -0.182 |
| Digital Acuity (aggregate) | | | | | | 3.76 | 0.591 | -0.047 | 0.285 | -0.165 |

*Digital Acuity Supplemental Analysis*

Although not part of the original research propositions, we found statistically significant differences when comparing digital acuity across technology leaders and business leaders. Using the independent t-test mean equivalent calculation in SPSS v28 (see table 5 below), we found a significant difference between the mean scores of technology leaders compared to business leaders for each digital acuity variable. By itself, this points to potential future research opportunities. For this research, we found this mean score difference relevant to understanding the correlation between digital acuity levels and DX success, described in subsequent sections. The strong statistical significance of the difference in mean scores for digital vision also drove additional analysis described in subsequent sections.

**Table 5**
**t-test for Equality of Means (n=71)**

| Digital Acuity Variables | t-test for Equality of Means for Role Category | | |
|---|---|---|---|
| | Mean Score Technology Leaders | Mean Score Business Leaders | t-Test *p*-value * |
| Digital Literacy | 3.73 | 3.30 | .010* |
| Digital Vision | 4.00 | 3.39 | <.001*** |
| Digital Champion | 4.00 | 3.65 | .030* |
| **Digital Acuity (aggregate variable)** | **3.91** | **3.45** | **<.001*** ** |

* $p < .05$, ** $p < .01$, *** $p < .001$

***Digital Transformation (DX) Success***

Unlike prior research on DX control system packages, this research sought to empirically test the correlation between components of the hypothesized DX control system and DX success. We operationalized our outcome variable, DX success, through two measured components:

1. **Increased competitiveness**: As a result of my company's overall digital initiatives, relative to my industry peers, my company has become more/less competitive.
2. **Improved customer value proposition**: As a result of my company's overall digital initiatives, relative to my industry peers, my company's customer value proposition has become better/worse than industry peers.

Before describing the relationship between the utilization of a DX control system and DX success, we provide the following descriptive statistics related to our research findings. First, like the digital acuity components, we found the mean scores for the digital success components to be greater than 3.00 (see table 6a below). The skewness of the aggregate control lever (digital success) and one of the components (customer value proposition) was not statistically significant using the SPSS v28 skewness calculation and Pearson's Coefficient of Skewness. However, the skewness of the competitiveness variable was statistically significant, albeit only slightly. Upon additional analysis, we found this to be attributable to industry-level variances. Consumer manufacturing companies and construction companies scored higher on competitiveness outcomes with meaningful Pearson coefficient of skewness values (see table 6b below). On its own, this industry variation may provide a basis for future research. However, we determined these insights to be out of scope for our research.

**Table 6a**
**DX Success Descriptive Statistics (n=71)**

| Digital Success Variables | Survey Response Frequency 1 | 2 | 3 | 4 | 5 | Mean | Std. Dev. | Skewness | Std Dev of Skewness | Pearson's Coefficient of Skewness |
|---|---|---|---|---|---|---|---|---|---|---|
| Competitiveness | 0 | 6 | 27 | 37 | 1 | 3.46 | 0.673 | -0.593 | 0.285 | **-2.081** |
| Improved Customer Value Proposition | 0 | 2 | 40 | 26 | 3 | 3.42 | 0.625 | 0.483 | 0.285 | 1.695 |
| DX Success (aggregate) | | | | | | 3.44 | 0.583 | -0.109 | 0.285 | -0.382 |

*Significant Pearson Coefficient of Skewness values are shown in bold.*

**Table 6b**
**DX Success Descriptive Statistics (n=71)**
**Increased Competitiveness by Industry**

| Industry | Increased Competitiveness Survey Response Frequency 1 | 2 | 3 | 4 | 5 | Mean | Std. Dev. | Skewness | Std Dev of Skewness | Pearson's Coefficient of Skewness |
|---|---|---|---|---|---|---|---|---|---|---|
| Industrial Manufacturing (n=30) | 0 | 4 | 16 | 9 | 1 | 3.23 | 0.728 | 0.178 | 0.427 | 0.417 |
| Consumer Manufacturing (n=21) | 0 | 2 | 5 | 14 | 0 | 3.57 | 0.676 | -1.357 | 0.501 | **-2.709** |
| Construction (n=9) | 0 | 0 | 1 | 8 | 0 | 3.89 | 0.333 | -3.000 | 0.717 | **-4.184** |
| Distribution (n=11) | 0 | 0 | 5 | 6 | 0 | 3.55 | 0.522 | -0.213 | 0.661 | -0.322 |
| All Industries (n=71) | 0 | 6 | 27 | 37 | 1 | 3.46 | 0.673 | -0.593 | 0.285 | **-2.081** |

*Significant Pearson Coefficient of Skewness values are shown in bold.*

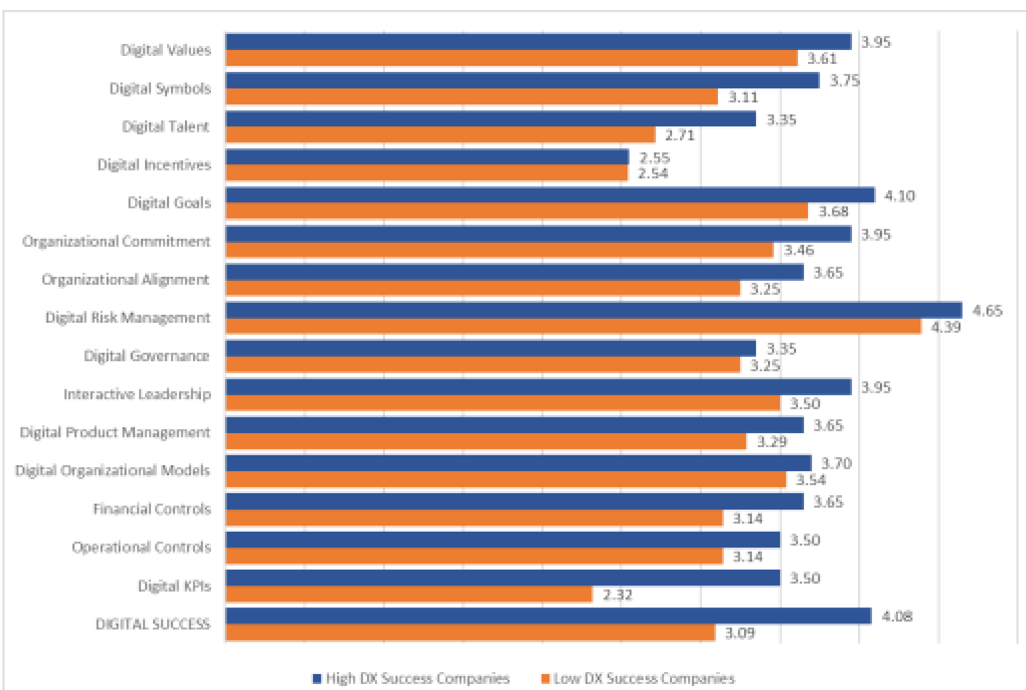
**DX Control System Correlation to DX Success**

Our research seeks to determine if utilization of prescribed DX control system processes and digital acuity are correlated to DX success. The null hypothesis suggests the variables are uncorrelated. To reject the null hypothesis, we utilize two statistical methods to determine correlation: 1) t-test for equality of means, and; 2) chi-squared test of independence.

***t-Test for Equality of Means Analysis***

Mean values for each component were higher for 14 of the 15 process components when comparing high DX success companies compared to low DX success companies. The use of digital incentives was the only component in which low DX success companies averaged higher responses (see figure 6 below).

**Figure 6: Process Component Mean Score – High DX Companies vs Low DX Companies**



To explore the relevance of these results, we first utilized the independent samples t-test within SPSS v28 to identify which DX control system components are correlated with DX success. Specifically, we assessed mean scores for process components and mean scores for the three digital acuity components across two sample sets -- high DX success companies and low DX success companies. The null hypothesis states that the difference between the two groups is insignificant.

We hypothesize that high DX success companies will have statistically significant higher means for each process component and each digital acuity component. To test the null hypothesis, an independent samples t-test was utilized (at a 90% confidence level) to determine if there were differences in process component utilization between companies with high DX success companies and low DX success companies. Similarly, the two measures of DX success were assessed separately – increased competitiveness and improved customer value proposition. Results are shown in table 7 below. Shaded components indicated no meaningful difference between high success companies and low success companies.

**Table 7**
**t-test for Equality of Means**

| DX Control Levers | Components | n | t-test for Equality of Means for Competitiveness | | | t-test for Equality of Means for Customer Value | | |
|---|---|---|---|---|---|---|---|---|
| | | | High | Low | t-Test *p* value | High | Low | t-Test *p* value |
| **Cultural Controls** | Values | 48 | 3.93 | 3.52 | .085 | 3.95 | 3.58 | .098$^{+}$ |
| | Symbols | 48 | 3.67 | 3.00 | .025$^{*}$ | 3.68 | 3.12 | .049$^{*}$ |
| | Talent Management | 48 | 3.30 | 2.57 | .009$^{**}$ | 3.23 | 2.77 | .069$^{+}$ |
| | Incentives | 48 | 2.48 | 2.62 | .345 | 2.50 | 2.58 | .411 |

| DX Control Levers | Components | n | t-test for Equality of Means for Competitiveness | | | t-test for Equality of Means for Customer Value | | |
|---|---|---|---|---|---|---|---|---|
| | | | High | Low | t-Test *p* value | High | Low | t-Test *p* value |
| **Planning Controls** | Goal Setting | 48 | 4.11 | 3.52 | $.025^{*}$ | 4.09 | 3.65 | $.073^{+}$ |
| | Employee Commitments | 48 | 3.89 | 3.38 | $.046^{*}$ | 3.91 | 3.46 | $.069^{+}$ |
| | Enterprise Alignment | 48 | 3.56 | 3.24 | .149 | 3.64 | 3.23 | .101 |
| | Risk Management | 48 | 4.59 | 4.38 | .135 | 4.68 | 4.35 | $.038^{*}$ |
| **Administrative Controls** | Digital Governance | 48 | 3.52 | 3.00 | $.084^{+}$ | 3.41 | 3.19 | .283 |
| | Interactive Leadership | 48 | 3.89 | 3.43 | $.071^{+}$ | 3.95 | 3.46 | $.057^{+}$ |
| | Digital Product Mgmt. | 48 | 3.74 | 3.05 | $.009^{**}$ | 3.59 | 3.31 | .174 |
| | Organizational Models | 48 | 3.81 | 3.33 | $.068^{+}$ | 3.68 | 3.54 | .330 |
| **Performance Management** | Financial Controls | 48 | 3.70 | 2.90 | $.016^{*}$ | 3.55 | 3.19 | .176 |
| | Operational Controls | 48 | 3.63 | 2.86 | $.013^{*}$ | 3.36 | 3.23 | .354 |
| | **Digital KPIs** | **48** | **3.26** | **2.24** | $\mathbf{.002^{**}}$ | **3.36** | **2.35** | $\mathbf{.002^{**}}$ |
| **Digital Acuity** | Digital Literacy | 71 | 3.76 | 3.39 | $.016^{*}$ | 3.69 | 3.52 | .175 |
| | Digital Vision | 71 | 4.00 | 3.58 | $.006^{**}$ | 4.03 | 3.64 | $.011^{*}$ |
| | Digital Champion | 71 | 4.05 | 3.70 | $.020^{*}$ | 4.10 | 3.74 | $.018^{*}$ |

$^{+}$ *p < .10, * p < .05, ** p < .01, *** p < .001*

For all but one component variable (digital incentives), the mean scores for companies with high competitiveness and high customer value propositions exceeded low success companies. In addition, statistically significant mean differences for competitiveness and/or customer value proposition were identified for 13 of the 15 process components and all three digital acuity components (*p*-values ranging from .002 to .084). In other words, higher process utilization and higher digital acuity are associated with companies also demonstrating higher levels of DX success. As a result, Proposition 1a, which states that utilization of a DX control system is positively related to a firm's DX success, is supported using the independent samples t-test method.

***Crosstabulation Analysis***

As a secondary analytical method to assess Proposition 1, we utilized crosstabulation analysis to determine a significant correlation between the level of utilization of prescribed leadership control process components and DX success. We determined similar correlations between the level of digital acuity and DX success. For these analyses, both the independent variables and the dependent variables were transformed into binary outcomes using the scales shown in table 8.

**Table 8**
**DX Control Variables * Digital Success Crosstabulations**

| Aggregate Variables | Responses Provided to 5-Point Likert Scale | Binary Value for Crosstab Analysis |
|---|---|---|
| Levels of Process Utilization (15 independent variables) | 1 - Strongly Disagree<br>2 - Disagree<br>3 - Neither Agree nor Disagree | Low Utilization (Value = 0) |
| | 4 - Agree<br>5 - Strongly Agree | High Utilization (Value = 1) |
| Levels of Digital Acuity (3 independent variables) | 1 - Strongly Disagree<br>2 – Disagree<br>3 - Neither Agree nor Disagree | Low Acuity (Value = 0) |
| | 4 - Agree<br>5 - Strongly Agree | High Acuity (Value = 1) |
| Levels of DX Success (2 dependent variables) | 1 - Strongly Disagree<br>2 - Disagree<br>3 - Neither Agree nor Disagree | Low Success (Value = 0) |
| | 4 - Agree<br>5 - Strongly Agree | High Success (Value = 1) |

To test the sensitivity of our classification scheme, a secondary method was used to assign the high/low values. The secondary method assigned a high value for any response which equaled or exceeded the mean value of all responses for any specific component. Likewise, low values were assigned to any response below the variable mean value. After running the same analyses, we found no material impact on the results. As a result, the following results are reported using the above-mentioned methodology.

Pearson's chi-square tests were performed to assess the relationship between each of the process control levers (15 in total) and the two measures of DX success. Factors with one-sided p-values of 0.10 or less were judged to be correlated with DX success. Results that are not statistically significant are shaded gray.

**Table 9**
**Process Utilization * DX Success Crosstabulations**

| DX Control Levers | DX Control Lever Components | | DX Success: High Competitiveness | DX Success: High Customer Value |
|---|---|---|---|---|
| **Cultural Controls Process Utilization** *n=48* | **Values** | High Utilization | 74.1% | 77.3% |
| | | Low Utilization | 25.9% | 22.7% |
| | | Pearson's R-value | .130 | .169 |
| | | ***p*-value *** | .184[c] | .121[c] |
| | **Symbols** | High Utilization | 66.7% | 63.6% |
| | | Low Utilization | 33.3% | 36.4% |
| | | Pearson's R-value | .331 | .213 |
| | | ***p*-value *** | **.011*** | **.071** |
| | **Talent Management** | High Utilization | 55.6% | 54.5% |
| | | Low Utilization | 44.4% | 45.5% |
| | | Pearson's R-value | .370 | .281 |
| | | ***p*-value *** | **.005**** | **.026*** |

| DX Control Levers | DX Control Lever Components | | DX Success: High Competitiveness | DX Success: High Customer Value |
|---|---|---|---|---|
| | **Incentives** | High Utilization | 22.2% | 22.7% |
| | | Low Utilization | 77.8% | 77.3% |
| | | Pearson's R-value | -.073 | -.048 |
| | | ***p*-value *** | .307[c] | .369[c] |
| **Planning Controls Process Utilization** *n=48* | **Goals** | High Utilization | 88.9% | 86.4% |
| | | Low Utilization | 11.1% | 13.6% |
| | | Pearson's R-value | .271 | .163 |
| | | ***p*-value *** | **.030**[*] | .130[c] |
| | **Commitment** | High Utilization | 85.2% | 81.8% |
| | | Low Utilization | 14.8% | 18.2% |
| | | Pearson's R-value | .358 | .222 |
| | | ***p*-value *** | **.007**[**] | **.062**[+] |
| | **Enterprise Alignment** | High Utilization | 59.3% | 63.6% |
| | | Low Utilization | 40.7% | 36.4% |
| | | Pearson's R-value | .210 | .251 |
| | | ***p*-value *** | **.073**[+] | **.041**[*] |
| | **Risk Management** | High Utilization | 100% | 100% |
| | | Low Utilization | 0% | 0% |
| | | Pearson's R-value | .236 | .192 |
| | | ***p*-value *** | **.051**[+] | **.092**[+] |
| **Administrative Controls Process Utilization** *n=48* | **Digital Governance** | High Utilization | 66.7% | 63.6% |
| | | Low Utilization | 33.3% | 36.4% |
| | | Pearson's R-value | .192 | .099 |
| | | ***p*-value *** | **.092**[+] | .247[c] |
| | **Interactive Leadership** | High Utilization | 77.8% | 81.8% |
| | | Low Utilization | 22.2% | 18.2% |
| | | Pearson's R-value | .221 | .259 |
| | | ***p*-value *** | **.063**[+] | **.036**[*] |
| | **Digital Product Management** | High Utilization | 70.4% | 63.6% |
| | | Low Utilization | 29.6% | 36.4% |
| | | Pearson's R-value | .277 | .099 |
| | | ***p*-value *** | **.028**[*] | .247[c] |

| DX Control Levers | DX Control Lever Components | | DX Success: High Competitiveness | DX Success: High Customer Value |
|---|---|---|---|---|
| | **Organization Models** | High Utilization | 77.8% | 72.7% |
| | | Low Utilization | 22.2% | 27.3% |
| | | Pearson's R-value | .313 | .157 |
| | | ***p*-value *** | **.015*** | .139c |
| **Performance Management Process Utilization** *n=48* | **Financial Controls** | High Utilization | 74.1% | 72.7% |
| | | Low Utilization | 25.9% | 27.3% |
| | | Pearson's R-value | .317 | .232 |
| | | ***p*-value *** | **.014*** | **.055+** |
| | **Operational Controls** | High Utilization | 66.7% | 59.1% |
| | | Low Utilization | 33.3% | 40.9% |
| | | Pearson's R-value | .331 | .129 |
| | | ***p*-value *** | **.011*** | .186c |
| | **Digital KPIs** | High Utilization | 51.9% | 59.1% |
| | | Low Utilization | 48.1% | 40.9% |
| | | Pearson's R-value | .390 | .455 |
| | | ***p*-value *** | **.004**** | **.001**** |

+ *p < .10, * p < .05, ** p < .01, *** p < .001*

There was a statistically significant (>90% confidence) and positive relationship between all but two DX control lever components and one or both measures of DX success. Specifically, the relationship between the utilization of the digital values and either measure of DX success (*p* = .121 and .184) was not meaningful, i.e., not statistically significant. Similarly, process utilization of digital incentives was not significant for either measure of DX success (*p* = .307 and .369). For all other combinations of the control lever components and DX success, R values ranged from .192 to .455 and one-sided *p*-values ranged from .001 to .092. In all cases, significant correlations demonstrated a positive relationship between process utilization and DX success. In other words, increased process utilization resulted in higher DX success. High levels of utilization of digital KPIs had the highest correlation and statistical significance with DX success (competitiveness: R=.390, *p*=.004; customer value proposition: R=.455, *p*=.001).

Similar analyses were conducted to determine the correlation between the digital acuity components (3 in total) and DX success (see table 10). Digital acuity components with one-sided *p*-values of 0.10 or less were judged to be correlated with DX success. Correlations that were not significant are shaded gray.

**Table 10**
**Digital Acuity Levels (Components) * DX Success Crosstabulations**

| Digital Control Levers | Digital Acuity Components | | DX Success | |
|---|---|---|---|---|
| | | | High Competitiveness | High Customer Value |
| Digital Acuity Levels *n=71* | Digital Literacy | High Literacy | 65.8% | 62.1% |
| | | Low Literacy | 34.2% | 37.9% |
| | | Pearson's R-value | .264 | .142 |
| | | ***p*-value *** | **.013*** | .115 |
| | Digital Vision | High Vision | 81.6% | 82.8% |
| | | Low Vision | 18.4% | 17.2% |
| | | Pearson's R-value | .233 | .202 |
| | | ***p*-value *** | **.025*** | **.045*** |
| | Digital Champion | High Champion | 78.9% | 79.3% |
| | | Low Champion | 21.1% | 20.7% |
| | | Pearson's R-value | .200 | .162 |
| | | ***p*-value *** | **.046*** | **.087+** |

+ *p < .10, * p < .05, ** p < .01, *** p < .001*

All three components of digital acuity had statistically significant correlations with either high competitiveness, high customer value, or both. Only one component, digital literacy, was not significantly correlated with improved value propositions, albeit only slightly outside of our significance range of $p <= .10$. In all cases, correlations demonstrated a positive relationship between digital acuity components and DX success. In other words, increased acuity resulted in higher DX success. Among the three components, digital literacy provided the highest significance and R values relative to high competitiveness (R=.264, *p*=.013). In other words, companies with digitally literate leaders have a 66% probability of also having higher competitiveness. Without digitally literate leaders, that probability drops to 34%. Digital vision showed the strongest correlation to customer value proposition (R=.202, *p*=.045) indicating companies with high digital vision have a higher incidence of high customer value. 83% of companies with high digital vision also have high customer value propositions compared to 17% of companies with low digital vision.

***Supplemental Crosstabulation Analysis – Business Leader Vision***

When analyzing subcategories of digital acuity data, we found strong correlation values and lowest *p*-values when correlating the digital vision of business leaders with DX success (see table 11). Crosstabulations that did not yield a significant correlation are shaded gray.

**Table 11**
**Digital Acuity Levels (Components) * Digital Success Crosstabulations**
**Business Leaders**

| **DX Control Lever** | **Digital Acuity Components** | | **DX Success** | |
|---|---|---|---|---|
| | | | **High Competitiveness** | **High Customer Value** |
| **Digital Acuity Levels** *N=23* | **Digital Literacy** | High Literacy | 45.5% | 42.9% |
| | | Low Literacy | 54.5% | 57.1% |
| | | Pearson's R-value | .215 | .112 |
| | | *p*-value * | .152 | .296 |
| | **Digital Vision** | High Vision | 81.8% | 85.7% |
| | | Low Vision | 18.2% | 14.3% |
| | | **Pearson's R-value** | **.568** | **.444** |
| | | ***p*-value *** | **.003****  | **.033*** |
| | **Digital Champion** | High Champion | 72.7% | 71.4% |
| | | Low Champion | 27.3% | 28.6% |
| | | Pearson's R-value | .151 | .086 |
| | | *p*-value * | .235 | .340 |

$^{+}$ $p < .05$, * $p < .05$, ** $p < .01$, *** $p < .001$

The digital vision of business leaders had positive, statistically significant correlations with high competitiveness and high customer value proposition. In all cases, correlations demonstrated a positive relationship between digital acuity components and DX success. In other words, the increased digital vision of business leaders resulted in higher DX success with high digital vision being characteristic in 82% of companies with high DX success. Without it, the probability drops to 18% or less. For business leaders, correlations between digital literacy and digital champion and DX success were not significant. The implications of this will be discussed in Chapter 5.

***Crosstabulation Results Summary***

Based upon crosstabulations which calculate the correlation between components of the hypothesized DX control system and DX success, the research suggests that 13 of the 15 leadership process components and all 3 digital acuity components are positively and significantly correlated to one or both measurements for DX success with at least a 90% confidence level (see table 12). In other words, companies that have high utilization of the 13 leadership process components or a high level of the 3 digital acuity components have a higher probability of achieving DX success. As a result, Proposition 1a, which states that utilization of a DX control system is positively related to a firm's DX success, is supported. However, only 16 of the 18 hypothesized components demonstrate a statistically significant correlation. Results that are not statistically significant are shaded gray.

**Table 12**
**Summary of Crosstabulation Results**
**Pearson Chi-Square Test (One-Sided *p*-Value)**

| DX Control Lever | Components | Pearson Chi-Square Test (One-Sided *p*-Value) | |
|---|---|---|---|
| | | High Competitiveness | High Customer Value |
| **Cultural Controls Process Utilization** *n=48* | Values | .184 | .121 |
| | Symbols | $.011^{*}$ | $.071^{+}$ |
| | Talent Management | $.005^{**}$ | $.026^{*}$ |
| | Incentives | .307 | .369 |
| **Planning Controls Process Utilization** *n=48* | Goal Setting | $.030^{*}$ | .130 |
| | Employee Commitments | $.007^{**}$ | $.062^{+}$ |
| | Enterprise Alignment | $.073^{+}$ | $.041^{*}$ |
| | Digital Risk Management | $.051^{+}$ | $.092^{+}$ |
| **Administrative Controls Process Utilization** *n=48* | Digital Governance | $.092^{+}$ | .247 |
| | Interactive Leadership | $.063^{+}$ | $.036^{*}$ |
| | Digital Product Mgmt. | $.028^{*}$ | .247 |
| | Organizational Models | $.015^{*}$ | .139 |
| **Performance Management Controls Process Utilization** *n=48* | Financial Controls | $.014^{*}$ | $.055^{+}$ |
| | Operational Controls | $.011^{*}$ | .186 |
| | Digital KPIs | $.004^{**}$ | $.001^{**}$ |

| DX Control Lever | Components | Pearson Chi-Square Test (One-Sided *p*-Value) | |
|---|---|---|---|
| | | High Competitiveness | High Customer Value |
| **Digital Acuity Levels** *n=71* | Digital Literacy | .013* | .115 |
| | Digital Vision | .025* | .045* |
| | Digital Champion | .046* | .087+ |

+ *p < .10, * p < .05, ** p < .01, *** p < .001*

### ***Comparing t-Test and Crosstabulation Results***

We utilized two statistical methods to assess the correlation between components of the hypothesized DX control system and DX success. Both methods indicated most DX control system components have a positive and statistically significant correlation with DX success – 16 of 18 components in both cases. However, the two methods provided slightly different lists of meaningful components. Table 12 below shows the p-value of the crosstab analysis. Crosstabulation and t-Test *p*-values which are not significant are shaded.

**Table 12**
**Summary of Crosstabulation and t-Test Results**
***p*-Values**

| DX Control Variables | Components | DX Success | | | |
|---|---|---|---|---|---|
| | | Competitiveness | | Customer Value | |
| | | Crosstab | t-test | Crosstab | t-test |
| **Cultural Controls Process Utilization** *n=48* | Values | .184 | .085+ | .121 | .098+ |
| | **Symbols** | .011* | .025* | .071 | .049* |
| | **Talent Management** | .005** | .009** | .026* | .069+ |
| | Incentives | .307 | .345 | .369 | .411 |
| **Planning Controls Process Utilization** *n=48* | Goal Setting | .030* | .025* | .130 | .073+ |
| | **Employee Commitments** | .007** | .046* | .062b | .069+ |
| | Enterprise Alignment | .073+ | .149 | .041* | .101 |
| | Digital Risk Management | .051+ | .135 | .092 | .038* |

| DX Control Variables | Components | DX Success | | | |
|---|---|---|---|---|---|
| | | Competitiveness | | Customer Value | |
| | | Crosstab | t-test | Crosstab | t-test |
| **Administrative Controls Process Utilization** *n=48* | Digital Governance | $.092^{+}$ | $.084^{+}$ | .247 | .283 |
| | **Interactive Leadership** | $.063^{+}$ | $.071^{+}$ | $.036^{*}$ | $.057^{+}$ |
| | Digital Product Mgmt. | $.028^{*}$ | $.009^{**}$ | .247 | .174 |
| | Organizational Models | $.015^{*}$ | $.068^{+}$ | .139 | .330 |
| **Performance Management Process Utilization** *n=48* | Financial Controls | $.014^{*}$ | $.016^{*}$ | .055 | .176 |
| | Operational Controls | $.011^{*}$ | $.013^{*}$ | .186 | .354 |
| | **Digital KPIs** | $.004^{**}$ | $.002^{**}$ | $.001^{**}$ | $.002^{**}$ |
| **Digital Acuity Levels** *n=71* | Digital Literacy | $.013^{*}$ | $.016^{*}$ | .115 | .175 |
| | **Digital Vision** | $.025^{*}$ | $.006^{**}$ | $.045^{*}$ | $.011^{*}$ |
| | **Digital Champion** | $.046^{*}$ | $.020^{*}$ | .087 | $.018^{*}$ |

$^{+}$ *p* < .10, * *p* < .05, ** *p* < .01, *** *p* < .001

Five of the 15 process components and 2 of the 3 digital acuity components were shown to have positive and statistically significant correlations with both forms of DX success and across both analytical methods. We found no meaningful correlation between incentives and DX success regardless of the method. That left 9 of the 15 process components and 1 of the 3 digital acuity components with mixed results. We take a non-reductionist view and do not eliminate those components with mixed results. Future research might be able to delineate the circumstances that drive these mixed results. We leave these components in our hypothesized DX control system package knowing that not all components will be relevant in all situations. As such, we propose that P1a is supported, albeit with one caveat.

**P1a: Utilization of a DX control system is positively related to the firm's DX success. [Supported with the caveat that the digital incentive component is not supported.]**

**Relative Impact on DX Success**

In previous sections, we demonstrated that surveyed companies claimed to utilize 11 of 15 prescribed leadership practices. We also noted that 14 of the 15 prescribed process components, along with all three digital acuity measures, were correlated with DX success. With such a complex framework, it would be important for practitioners to understand the relative impact of each variable on the ultimate outcome of DX success. We propose that components of the DX control system differ in their impact on DX success. We seek to understand which components of the hypothesized model provide the greatest impact.

To assess relative impact, we utilized logistic regression (LR) analysis. LR uses dichotomous outcome variables and can use either linear or dichotomous independent variables. We utilized dichotomous variables for both the independent and dependent variables using the method shown in table 8 above.

The first step in our analysis was to test for multicollinearity across the independent variables. We utilized SPSS v28 to calculate a Pearson correlation coefficient. Appendix 5 shows the correlation table. Although correlations between some of the predictor variables are statistically significant, all correlations were below the prescribed threshold *p*-value of 0.80 (Midi, Sarka & Rana, 2010).

Next, we selected the appropriate predictor variables to include in the LR analysis. As noted by Pampel (2000), choosing the correct predictors is an important step in LR. We attempted to choose the smallest number of predictor variables (Stoltzfus, 2011) by identifying those predictor variables which have a statistically significant correlation with the outcome variable. Table 13 below identifies the p-value of the correlations and the predictor variables selected for the LR analysis with shaded variables excluded from the analysis.

**Table 13**
**Summary of Crosstabulations Results**
**Pearson Chi-Square Test (One-Sided *p*-Value)**

| DX Control Levers | Components | *p*-Value of Pearson Correlation with DX Success Variable |
|---|---|---|
| **Utilization of Cultural Controls** | Values | .220 |
| | Symbols | $.018^{*}$ |
| | Talent Management | $.007^{**}$ |
| | Incentives | .500 |
| **Utilization of Planning Controls** | Goal Setting | .206 |
| | Employee Commitments | $.035^{*}$ |
| | Enterprise Alignment | $.041^{*}$ |
| | Digital Risk Management | .115 |
| **Utilization of Administrative Controls** | Digital Governance | .424 |
| | Interactive Leadership | $.081^{+}$ |
| | Digital Product Mgmt. | .220 |
| | Organizational Models | .105 |
| **Utilization of Performance Management Controls** | Financial Controls | $.009^{**}$ |
| | Operational Controls | $.068^{+}$ |
| | Digital KPIs | $<.001^{***}$ |

$^{+}$ *p < .10, * p < .05, ** p < .01, *** p < .001*

A backward elimination logistic regression analysis was performed using the eight predictor variables shown in table 13 above to determine their effects on DX success. The logistic regression model was statistically significant, $X^2$ (2, N = 48) = 16.314, *p* = <.001. The model explained 38.8% (Nagelkerke $R^2$) of the variance in DX success and correctly classified 77.1% of cases compared to the null hypothesis model of 58.3%. More importantly, companies which effectively utilized digital KPIs were nine times as likely to achieve DX success as those that do not (OR=9.246, 90%CI [2.7, 31.1]). Digital symbols, employee commitment, enterprise alignment, financial controls, and operational controls were not associated with DX success, but utilization of digital talent management processes provides three times better odds of achieving DX success (OR=3.284, 90%CI [1.0, 10.7]). The LR analysis results are summarized in tables 14a and 14b below.

**Table 14a**
**Results of Logistic Regression for DX Success**
**Stepwise Progress**

| Step | Chi-Square | df | *p*-value | Hosmer and Lemeshow Test Chi-Square | Hosmer and Lemeshow Test *p*-value | Nagelkerke $R^2$ | Model Prediction Accuracy |
|---|---|---|---|---|---|---|---|
| 1 | 19.714 | 9 | .020* | 8.919 | .259 | .453 | 81.3% |
| 2 | 19.713 | 8 | .011* | 8.715 | .274 | .453 | 81.3% |
| 3 | 19.704 | 7 | .006** | 8.538 | .201 | .453 | 81.3% |
| 4 | 19.686 | 6 | .003** | 6.318 | .503 | .453 | 81.3% |
| 5 | 19.078 | 5 | .002** | 7.114 | .524 | .441 | 79.2% |
| 6 | 18.112 | 4 | .001** | 1.064 | .983 | .423 | 77.1% |
| 7 | 17.496 | 3 | <.001*** | 2.392 | .793 | .411 | 77.1% |
| **8** | **16.314** | **2** | **<.001*** ** | **0.491** | **.782** | **.388** | **77.1%** |

$^{+}$ $p < .10$, $^{*}$ $p < .05$, $^{**}$ $p < .01$, $^{***}$ $p < .001$

**Table 14b**
**Results of Logistic Regression for DX Success**
**Statistics for Final Model**

| Model Components | Coefficient | *p*-value | β | 90% C.I. | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| **Digital KPIs** | **2.224** | **.003**** | **9.246** | **2.746** | **31.136** |
| Digital Talent | 1.189 | .097⁺ | 3.284 | 1.010 | 10.677 |
| Constant | -1.655 | .002** | .191 | - | - |

*$^{+}$ $p < .10$, $^{*}$ $p < .05$, $^{**}$ $p < .01$, $^{***}$ $p < .001$*

Using the backward stepwise elimination method within the LR analysis, we determined that high utilization of two model components (digital KPIs and digital talent management) provide the greatest odds of achieving DX success. As a result, Proposition 1b is supported.

**P1b: Components of the DX control system differ in their impact on DX success. [Supported.]**

**Moderated Linear Regression**

An important element of our hypothesized DX control system is the incorporation of leadership digital acuity into the model. We propose that high levels of digital acuity among top-level leaders would have a direct correlation with DX success. We sought to further understand how digital acuity influenced DX success and suggested that digital acuity played a moderating role in the impact of the utilization of the DX control system processes.

Simple linear regression confirmed our expectations of the interaction between the highest-level categories of our hypothesized model. In other words, the data indicated positive and significant correlations between these high-level aggregate variables – Process

Utilization, Digital Acuity, and DX Success. Table 15 below demonstrates these correlations.

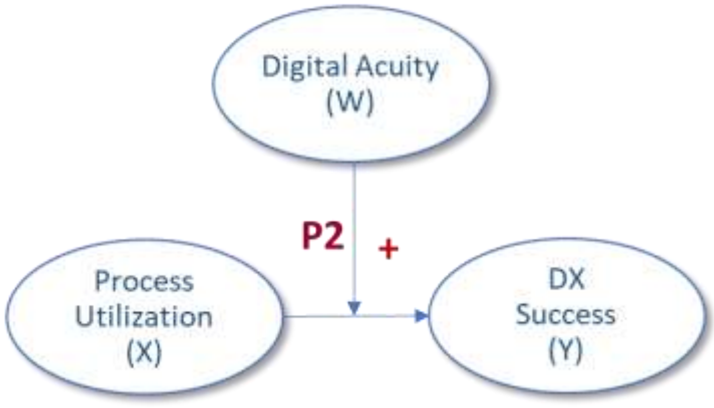
**Table 15**
**Correlation Between High-Level Aggregate Variables**

| | Process Utilization | DX Success |
|---|---|---|
| **Digital Acuity** | R = .389<br>*p* = .006** <br>n = 48 | R = .326<br>*p* = .005** <br>n = 71 |
| **Process Utilization** | | R = .388<br>*p* = .006** <br>n = 48 |

* $p < .05$, ** $p < .01$, *** $p < .001$

To assess proposition 2, we examined whether digital acuity (W) moderated the relationship between process utilization (X) and DX success (Y) as visualized in figure 7 below. We presumed high levels of digital acuity would have a positive impact on the relationship between process utilization and DX success such that higher levels of digital acuity would increase the impact process utilization has on DX success.

**Figure 7: Hypothesized Moderation Model**



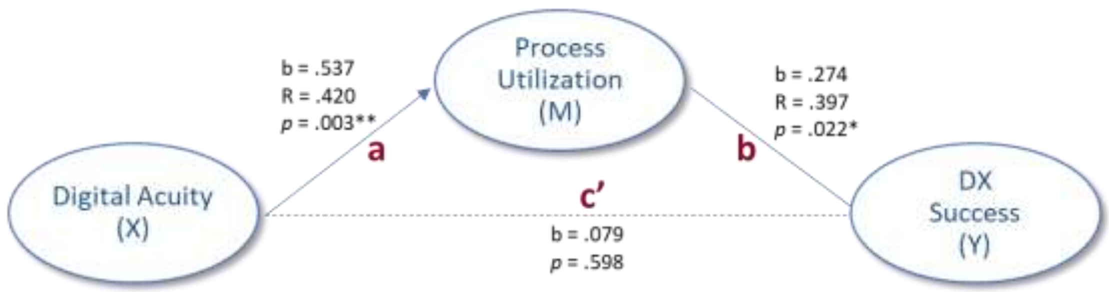
To examine these relationships, we used model #1 within Hayes's (2018) PROCESS macro. Our moderation model containing process utilization and digital acuity and the interaction explained a significant proportion of the variance in DX success (R2= .4186; F(3,44) = 3.1166; *p*= .036). However, the overall model was not statistically significant as *p*-value of the interactive effect was .34 and the *p*-value of the relationship between digital acuity to DX success was .42. Therefore, we cannot provide evidence of the moderating effect of digital acuity on the relationship between process utilization and DX success.

**P1b: Digital acuity of top managers moderates the relationship between an effective DX control system and DX success such that higher digital acuity strengthens the positive relationship [Not supported but with a proposed alternate model].**

**Alternate Model**

Given the significant correlation across the three high-level aggregate variables, we examined alternate models to explain the relationship between digital acuity, process utilization, and DX success. We hypothesized an alternate model in which digital acuity is an antecedent to the relationship between process utilization and DX success (see figure 8 below). Specifically, leaders with greater digital acuity (X) would drive higher levels of process utilization (M), and higher levels of process utilization would be correlated to higher levels of DX success (Y). We used model #4 within Hayes's (2018) PROCESS macro to test this hypothesis. Leadership digital acuity was positively and significantly related to process utilization (b= .537, *p*=.003). Process utilization was positively and significantly related to DX success (b= .274, *p*=.022). In addition, the relationship between leadership digital acuity and DX success (i.e., the direct effect) was insignificant (p>.10) when adjusted for the effects of the mediator.

**Figure 8: Proposed Fully Mediated Model**




In the PROCESS macro, we used bootstrapping to test the significance of the indirect effect, with 5,000 bootstrap samples and a 90% confidence interval. The unstandardized indirect effect was positive (Effect = .147 [90% CI: .0265; .333]), and because the 90% confidence interval did not include zero the effect was statistically significant. Thus, we propose an alternate model whereby process utilization fully mediates the relationship between leadership digital acuity and DX success.

**Results Summary**

Despite the limited sample size, our results supported the underlying premise of our research. First, the hypothesized model based upon the M&B and Trenkle's (2020) management control system packages was representative of the DX activities conducted by the companies in our survey sample. Secondly, 17 of the 18 proposed components were positively and significantly correlated to DX success. Third, using logistic regression techniques, we identified that not all components affected DX success equally. We found higher utilization of digital KPIs, and to a lesser degree, digital talent management controls had a profound impact on the level of DX success. Finally, while our proposed regression model with digital acuity acting as a moderator to the relationship between process utilization and DX success was not supported, we did identify a likely alternate model. The alternate model provides insight into how digital acuity and process utilization interact to drive DX success.

In summary, our research provides empirical evidence of the effectiveness of DX control systems in driving DX success. It highlights the critical components of the control system which provided the most profound impact on success. As importantly, we have evidence to suggest a fully mediated regression model which provides insight into how the model constructs interact. While the research has limitations such as small sample size with attending risk of confounding factors of multivariate analysis, it successfully provides additional insights for academic researchers and business leaders while providing a strong foundation for future research.

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# Chapter 5: Discussion

Our research provides an incremental step in a long and growing body of research on digital transformation and the nascent use of management control systems theory to better understand the drivers of DX success. The use of management control systems theory puts the focus on leadership. However, despite the important challenges associated with DX leadership, research on this topic remains relatively underdeveloped as evidenced by Chawla's (2020) bibliometric analysis (see appendix 1). We believe there are two important elements to DX leadership research: 1) leader actions, and; 2) leader cognitions. Put another way, who they are and what they do.

Leadership actions are embodied within the business processes they implement within their firm. Some companies refer to a set of leadership processes as a "business operating system" such as the Danahar Business System (DBS). The academic corollary is referred to as management control systems (MCS). Sets of control activities, or leadership processes, have been theorized as a management control system package. We leveraged an MCS package proposed by Malmi & Brown (2008) which attempted to operationalize Simons' (1994) strategic operating model. We followed the lineage of that research to Trenkle (2020) who applied the M&B model to digital transformation theory.

By leveraging research on MCS theory, we extended and empirically tested a framework proposed by Trenkle which describes a set of leadership processes associated with DX success. Our research largely supports a hypothesized version of Trenkle's framework. The findings explicated a correlation between process utilization and DX success. It further prioritized the relative impact of these components on DX success.

Leadership cognition was operationalized in our research as a set of leadership skills necessary for an increasingly digital world, particularly for companies within physical industries. These skills were combined into a potentially new construct we refer to as digital acuity. While each component is backed by prior research, we believe this research is the first to empirically test the construct in the context of a management control system. More importantly, our data suggests all three digital acuity elements are important contributors to DX success. As such, we hope this research represents a jumping-off point for additional academic and business research.

**Implications for Research**

Our findings advance knowledge on DX by validating and extending research designed to provide leaders with a playbook for DX success. First, we empirically tested a line of theoretically derived research on the use of management control systems. Research on MCSs originated in the 1980s. Early on, MCS models were proposed to go beyond the original scope of financial management. Simons (1995) proposed his Levers of Control model for organizations to drive strategy. Malmi & Brown (2008) provided a theoretical framework to operationalize Simons' model. Trenkle (2020) applied the M&B framework in the context of DX. While MCS models have been empirically tested, including Simons' Levers of Control, we are not aware of any research which links the use of these models to DX success. Our research not only confirms these theoretical frameworks but also provides measurement methods to further test future iterations. Our data measured the correlation to the desired outcome of DX success. It also provides relative importance to the components of these models.

Secondly, we extended previous models by adding a new leadership dimension – digital acuity. The idea that leaders of incumbent companies need new skills for the future is not new. However, empirically tested research appeared to be lacking. The research results from this study supports the notion that digital skills are required for top-level managers, but also that these skills are correlated with important outcome measures. In doing so, our model provided a tested foundation for future research on these leadership skills required in an increasingly digital world.

Lastly, our research proposed a causation model describing the relationship between digital acuity, process utilization, and DX success. Beyond just correlation, our research suggested a causation effect between the elements of our model. The research data did not support our original hypothesis of a moderation model. However, the data provided support for an alternate model. Specifically, our research points to a potential fully mediated model whereby digital acuity is an antecedent to process utilization. Together, this mediated relationship drives DX success. This is the first evidence we know of that points to a structure model.

## Implications for Practice

This research was pursued due to the general lack of practical knowledge on DX and the unsubstantiated and/or contradictory advice provided by so-called business experts. Most research focuses on the technologies associated with DX. Less is known about the human elements. This gap creates a challenge for top-level managers of incumbent firms who are faced with digital disruption, even in physical industries. These leaders understand the impetus but lack the knowledge and confidence on how to address it. Even worse, their organizations have low confidence in their abilities.

This is not the first time these companies have faced transformational waves. However, other transformational initiatives, such as total quality management, were based upon well-documented processes and capabilities. DX comes with the same level of relevance and urgency for incumbent companies, but with much less utilization. This research builds a process template, organizational competencies, and leadership capabilities to arm incumbent companies with the tools necessary to succeed in their DX journey.

To start, an empirically tested DX control system provides incumbents with a framework from which to assess their current organizational capabilities and leadership practices. The framework touches on all four of Simons' (1994) Levers of Control. The DXCS identifies belief systems, boundary systems, diagnostic systems, and interactive leadership systems, all of which Simons suggests are necessary for organizational transformation. In addition, this research translates the components which support those levers to prescribed DX leadership processes. Any company can calibrate its organizational capabilities against these levers and components to identify gaps and develop organizational development plans.

With 15 potential processes, the challenge may seem daunting. Our research helps companies prioritize components in the interest of achieving the biggest gains. Specifically, incumbent companies will be best served using digital KPIs to guide their DX initiatives. This may not require new processes, but instead, can be incorporated into existing strategy execution processes such as the Balanced Scorecard approach or Hoshin Kanri's Targets-to-Improve.

Finally, this research helps incumbent companies update their established leadership development programs with the newly required digital leadership competencies. Organizational development leaders can quickly develop programs that raise digital literacy across the leadership staff through structured training on new technologies. Similarly, many leadership competency frameworks already incorporate innovation and the ability to drive innovation in their required skills models. The addition of a digital innovation champion component to those models would be an important addition.

Digital vision might be a greater challenge to digital acuity. Our data indicated digital vision within business leaders has a positive and statistically significant correlation to DX success. However, teaching leaders how to apply these new technologies might be a more challenging endeavor. Organizations and business consultants are starting to use new business modeling tools (e.g., business canvas and enterprise architecture) to help companies define a digital vision.

**Opportunities for Future Research**

Our research data provided several insightful and relevant nuggets worthy of additional exploration. The most actionable insight was the important role digital KPIs play in DX success. Research results indicated that for every one-unit improvement in utilization of digital KPIs, a company can expect a 9-times chance for improvement in DX success. This is powerful, but not completely surprising. Variations of the theme "you get what you measure" are common. Ariely (2010) suggests choosing the right business metrics is key to changing what CEOs care about. Additionally, CEOs can analyze the effectiveness of digital investments when they know the most important metrics to monitor (Fitzpatrick & Strovnink, 2021). Given the impact of digital KPIs, future research should explicate what it means to effectively utilize digital KPIs. This may include some form of qualitative research to identify relevant metrics and determine which ones are most effective in a particular situation.

Optimizing the use of digital KPIs was perhaps evidenced by the disparity in our two dependent variable measurements: 1) increased competitiveness, and; 2) improved customer value proposition. Participating companies rated higher on competitiveness than on value proposition. Similarly, the DX control system component processes had much stronger correlations with competitiveness than they did on customer value proposition. However, both are important elements of DX success. Yet, it is uncertain why they behaved differently in our research. It is possible that improving customer value propositions requires different DX control system processes. Perhaps Trenkle's qualitative study of firms could be repeated for companies demonstrating improved customer value propositions to explicate a new set of leadership processes not yet identified by M&B, Trenkle, or this research.

An interesting dichotomy in our research results was the positive impact of managing digital talent but the negligible impact of digitally oriented incentives. Intuitively, these two variables would seem to be linked as digital talent would seemingly expect incentives modeled after technology companies. For example, Catlin (2015) suggests the right incentives are required to nurture digital talent. However, incumbent organizations are often reluctant to utilize make-or-break incentive plans found in technology startups (Hildebrand, 2021). Yet, it may not be possible to attract digital talent without those incentives. Understanding the conflict between prior research on incentive plans and our research data would be valuable for leaders of incumbent organizations and an important distinction for DX research.

During our analyses, we identified a significant difference in mean scores of the digital acuity variables between technology leaders and business leaders. Of note was the very high correlation between the digital vision of business leaders and DX success. Companies with leaders who had high digital vision had a much higher probability of 86% vs 14% of achieving DX success than those with leaders with low digital vision. These results potentially point to a clear and specific opportunity for leaders of incumbent companies. Specifically, leaders must be able to define how their companies apply digital technologies. Future research should combine insights on strategy formulation with DX to help leaders best formulate the right use of the technologies of the fourth industrial revolution. This opportunity could create an interesting new intersection between strategic theory such as Resource Based View (RBV) or Dynamic Capabilities Theory with DX theory.

Finally, we were not able to discern the impact of rigorous digital risk management practices in our research. Process utilization of digital risk management was, by far, the highest in the participating companies with a mean score of 4.5 out of 5. Ninety-six percent of participating companies indicated they agree or strongly agree with their utilization of these practices. However, because high-DX-success and low-DX-success companies both demonstrated high digital risk management process utilization, the data did not discern if these practices are sufficient for DX success. An important follow-up question not determined by our research data is whether these practices are necessary for DX success. In other words, digital risk management practices may be required in digital transformation, or they may be irrelevant. Intuitively, incumbent companies seemingly must manage risk to be successful in their DX efforts. However, additional research would be required to support this intuition.

**Research Limitations**

Digital transformation is a business strategy that is embedded in the highest levels of the organization. It has become a mandate for CEOs (Siebel, 2017) who play a critical role in defining a digital future and ensuring the organization is aligned toward a common vision (Guzman, 2020). As such, DX research would be meaningless without input from top-level managers. As many researchers would attest, collecting data from top-level managers is challenging. Our recruiting process required significant efforts to engage our 71 respondents. Despite this feat, more data would improve the statistical significance of this research and provide more robust insights. We hope researchers find these analyses interesting and continue to collect additional data points to confirm or refute our findings. With Trenkle's (2020) DX control system largely intact from our findings, future research could focus on discreet components of the model, potentially reducing the challenges of such a wide research scope.

Additionally, despite extensive research on DX, there is a surprising lack of proven measurement models for DX success and digital acuity. DX success provides an important outcome measure for any causation modeling. Our definition was derived from adjacent research and subject matter experts. While the measurement methods were based upon subjective assessments, prior research suggests subjective methods can be as accurate as objective measures of success (Chenhall, 2003). However, this is the first research that we know of which sought to operationalize management models for successful DX. Future research should continue to extend and refine common measurement models for DX success.

Similarly, we were excited to have extended prior research with the addition of digital acuity as a supported component of DX control system models. Practitioners are increasingly examining leadership development models which focus on digital acuity. However, this is the first research we know of that correlated leadership digital acuity with DX success. Given the importance of DX in most organizations, digital acuity is worthy of increased focus in the academic world. One avenue for future research would be to explore the meaning and value of digital acuity across technology leaders as compared to business leaders. We found significantly different levels of digital acuity across the three components (literacy, vision, and champion) between these two groups. Additional data and research could better delineate the predictive power of the three components for each leadership category. We believe digital acuity for business leaders could be different than technology leaders for companies to achieve DX success.

Of note, we saw meaningful differences in the predictive value of components across our two measurements of DX success – increased competitiveness and improved value proposition. Our results suggested companies are achieving the former more so than the latter. Yet, some suggest the real value in DX is represented by an improved customer value proposition. With that in mind, additional research is required to focus more deeply on the customer value proposition outcome variable and to better understand the drivers of that objective.

We found important correlations among the three high-level aggregate variables – digital acuity, process utilization, and DX success. While we were not able to support our original moderation model, we did find evidence of a statistically significant mediation model (see figure 7). Our limited sample size prevented us from declaring this mediation model as the best model. As such, we hope additional research can either verify this mediation model or identify a more predictive model. With additional data, we believe structured equation models can be developed to quantitatively evaluate alternate models.

Finally, our focus was on incumbent companies within physical industries. We included several industries within the definition of "physical" including industrial manufacturing, consumer manufacturing, distribution, and construction. The premise was that products these companies provide cannot, by themselves, be displaced by technology. However, we also believe these companies are at risk of digital disruption as digital-native companies increasingly disintermediate the incumbent company's customer value proposition. However, the research data indicated these industries may not be homogenous. We saw statistically significant differences in DX success values across industries. Consumer manufacturing companies appear to be achieving greater success than industrial manufacturing companies. Likewise, our data indicated construction companies are also achieving greater competitiveness from their DX initiatives. These differences warrant additional industry-specific research to improve the analyses or cross-industry analyses to understand the differences across industries. Either approach should provide incremental value to our findings.

**General Conclusions**

We sought to expand knowledge on a relatively under-researched element of digital transformation -- leadership. Our primary goal was to empirically validate prior research to better understand what processes top-level managers should utilize to achieve DX success. This knowledge can be useful for leaders of incumbent companies who understand the importance of DX but are not confident in their ability to lead it.

To this end, our research supported a merged version of the Trenkle and M&B models, except for one component, by demonstrating the correlation between process utilization and DX success. Additionally, by comparing the level of process utilization across high-DX-success companies vs low-DX-success companies, we demonstrated a statistically significant difference in several key components of the hypothesized model. Lastly, using logistic regression modeling, we highlighted the overwhelming importance of the utilization of digital KPIs and, to a lesser degree, digital talent management practices.

We also sought to extend prior research with the addition of leadership capabilities to the existing DX control system framework. Based upon research on leadership capabilities in related environments, we proposed a construct for these capabilities, digital acuity. We also identified three measurable components: 1) digital literacy; 2) digital vision, and; 3) digital champion. Leveraging insights from 71 survey participants, we found a statistically significant and positive correlation between digital acuity and DX success.

More importantly, we sought to understand how digital acuity impacts DX success through the development of moderation and mediation models. Although we cannot confirm whether it is the best or only explanatory model, we did identify a fully mediated regression model suggesting digital acuity is an antecedent to process utilization which, in turn, drives digital transformation success.

In addition to providing new research insights, understanding the importance of digital acuity will be valuable for leaders of incumbent companies. Today's leaders have low confidence in their abilities to lead DX initiatives and their organizations have even less faith in their skills. A leadership development framework would be valuable to raise their knowledge and confidence to succeed.

Overall, our research achieved its original objectives. We found support for 2 of 3 of our original propositions. And, while we did not find support for our third proposition, we did identify an alternate model which could prove equally valuable. As such, we are confident this research will add value to academic research streams on DX while providing practical knowledge for leaders of incumbent companies. Given the make-or-break importance of DX on incumbent firms, we believe our findings can provide a meaningful contribution to both audiences.

## References

Abernathy, M.A., & Chua, W.F., (1996). A field study of control system "redesign": the impact of institutional processes on strategic choice. *Contemporary Accounting Research*, *13*(2), 569–606.

Amat, J., Carmona, S., & Roberts, H. (1994). Context and change in management accounting systems: a Spanish case study. *Management Accounting Research*, *5*(2), 107-122.

Ariely, D. (2010). You are what you measure. *Harvard Business Review*, *88*(6), 38.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Beath, C. M. (1991). Supporting the information technology champion. *MIS Quarterly, 15*(3), 355-372.

Bedford, D. S. (2015). Management control systems across different modes of innovation: Implications for firm performance. *Management Accounting Research*, *28*, 12-30.

Bedford, D. S., & Malmi, T. (2015). Configurations of control: An exploratory analysis. *Management Accounting Research*, *27*, 2-26.

Bedford, D. S. (2020). Conceptual and empirical issues in understanding management control combinations. *Accounting, Organizations and Society*, *86*, 101187.

Bhagwat, R., & Sharma, M. K. (2007). Performance measurement of supply chain management: A balanced scorecard approach. *Computers & Industrial Engineering*, *53*(1), 43-62.

Bisbe, J., & Otley, D. (2004). The effects of the interactive use of management control systems on product innovation. *Accounting, Organizations and Society*, *29*(8), 709-737.

Bower, J., & Christensen, C. (1995). Disruptive technologies: Catching the wave. *Harvard Business Review, 73*(1), 43-53.

Bughin, J., Deakin, J., & O'Beirne, B. (2019, October 22). *Digital transformation: Improving the odds of success*. McKinsey. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-transformation-improving-the-odds-of-success

Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization Science, 15*(5), 555-568.

Catlin, T., Scanlan, J., & Willmott, P. (2015, June 1). *Raising your digital quotient*. McKinsey. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/raising-your-digital-quotient

Chawla, R. N., & Goyal, P. (2021). Emerging trends in digital transformation: a bibliometric analysis. *Benchmarking: An International Journal*, *29*(4), 1069-1112.

Chen, G. Y., & Zhang, J. S. (2011, September). Analysis on transformational leadership in post-crisis era: Evidence from Jack Welch in GE. *Proceedings from 2011 International Conference on Electronics, Communications and Control (ICECC),* 3117-3120. https:/doi.org/10.1109/icecc.2011.6068139

Chenhall, R. H. (2003). Management control systems design within its organizational context: findings from contingency-based research and directions for the future. *Accounting, Organizations and Society*, *28*(2-3), 127-168.

Christensen, C. M. (1997). *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business Review Press.

Church, Z. (2020, March 3). *Writing a new leadership playbook.* MIT Sloan. https://mitsloan.mit.edu/ideas-made-to-matter/writing-a-new-leadership-playbook

Crespo, N.F., Rodrigues, R., Samagaio, A., & Silva, G.R. (2019). The adoption of management control systems by start-ups: internal factors and context as determinants. *Journal of Business Research, 101,* 875-884.

Danaher Corporation. (2021). *Danaher Business System*. https://www.danaher.com/how-we-work/danaher-business-system

Danoesastro, M. (2017, May 22). *A CEO's guide to leading digital transformation*. BCG Group. www.bcg.com/publications/2017/digital-transformation-digital-organization-ceo-guide-to-digital-transformation

Das, S. C. (2019). *Management control systems: principles and practices*. PHI Learning.

Davila, A., & Foster, G. (2007). Management control systems in early-stage startup companies. *The Accounting Review*, *82*(4), 907-937.

Davila, A., Foster, G., & Li, M. (2009). Reasons for management control systems adoption: Insights from product development systems choice by early-stage entrepreneurial companies. *Accounting, Organizations and Society*, *34*(3-4), 322-347.

Davila, A., Foster, G., & Jia, N. (2015). The valuation of management control systems in start-up companies: International field-based evidence. *European Accounting Review*, *24*(2), 207-239.

DDI. (2018). *Global leadership forecast 2018.* https://www.ddiworld.com/research/global-leadership-forecast-2018

DDI. (2019). *Digital leadership quotient.* [Business presentation]

DDI. (2021). *Global leadership forecast 2021*. https://www.ddiworld.com/global-leadership-forecast-2021

Dewer, C., & Keller, S. P. (2007, February 1). *The CEO's Role in Leading Transformation.* McKinsey. https://www.mckinsey.com/business-functions/organization/our-insights/the-ceos-role-in-leading-transformation

Doz, Y., Doz, Y. L., & Kosonen, M. (2008). *Fast strategy: How strategic agility will help you stay ahead of the game*. Pearson.

Doz, Y. L., & Kosonen, M. (2010). Embedding strategic agility: A leadership agenda for accelerating business model renewal. *Long Range Planning*, *43*(2-3), 370-382.

Drucker, P. (1980). *Managing in Turbulent Times*. Harper Collins.

Drucker, P. (1994). The theory of business. *Harvard Business Review, 72*(5), 95.

El Sawy, O. A., Kraemmergaard, P., Amsinck, H., & Vinther, A. L. (2016). How LEGO built the foundations and enterprise capabilities for digital leadership. *MIS Quarterly Executive*, *15*(2), 141-166.

Felício, T., Samagaio, A., & Rodrigues, R. (2021). Adoption of management control systems and performance in public sector organizations. *Journal of Business Research*, *124*, 593-602.

Fisher, J. G. (1998). Contingency theory, management control systems and firm outcomes: past results and future directions. *Behavioral Research in Accounting*, *10,* 47.

Fisk, P. (2002). The making of a digital leader. *Business Strategy Review*, *13*(1), 43-50.

Fitzpatrick, M., & Strovnink, K. (2021, January 29). *How do you measure success in digital? Five metrics for CEOs*. McKinsey. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/how-do-you-measure-success-in-digital-five-metrics-for-ceos

Gartner. (2017, September 28). *Digital business KPI's: defining and measuring success.*

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 update.* Allyn & Bacon.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Proceedings of the Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, The Ohio State University, Columbus, Ohio.* 82-88. https://scholarworks.iupui.edu/bitstream/handle/1805/344/Gliem%20&%20Gliem.pdf

Govindarajan, V., & Fisher, J. (1990). Strategy, control systems, and resource sharing: Effects on business-unit performance. *Academy of Management Journal*, *33*(2), 259-285.

Govindarajan, V., & Euchner, J. (2010). Making strategic innovation work: An interview with Vijay Govindarajan. *Research Technology Management*, 53(5), 15-20.

Govindarajan, V., & Immelt, J. R. (2019). The only way manufacturers can survive. *MIT Sloan Management Review, 60*(3), 24-33.

Greiner, L. E. (1997). Evolution and Revolution as Organizations Grow: A company's past has clues for management that are critical to future success. *Family Business Review*, *10*(4), 397-409.

Greiner, L. E. (1998). Evolution and revolution as organizations grow. *Harvard Business Review*, *76*(3), 55-64.

Gryta, T., & Mann, T. (2020). *Lights Out: Pride, Delusion, and the Fall of General Electric*. Houghton Mifflin.

Guzmán, V. E., Muschard, B., Gerolamo, M., Kohl, H., & Rozenfeld, H. (2020). Characteristics and skills of leadership in the context of industry 4.0. *Procedia Manufacturing*, *43*, 543-550.

Hanelt, A., Piccinini, E., Gregory, R. W., Hildebrandt, B., & Kolbe, L. M. (2015). Digital transformation of primarily physical industries - Exploring the impact of digital trends on business models of automobile manufacturers. *Wirtschaftsinformatik*, *88*(3-5), 1313-1327.

Hayes, A. F. (2022). The PROCESS macro for SPSS and SAS (version 4.1) [Computer software]. *Retrieved from https://www.processmacro.org*.

Heath, K., Martin, L., & Shahisaman, L. (2017). Global leadership competence: The intelligence quotient of a modern leader. *Journal of Leadership Education*, *16*(3), 134-145.

Henderson, K. M., & Evans, J. R. (2000). Successful implementation of Six Sigma: benchmarking General Electric Company. *Benchmarking: An International Journal*, *7*(4), 260-281.

Henri, J. F. (2006). Management control systems and strategy: A resource-based perspective. *Accounting, Organizations and Society*, *31*(6), 529-558.

Henri, J. F., & Wouters, M. (2020). Interdependence of management control practices for product innovation: The influence of environmental unpredictability. *Accounting, Organizations and Society*, *86*, 101073.

Hess, T., Matt, C., Benlian, A., & Wiesbock, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive*, *15*(2), 123-139.

Howell, J. M., & Higgins, C. A. (1990). Champions of technological innovation. *Administrative Science Quarterly*, *35*(2), 317-341.

Howell, J. M., Shea, C. M., & Higgins, C. A. (2005). Champions of product innovations: defining, developing, and validating a measure of champion behavior. *Journal of Business Venturing*, *20*(5), 641-661.

Immelt, J. R., Govindarajan, V., & Trimble, C. (2009). How GE is disrupting itself. *Harvard Business Review*, *87*(10), 56-65.

Jabbar, A. A., & Hussein, A. M. (2017). The role of leadership in strategic management. *International Journal of Research-Granthaalayah*, *5*(5), 99-106.

Jones, M. D., Hutcheson, S., & Camba, J. D. (2021). Past, present, and future barriers to digital transformation in manufacturing: A review. *Journal of Manufacturing Systems*, *60*, 936-948.

Kallunki, J. P., Laitinen, E. K., & Silvola, H. (2011). Impact of enterprise resource planning systems on management control systems and firm performance. *International Journal of Accounting Information Systems*, *12*(1), 20-39.

Kane, G. C. (2017, April 4). Digital maturity, not digital transformation. *MIT Sloan Management Review*. https://sloanreview.mit.edu/article/digital-maturity-not-digital-transformation/

Kane, G. C. (2018, August 3). Is the Right Group Leading Your Digital Initiatives? *MIT Sloan Management Review*. https://sloanreview.mit.edu/article/is-the-right-group-leading-your-digital-initiatives/

Kane, G. C., Phillips, A. N., Copulsky, J., & Andrus, G. (2019, March 12). How digital leadership is (n't) different. *MIT Sloan Management Review*. https://sloanreview.mit.edu/article/how-digital-leadership-isnt-different/

Kappelman, L., Torres, R., McLean, E., Maurer, C., Johnson, V., & Kim, K. (2019). The 2018 SIM IT issues and trends study. *MIS Quarterly Executive*, *18*(1), 7.

Kelly, R. (2018). *Constructing leadership 4.0: Swarm leadership and the fourth industrial revolution*. Springer.

Klein, M. (2020). Leadership characteristics in the era of digital transformation. *Business & Management Studies: An International Journal*, *8*(1), 883-902.

King, R., Clarkson, P.M., & Wallace, S. (2010), Budgeting practices and performance in small healthcare businesses. *Management Accounting Research*, *21*(1), 40-55.

Langfield-Smith, K. (1997). Management control systems and strategy: a critical review. *Accounting, Organizations and Society*, *22*(2), 207-232.

Langfield-Smith, K. (2006). A review of quantitative research in management control systems and strategy. *Handbooks of Management Accounting Research*, *2*, 753-783.

Malmi, T., & Brown, D. A. (2008). Management control systems as a package—Opportunities, challenges, and research directions. *Management Accounting Research*, *19*(4), 287-300.

Mann, T., & Gryta, T. (2020, July 18). The Dimming of GE's bold digital dreams. *The Wall Street Journal.* www.wsj.com/articles/the-dimming-of-ges-bold-digital-dreams-11595044802

Marx, F., Wortmann, F., & Mayer, J. H. (2012). A maturity model for management control systems. *Business & Information Systems Engineering*, *4*(4), 193-207.

Mazzone, D. M. (2014). *Digital or death: digital transformation: the only choice for business to survive smash and conquer*. Smashbox Consulting Inc.

McCarthy, P., Sammon, D., & Alhassan, I. (2021). Digital transformation leadership characteristics: A literature analysis. *Journal of Decision Systems,* 1-31. https://doi.org/10.1080/12460125.2021.1908934

Midi, H., Sarkar, S. K., & Rana, S. (2010). Collinearity diagnostics of binary logistic regression model. *Journal of Interdisciplinary Mathematics*, *13*(3), 253-267.

Mithas, S., & McFarlan, F. W. (2017). What is digital intelligence? *IT Professional*, *19*(4), 3-6.

Nadkarni, S., & Prugl, R. (2021). Digital transformation: a review, synthesis, and opportunities for future research. *Management Review Quarterly*, *71*(2), 233-341.

Noon, C. (2020, March 2). *Jack Welch, The ultimate manager who oversaw GE's rise to the most valuable company, dies at 84*. General Electric. https://www.ge.com/news/reports/jack-welch-the-ultimate-manager-who-oversaw-ges-rise-to-the-most-valuable-company-dies-at-84

Ocasio, W., & Joseph, J. (2008). Rise and fall-or transformation: The evolution of strategic planning at the General Electric Company, 1940–2006. *Long Range Planning*, *41*(3), 248-272.

Otley, D. T. (1980). The contingency theory of management accounting: achievement and prognosis. *Accounting, Organizations and Society*. *5*(4), 413-428.

Pampel, F. C. (2000). *Logistic regression: A primer*. Sage.

Papadonikolaki, E., & Azzouz, A. (2018). Boundary spanning and knowledge brokering for digital innovation. *Proceedings of the 16th Engineering Project Organization Conference (EPOC).* Brijuni, Croatia: Engineering Project Organization Society (EPOS). https://www.researchgate.net/publication/325575977_Boundary_spanning_and_knowledge_brokering_for_digital_innovation

Reddy, S. K., & Reinartz, W. (2017). Digital transformation and value creation: Sea change ahead. *GfK Marketing Intelligence Review*, *9*(1), 10.

Reinartz, W., Wiegand, N., & Imschloss, M. (2019). The impact of digital transformation on the retailing value chain. *International Journal of Research in Marketing*, *36*(3), 350-366.

Sainger, G. (2018). Leadership in digital age: A study on the role of leader in this era of digital transformation. *International Journal on Leadership*, *6*(1), 1.

Sandelin, M. (2008). Operation of management control practices as a package—A case study on control system variety in a growth firm context. *Management Accounting Research*, *19*(4), 324-343.

Schlegel, D. (2019). Value Creation in the Private Equity Industry. *International Journal of Management Cases*, *21*(2).

Schon, D. A. (1963). Champions for radical new inventions. *Harvard Business Review*, *41*, 77-86.

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press.

Schumpeter, J. A. (1942). *Capitalism, socialism, and democracy*. Harper.

Schwab, K. (2017). *The Fourth Industrial Revolution*. Currency.

Sebastian, I. M., Ross, J. W., Beath, C., Mocker, M., Moloney, K. G., & Fonstad, N. O. (2017). How big old companies navigate digital transformation. *Management Review Quarterly*, *16*(3), 197-213.

Siebel, T. M. (2017). *Why digital transformation is now on the CEO's shoulders*. McKinsey. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/why-digital-transformation-is-now-on-the-ceos-shoulders

Simons, R. (1987). Accounting control systems and business strategy: an empirical analysis. *Accounting, Organizations and Society*, *12*(4), 357-374.

Simons, R. (1990). The role of management control systems in creating competitive advantage: new perspectives. *Accounting, Organizations and Society*, *15*(1-2), 127-143.

Simons, R. (1991). Strategic orientation and top management attention to control systems. *Strategic Management Journal*, *12*(1), 49-62.

Simons, R. (1994). *Levers of control: How new top managers use control systems as levers of strategic renewal*. Harvard Business School Press.

Simons, R. (2000). *Performance measurement and control systems for implementing strategies*. Pearson.

Spekle, R. F., & Widener, S. K. (2020). Insights on the use of surveys to study management control systems. *Accounting, Organizations and Society*, *86*, 101184.

Stoltzfus, J. C. (2011). Logistic regression: a brief primer. *Academic Emergency Medicine*, *18*(10), 1099-1104.

Sullivan, C., & Staib, A. (2017). Digital disruption 'syndromes' in a hospital: important considerations for the quality and safety of patient care during rapid digital transformation. *Australian Health Review*, *42*(3), 294-298.

Sutcliff, M., Narsalay, R., & Sen, A. (2019, October 18). The two big reasons that digital transformations fail. *Harvard Business Review*. https://hbr.org/2019/10/the-two-big-reasons-that-digital-transformations-fail

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319-1350.

Teece, D., Peteraf, M., & Leih, S. (2016). Dynamic capabilities and organizational agility: Risk, uncertainty, and strategy in the innovation economy. *California Management Review*, *58*(4), 13-35.

Teece, D. J. (2018). Dynamic capabilities as (workable) management systems theory. *Journal of Management & Organization 24*(3), 359-368.

Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *67*(6), 1673-1687.

Theriou, N., Maditinos, D. I., & Theriou, G. (2017). Management control systems and strategy: A resource-based perspective. Evidence from Greece. *International Journal of Business and Economic Sciences Applied Research*, *10*(2), 35-47.

Trenkle, J. (2020). *Digital transformation in small and medium-sized enterprises: Strategy, management control, and network involvement*. [Doctoral dissertation, Ludwig Frohler Institute]. Nomos. https://doi.org/10.5771/9783748922131

Vaghefi, M. R., & Huellmantel, A. B. (1998). Strategic leadership at General Electric. *Long Range Planning*, *31*(2), 280-294.

Venkatraman, N., & Ramanujam, V. (1987). Measurement of business economic performance: An examination of method convergence. *Journal of Management, 13*(1), 109–122.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118-144.

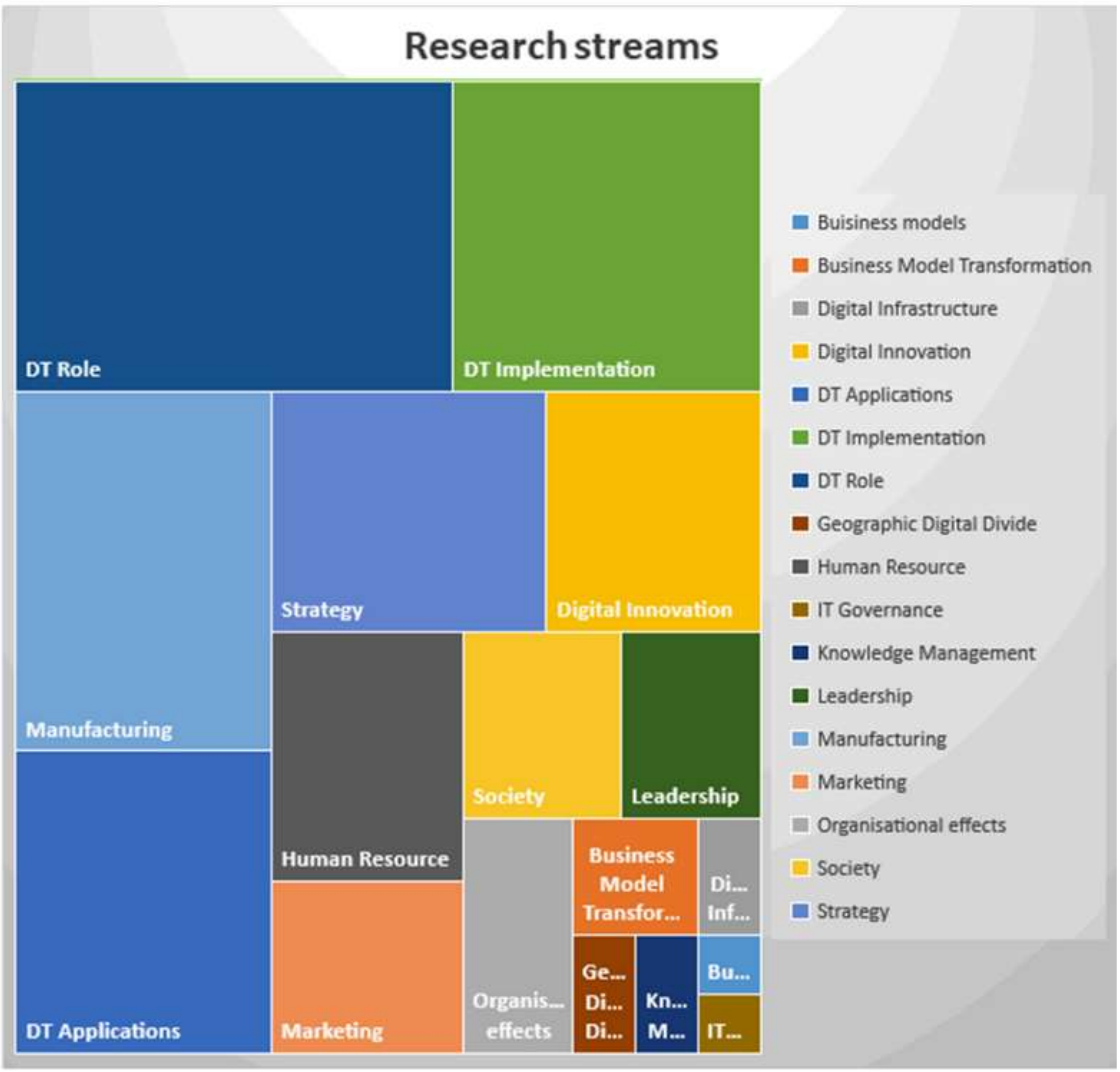
Warner, K. S., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326-349.

Waters, R. C. (2009). Evolution of leadership development at General Electric. *Engineering Management Journal*, *21*(1), 42-46.

Westerman, G., Bonnet, D., & McAfee, A. (2014). The nine elements of digital transformation. *MIT Sloan Management Review, 55*(3), 1-6.

## Appendix 1
## Bibliometric Analysis

Figure 1: Research streams in digital transformation domain (Chawla, 2020)



# Appendix 2
# DX Research Themes

Thematic map for themes within digital transformation literature (Nadkarni, 2021)

Figure 1: Actor-driven themes

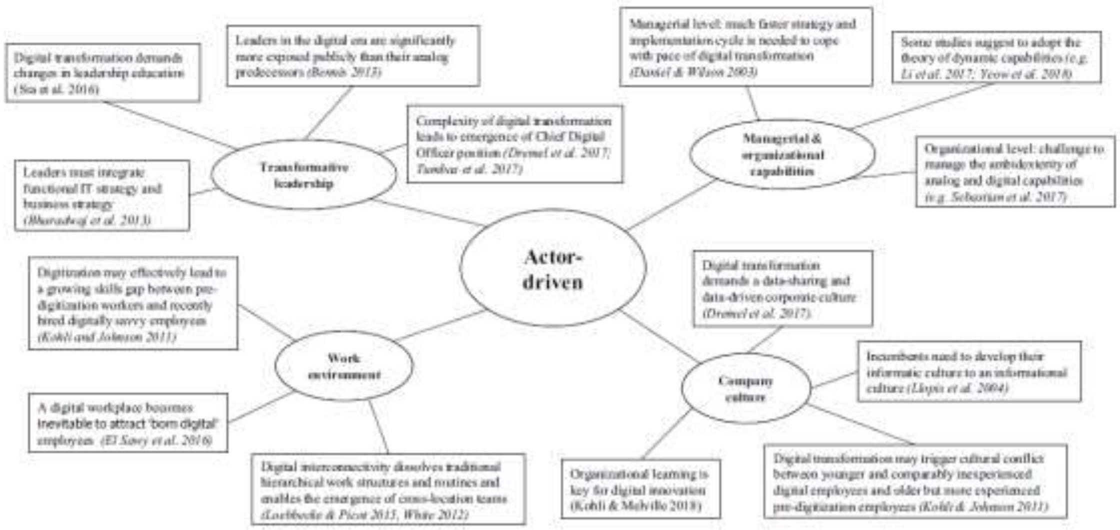
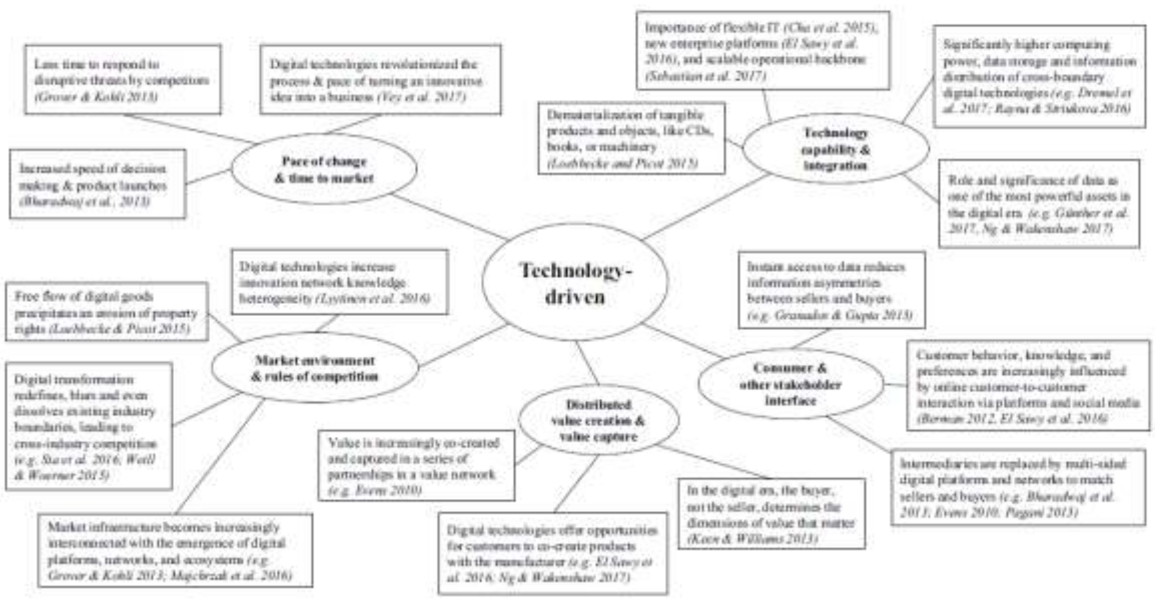



Figure 2: Technology-driven themes



# Appendix 3
# Malmi & Brown Model

Management control system as a package (Malmi & Brown, 2008)

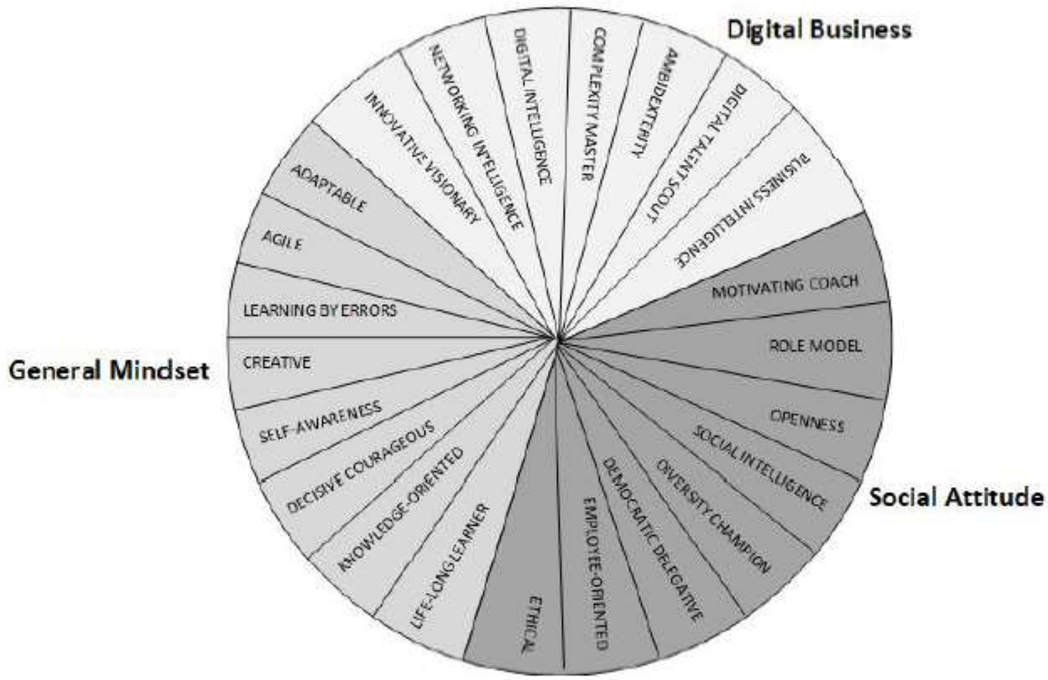
<table>
<tr><th colspan="7">Cultural Controls</th></tr>
<tr><td colspan="2">Clans</td><td colspan="3">Values</td><td colspan="2">Symbols</td></tr>
<tr><th colspan="2">Planning</th><th colspan="4">Cybernetic Controls</th><th rowspan="2">Reward and Compensation</th></tr>
<tr><td>Long range planning</td><td>Action planning</td><td>Budgets</td><td>Financial Measurement Systems</td><td>Non Financial Measurement Systems</td><td>Hybrid Measurement Systems</td></tr>
<tr><th colspan="7">Administrative Controls</th></tr>
<tr><td colspan="2">Governance Structure</td><td colspan="3">Organisation Structure</td><td colspan="2">Policies and Procedures</td></tr>
</table>

Description of MCS package framework (Malmi & Brown, 2008):

| Elements | Description | Components |
|---|---|---|
| Planning | Ex-ante form of control (Flamholtz et al., 1985); first it sets out the goals of the functional areas of the organisation thereby directing effort and behaviour; second, it provides the standards to be achieved in relation to the goal, making clear the level of effort and behaviour expected; third, it enables congruence by aligning goals across the functional areas of an organisation, thereby controlling the activities of groups and individuals. | Action planning—goals and actions for the immediate future, usually a 12-month period, are established; has a tactical focus. Long-range planning—the goals and actions for the medium and long run are established; has a more strategic focus |
| Cybernetic | There are five characteristics of cybernetic control (Green and Welsh, 1988). First, there are measures that enable quantification of an underlying phenomenon, activity or system. Second, there are standards of performance or targets to be met. Third, there is a feedback process that enables comparison of the outcome of the activities with the standard. This variance analysis arising from the feedback is the fourth aspect of cybernetic control systems. Fifth is the ability to modify the system's behaviour or underlying activities. | *Budgets* (Bunce et al., 1995; Hansen et al., 2003), *Financial measures* (Ittner and Larcker, 1998), *Non-financial measures* (Ittner and Larcker, 1998), *Hybrids* that contain both financial and non-financial measures such as the Balanced Scorecard (BSC) (Greenwood, 1981; Kondrasuk, 1981; Ittner and Larcker, 1998; Kaplan and Norton, 1992, 1996a,b, 2001a,b; Malina and Selto, 2001) |
| Reward/compensation | Motivating and increasing the performance of individuals and groups through attaching rewards to control effort direction, effort duration, and effort intensity. | Attaching rewards and or compensation to achievement of goals (Flamholtz et al., 1985; Bonner and Sprinkle, 2002) |
| Administrative | Administrative control systems are those that direct employee behaviour through the organizing of individuals (organisation design and structure), the monitoring of behaviour and who employees are made accountable to for their behaviour (governance); and through the process of specifying how tasks or behaviours are to be performed or not performed (policies and procedures), (Simons, 1987). | *Organisational design and structure* (Otley and Berry, 1980; Emmanuel et al., 1990; Abernethy and Chua, 1996; Alvesson and Karreman, 2004), *Governance structures* within the firm (Abernethy and Chua, 1996), *Procedures and policies* (Macintosh and Daft, 1987; Simons, 1987) |
| Culture | The values, beliefs and social norms which are established influence employees behaviour. (Birnberg and Snodgrass, 1988; Dent, 1991; Pratt and Beaulieu, 1992). | *Value-based controls* (Simons, 1995), *Clan controls* (Ouchi, 1979), *Symbols* (Schein, 1997) |

# Appendix 4
# Digital Leadership

Digital leadership components (Klein, 2020)



# Appendix 5
# Test for Multicollinearity Across Dichotomous Process Variables

**Correlations**

| | | Values High/Low | Services High/Low | Talent High/Low | Incentives High/Low | Goals High/Low | Commitment High/Low | Alignment High/Low | Risk High/Low | Governance High/Low | Leadership High/Low | Product High/Low | Organization High/Low | Financial High/Low | Operational High/Low | KPI High/Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Values High/Low | Pearson Correlation | – | | | | | | | | | | | | | | |
| | N | 71 | | | | | | | | | | | | | | |
| Services High/Low | Pearson Correlation | .673** | – | | | | | | | | | | | | | |
| | Sig. (1-tailed) | <.001 | | | | | | | | | | | | | | |
| | N | 71 | 71 | | | | | | | | | | | | | |
| Talent High/Low | Pearson Correlation | .521** | .620** | – | | | | | | | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | | | | | | | | | | | | | |
| | N | 71 | 71 | 71 | | | | | | | | | | | | |
| Incentives High/Low | Pearson Correlation | .163 | .218* | .401** | – | | | | | | | | | | | |
| | Sig. (1-tailed) | .084 | .034 | <.001 | | | | | | | | | | | | |
| | N | 71 | 71 | 71 | 71 | | | | | | | | | | | |
| Goals High/Low | Pearson Correlation | .642** | .589** | .436** | .270* | – | | | | | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | <.001 | .012 | | | | | | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | | | | | | | | | | |
| Commitment High/Low | Pearson Correlation | .576** | .533** | .440** | .245* | .724** | – | | | | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | <.001 | .020 | <.001 | | | | | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | | | | | | | | | |
| Alignment High/Low | Pearson Correlation | .647** | .471** | .375** | .234* | .606** | .567** | – | | | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | <.001 | .025 | <.001 | <.001 | | | | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | | | | | | |
| Risk High/Low | Pearson Correlation | .628** | .543** | .446** | .254* | .732** | .648** | .527** | – | | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | <.001 | .016 | <.001 | <.001 | <.001 | | | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | | | | | |
| Governance High/Low | Pearson Correlation | .461** | .491** | .358** | .328** | .579** | .496** | .337** | .539** | – | | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | .001 | .003 | <.001 | <.001 | .002 | <.001 | | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | | | | |
| Leadership High/Low | Pearson Correlation | .664** | .555** | .330** | .107 | .529** | .699** | .468** | .628** | .693** | – | | | | | |
| | Sig. (1-tailed) | <.001 | <.001 | .002 | .187 | <.001 | <.001 | <.001 | <.001 | <.001 | | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | | | |
| Product High/Low | Pearson Correlation | .348** | .431** | .293** | .251* | .579** | .436** | .398** | .595** | .469** | .461** | – | | | | |
| | Sig. (1-tailed) | .002 | <.001 | .007 | .017 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | | |
| Organization High/Low | Pearson Correlation | .488** | .421** | .302** | .381** | .593** | .634** | .452** | .538** | .568** | .489** | .384** | – | | | |
| | Sig. (1-tailed) | <.001 | <.001 | .005 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | | |
| Financial High/Low | Pearson Correlation | .376** | .597** | .339** | .237* | .645** | .580** | .557** | .613** | .641** | .604** | .618** | .482** | – | | |
| | Sig. (1-tailed) | <.001 | <.001 | .002 | .023 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | | |
| Operational High/Low | Pearson Correlation | .316** | .606** | .420** | .140 | .510** | .539** | .539** | .543** | .491** | .555** | .552** | .481** | .767** | – | |
| | Sig. (1-tailed) | .003 | <.001 | <.001 | .123 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | |
| KPI High/Low | Pearson Correlation | .271* | .416** | .406** | .363** | .457** | .452** | .367** | .414** | .435** | .337** | .425** | .504** | .608** | .554** | – |
| | Sig. (1-tailed) | .011 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | .002 | <.001 | <.001 | <.001 | <.001 | |
| | N | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 |

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

# Appendix 6
## Survey Questions and Summary Results

| No. | Survey Question | N | Mean | Std Dev |
|---|---|---|---|---|
| 1.3.a | Digital Literacy: My technical knowledge of digital technologies. | 71 | 3.59 | 0.729 |
| 1.3.b | Digital Vision: My ability to envision how best to apply digital technologies in my company. | 71 | 3.80 | 0.710 |
| 1.3.c | Digital Champion: My ability to provide necessary leadership to effect the digital transformation. | 71 | 3.89 | 0.728 |
| 2.1 | My company regularly demonstrates formal commitments exhibiting a high emphasis placed on technology. | 48 | 3.75 | 1.000 |
| 2.2 | My company conducts a regular cadence of communications highlighting the company's digital strategy and activities. | 48 | 3.38 | 1.178 |
| 2.3 | My company has formal processes to ensure the availability of sufficient and capable digital personnel. | 48 | 2.98 | 1.062 |
| 2.4 | My company has formal processes to motivate and increase performance of individuals and groups associated with the firm's digital initiatives. | 48 | 2.54 | 1.166 |
| 3.1 | My company has formalized goal setting processes for digital teams and functional areas involved in the company's digital initiatives. | 48 | 3.85 | 1.031 |
| 3.2 | My company utilizes regular planning processes to build employee commitments to plans. | 48 | 3.67 | 1.038 |
| 3.3 | My company has formal processes which promote enterprise-wide coordination of digital initiatives by aligning digital goals across the organization. | 48 | 3.42 | 1.088 |
| 3.4 | My company has formal processes to mitigate/manage risks associated with digital initiatives. | 48 | 4.50 | 0.652 |
| 4.1 | My company has a formal enterprise governance process and/or structured management processes to manage decisions and investments in digital initiatives separate from traditional IT governance. | 48 | 3.29 | 1.288 |

| No. | Survey Question | N | Mean | Std Dev |
|---|---|---|---|---|
| 4.2 | My company ensures top-level leaders provide regular interactive engagement with the firm's digital initiatives which includes continuous challenging and debating assumptions and action plans. | 48 | 3.69 | 1.075 |
| 4.3 | My company regularly adheres to formal digital product management processes. | 48 | 3.44 | 1.029 |
| 4.4 | My company has adjusted its organization models to support our digital initiatives. | 48 | 3.60 | 1.106 |
| 5.1 | My company utilizes formal financial control systems associated with digital initiatives. | 48 | 3.35 | 1.296 |
| 5.2 | My company utilizes formal operational (non-financial) control systems associated with digital initiatives. | 48 | 3.29 | 1.202 |
| 5.3 | My company regularly reviews and relies on formal enterprise-level performance indicators of our digital outcomes. | 48 | 2.81 | 1.266 |
| 6.1 | As a result of my company's overall digital initiatives, relative to my industry peers, my company has become more/less competitive. | 71 | 3.46 | 0.673 |
| 6.2 | As a result of my company's overall digital initiatives, relative to my industry peers, my company's customer value proposition has become better/worse than industry peers. | 71 | 3.42 | 0.625 |