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Effects of Digital Transformation Initiatives on IT Performance: Evidence from US State Governments

Quang "Neo" Bui
Rochester Institute of Technology, qnbbbu@rit.edu

Son Bui
Texas A&M University – Commerce, son.bui@tamuc.edu

Giant Moven Lee
Rochester Institute of Technology, gml8500@rit.edu

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Quang "Neo" Bui
Rochester Institute of Technology
qnbbbu@rit.edu

Son Bui
Texas A&M University – Commerce
Son.bui@tamuc.edu

Giant Moven Lee
Rochester Institute of Technology
gml8500@rit.edu

Abstract

For governments around the world, digital transformation (DT) initiatives have been a cornerstone in a plan to gain strategic competitiveness in the global market. However, DT initiatives have a high failure rate, and prior studies have suggested that DT initiatives are disruptive and evolutionary by nature, requiring a longitudinal examination of DT initiatives to fully understand how their effects unfolded over time. In this exploratory study, we use an event study analysis to unveil the effects of DT initiatives on IT performance over a decade in 25 US state governments. The results suggest that DT initiatives only have a significant and positive effect on radical transformation of IT performance, but not for incremental transformation of IT performance. The findings support a revolutionary perspective on effects of DT initiatives and suggest that for public organization, radical transformation is worth considering despite of the risks.

Keywords: digital transformation, US state governments, even study methodology

Introduction

In recent years, digital transformation (DT) has been a key initiative taken by organizations to leverage new digital technologies such as cloud computing, business analytics, Internet of Thing, or Artificial Intelligence to fundamentally change how products and services are delivered to customers (Dremel et al., 2017; Vial, 2019). Amidst these technological developments, governments across the world have raced to adopt the newest digital technologies to strategically improve their competitiveness over others (European Center for Digital Competitiveness, 2021). For instance, the Chinese government aggressively invested in big data technologies to "intelligentize decision making" and make China a global center for AI by 2030 (Grossman et al., 2020). In the US, federal and state policy makers have strategically turned their attention to digital technologies as a key piece in improving service delivery while keeping IT costs under control (Wood, 2016), or even dealing with the COVID-19 pandemic (Moser-Plautz & Schmidthuber, 2023). Undoubtedly, both the private and public sector recognize the critical role of DT in driving future growth.

Against this backdrop, there is a proliferation of studies on DT initiatives taken across sectors (Nadkarni & Prügl, 2020; Vial, 2019). These studies suggest two key observations. First, DT is a *transformation process* that bring about disruption to many aspects of an organization, including IT architecture renewal (Wimelius et al., 2021), workforce transformation (Eden et al., 2019), redesign of organizational structure and processes (Dremel et al., 2017), or continuously strategizing to formulate digital strategy (Chanias et al., 2019). Second, DT initiatives usually unfold over a long period of time before bringing a complete

transformation to organizational performance. In other words, DT initiatives are often *evolutionary* rather than revolutionary by nature (Morakanyane et al., 2017). For instance, AUDI took more than five years to establish big data analytics to support decision makings (Dremel et al., 2017); or DBS Bank took seven years with over 800 million to digitalize its banking services (Sia et al., 2016). Within the public sectors, these characteristics of DT initiatives are particularly important as public agencies often lack funding, competitive pressure, and too entangle in bureaucracy red tapes and organizational complexities to swiftly engage in digital transformation (Irani et al., 2023).

Given the increase interest in DT initiatives in the public sector and the disruptive and evolutionary nature of DT initiatives, this study aims to investigate DT initiatives taken by 50 US state government over a decade to determine their effects on IT performance over time. Our research question is: *what are the impacts over time of DT initiatives on the IT performance of the US state governments?* Using publicly available data from state websites, we conduct an event study analysis and find that DT initiatives only have a significant and positive effect on radical transformation of IT performance, but not for incremental transformation of IT performance. The findings support a revolutionary perspective on effects of DT initiatives and suggest that for public organization, radical transformation is worth considering despite of the risks.

The rest of the paper is as follows. We first review the theoretical and substantial background on DT and performance in the US state governments. Then, a research model is presented, following by the methodology and findings. The paper is concluded with a discussion on the contributions and the next step of the research.

Theoretical Background: Digital Transformation and Performance

There is a proliferation of DT definitions as DT is complex and needs to be studied using a transdisciplinary perspective (Nambisan et al., 2020). In this paper, we adopted the definition by Vial (2019) who conceptually define DT as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (p. 118). This definition allows us to have a broader range for DT which can encompass e-government or centralization initiatives, all of them have historically been key IT transformation initiatives in the public sector (Markus et al., 2013).

While prior studies have produced success stories of DT initiatives, there are also accounts of failure or negative impacts of DT initiatives on organizational performance. For instance, Irani et al. (2023) linked the failure of the National Programme for Information Technology (NPfIT) project in UK to establish a centralized electronic records system to the complexity of legacy systems, data incompatibility and migration issues, and user resistance, to name a few. In another case, Wimelius et al. (2021) reported the failure of a technology renewal initiative in a large public health care organization due to management issues. More alarmingly, it is estimated that DT failure rate can be as high as 84%, drawing a bleak picture for DT initiatives (Libert et al., 2016).

While there are as many failure factors as success factors in DT initiatives, there is a common culprit in failed DT cases: the disruption to organizational operations introduced by DT initiatives. Researchers have summarized evidence from DT studies and conclude that DT must be viewed as a *disruptive process* that requires systematic transformation across multiple organizational aspects. This includes transformation in IT architecture, workforce, process and structure, to strategy (Eden et al., 2019; Gong & Ribiere, 2021; Hess et al., 2016; Nadkarni & Prügl, 2020; Vial, 2019). Furthermore, the DT process is a complex and often prolong process that unfolded over a long period of time. For instance, AUDI took more than five years to establish big data analytics to support decision makings (Dremel et al., 2017); or DBS Bank took seven years with over 800 million to digitalize its banking services (Sia et al., 2016). Thus, the effects of DT initiatives on performance are often *evolutionary* rather than revolutionary (Morakanyane et al., 2017).

Given the disruptive and evolutionary nature of DT initiatives, it is important to take a longitudinal examination on the DT process to fully understand how its effects unfolded over time. Next, we review the DT process in the U.S. state governments over time.

Substantial Background: Digital Transformation in U.S. State Governments

The first significant IT transformation initiative in the US public sector is the Clinger-Cohen Act of 1996 which aimed to reform IT management practices in US federal governments [1]. Among its many mandates was a requirement for federal agencies to establish offices of Chief Information Officers (CIO) and to develop IT architecture to establish accountability in IT management and reduce IT costs and complexity. These IT management reform quickly spilled over to state governments who were under the same pressure to improve IT efficiency and reduce IT costs. From then, the US state governments have constantly leveraged IT transformation initiatives to continuously keep up with the rising costs and complexity of IT management [2]. In this paper, we focus on the DT initiatives in the U.S. state governments because they make up a medium-size population to observe how DT initiatives diffuse across states.

Historically, there are two waves of digital transformation among state governments. The first one, referred to as DT v1.0, occurs in the 2000-2010 period. During this time, states focus on modernizing their IT infrastructure and services through e-government projects, data consolidation, IT governance centralization, IT shared services, and centralized project management (Markus et al., 2013). This is due to the fact that IT management in state government has been mostly decentralized for a long time, leading to rising IT costs, complex and disintegrated data management issues, and suboptimal IT services. Facing these challenges and ongoing fiscal crises, many state CIOs and governors attempted to introduce efficient IT management logics from the public sector and the New Public Management approach that focuses on performance measurement, citizen-focused reform, and increased accountability and efficiency (Wittmann, 2008). As a result, IT centralization and service consolidation become the key initiatives in this period.

In the second wave (hereafter DT v2.0) which is ongoing and started roughly in 2010, states focus on digitalize and transform their services through new digital technologies such as cloud computing, AI, machine learning, security (Wood, 2016). A significant motivator for these initiatives was the waves of IT management reform introduced by the Obama Administration during the Great Recession of 2008, the advancements in digital technologies, as well as the changing in expectations of citizens. For instance, the Obama administration appointed the first national CIO and the first national CTO in 2009, the first Chief Information Security Officer in 2016, and the first Chief Data Officer in 2015. In 2014, the 18F agency was established to act as a "consulting agency" within the government to modernize government technology [3]. Within the state governments, the use of big data analytics, cloud computing are increasing (NASCIO, 2010, 2011). These initiatives are ways for state government to continue tackle the ongoing fiscal crises and leverage digital technologies for the better goods.

Clearly these two transformation waves are related. Researchers have suggested that the first wave will establish the foundational IT architecture and governance logic for successful transformation in the second wave (Markus et al., 2013). This aligns well with the view that digital transformation is a disruptive and evolutionary process. Next, we present our research model to explore how DT initiatives impact IT performance.

Research Model and Hypothesis Development

Because DT initiatives are disruptive and evolutionary by nature, we theorize that a DT process in a state government is a process of going from DT v1.0 to DT v2.0, and how that process unfolds will have a transformational effect on IT performance of that state overall. Figure 1 depicts our model. We propose that as state engage in DT initiatives, there will be a positive impact on IT performance. Furthermore, the IT performance transformation can happen either through a radical or an incremental manner (Gong et al., 2020). Prior studies have suggested that while DT initiatives may ultimately overhaul existing systems, an

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[1] https://en.wikipedia.org/wiki/Information_Technology_Management_Reform_Act_of_1996

[2] We use the term Digital Transformation loosely in this paper and sometimes will adopt the term IT transformation to refer to significant IT projects taken by state governments in the past. While they are not strictly digital transformation initiatives, they represent a key piece in the history of the IT management reform and an antecedent to current DT initiatives.

[3] https://en.wikipedia.org/wiki/18F

all-out approach to replace legacy systems at once is too risky; hence, it is better to conduct DT initiatives through incremental changes (Furr & Shipilov, 2019). This especially true for public organizations that often laden with a complex mesh of legacy systems and often focus on short-term outcomes (Mergel et al., 2019). Therefore, incremental transformation in IT performance is more desirable. However, others have suggested that many public organizations took advantage of technology refresh to leapfrog in IT performance, seeking to completely revamp their processes and structures (Bui, 2014; Gong et al., 2020). In this paper, we follow the resource base view and posit that the more DT initiatives a state has, the more likely the state will experience a radical transformation in IT performance due to the completely overhaul happening in multiple facets of the organization (Homburg & Wielgos, 2022; Yeow et al., 2018). We posit:

> **Hypothesis 1**: the more DT initiatives a state has, the more likely the state will experience a radical transformation in IT performance.

Figure 1. Research Model
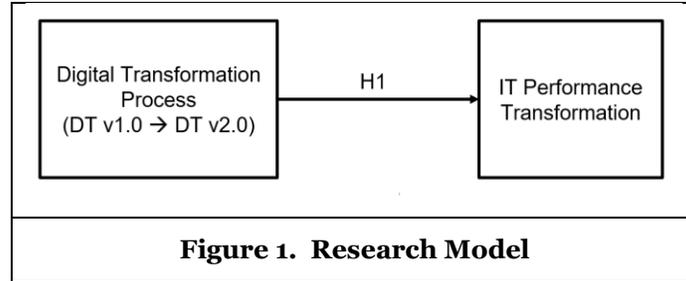
Method

Data Collection

To explore the effects of DT initiatives on IT performance in US state governments, we follow an archival research methodology (Ventresca & Mohr, 2002) to systematically collect data related to DT projects across 50 U.S. state governments. A theoretically supported data collection framework was used (see Appendix A). The framework consists of two elements:

Data on DT initiatives: We first identified a common list of DT initiatives commonly adopted by US state governments to allow a systematic comparison. To do so, we used the list of State CIO Priorities reported by the National Association of State CIOs (NASCIO) from 2002 to 2022. Each year, NASCIO conducts a survey of the state CIOs to identify and prioritize the top policy and technology issues facing state government. The CIOs top ten priorities are then identified and used as input to NASCIO's programs, planning for conference sessions, and publications. We collected these priorities and gave them a score based on their priorities, then ranked them using the total points over time. The higher the point, the more important the priority was, and the more popular it was among state CIOs. The top five priorities for state CIOs were: consolidation (e.g., data center, service, outsourcing), security, data analytics, cloud computing, and digitalization (e.g., e-government, open data, mobile app). We then organized them by time periods (DT v1.0 and DT v2.0). The results were the following:

- Common initiatives in DT v1.0: data center consolidation, centralization of IT governance, consolidation of IT services
- Common initiatives in DT v2.0: cloud computing, big data analytics, security, and others (e.g., AI)

Once the framework was established, data collection was carried out by teams of master students. For each state, two independent teams (3-5 students each team) collected publicly available data on the above initiatives from multiple sources (state websites, website snapshots on archival.org, media news, LinkedIn profiles) and entered these into a master database. Details on how certain events unfolded were also collected whenever possible. Typically, for each initiative, we identified two elements: 1) the year the initiative started, and 2) the progress updates or outcomes of that initiatives if possible. By using two teams for each state, it allowed us to have a thorough investigation for each state. Then, the data were verified by a team of researchers who have more experience on DT research in the public sector. The researchers were

the subject matter and were able to verify the collected data as well as identify missing data. In this case, another team of students were used to further collect the missing data. The data collection for a state completed when the researchers reached a consensus on the collected data, that is, we were able to exhaustively collect all possible evidence on DT initiatives for a given state to the best of our ability.

Data on IT performance: We used the IT performance score from the Digital State Survey published by GovTech Digital States Program.[4] The Digital States Survey uses a biennial survey to evaluate states' use of technology to improve service delivery, increase capacity, streamline operations and reach policy goals and assigns each state a grade based on quantifiable results. These surveys represent a comprehensive overview of how 50 US states leverage IT to delivery services. The results of these surveys were entered into an Excel master data for each state. We then converted the rankings to a point system in which the highest rank A equals to 11 points and the lowest rank D- equals to 1 point.

Data Analysis

Our dataset consists of 25 states with a mix of performance rankings. Because we examine the effects of a series of events on a series of performance scores over time, we employed an event study analysis (Im et al., 2001). An event study analysis is a methodology that is used to measure how IT Performance transformed due to newly released digital transformation announcements. This assumes that if DT initiatives yield a positive Net Present Value (NPV), the long-term value of IT performance should increase. Such changes in DT initiatives will allow us to calculate the outcomes of IT performance transformation (Nagm, F., & Kautz, K. 2009). Selection of our event study length is based on previous event studies and institutional factors (Im et al., 2001). Since our study focuses on long-term impact of DT initiatives, the period of estimating IT Performance outcomes is two years before and after DT initiatives announcement to estimate expected outcomes:

- Independent variable—DT announcements: the variable DT is operationalized by counting how many initiatives were announced for DT v.1 and DT v.2.
- Dependent variable— Abnormal IT Performance outcome: the outcome variable is operationalized by capturing the unusual long-term change of performance scores of a given state resulted by DT announcements. The abnormal IT Performance outcome is calculated as follow:

$$AR_{it} = R_{it} - \hat{R}_{it}$$

where

AR_t: Abnormal IT Performance outcome of state i for time period t;

R_{it} : Actual IT Performance outcome of state i for time period t; The actual outcome was published by GovTech Digital States Program

$\hat{R}_{it}$: Expected IT Performance outcome of state i for time period t; The expected outcome was derived from previous actual outcome at time period t - 1;

To test whether abnormal IT Performance outcome returns over the event period are significantly different from zero, we first calculate aggregated average abnormal outcome (CAO) for the time period t as follow:

$$CAO = \frac{1}{N} \sum_{i=1}^{N} \sum_{t=t1}^{t2} AR_{it}$$

where N = Number of states

Finally, to assess the statistical significantly of the average effect of the DT initiative announcements on the IT Performance outcome, the t-statistic is defined as:

$$t = \frac{SD}{CAO}$$

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[4] https://www.govtech.com/cdg/digital-states

where SD is standard deviation of actual IT Performance outcome of all states:

$$SD = \sqrt{\frac{\sum |R_{it} - \mu_i|^2}{N}}$$

with μ_i is mean of all actual IT Performance outcomes for state i;

Findings and Discussion

To exam the DT initiative effect, the sample was separated into radical and incremental transformation firms. Using the Digital State Survey, we identified any states involves more than once DT transformation, resulting in more than one rank jump is radical transformation state. Table 1 below shows of DT initiative effects:

	Sample Size	CAO	t-value
All States	25	1.60	1.42
Incremental transformation Group	12	0.01	0.01
Radical Transformation Group	13	3.08	2.62*

Table 1. IT Performance Outcomes Resulted to DT initiative announcements.

*p < 0.05, **p < 0.01

As showed in the table, the full sample did not demonstrate that DT initiative are related to increases of IT Performance outcomes (t = 1.42, p > 0.05). This result is consistent with previous studies (Dos Santos et al. 1993) that an average of DT initiatives does not increase overall IT performance. Similarly, abnormal IT Performance outcome was significantly for radical transformation states (t = 2.62, p < 0.05), whereas it was insignificantly for incremental transformation states (t = 0.01, p > 0.05). This result support the expectation about the IT initiative effects, indicating that states will experience substantial IT performance changes if there are multiple completely overhaul happening in multiple facets of the state's organizations (Homburg & Wielgos, 2022; Yeow et al., 2018). Thus, the H1 cannot be rejected.

Future Directions

This study is exploratory by nature, and our plan is to completely collect the data for all 50 US states. The findings reported here are preliminary and should be treated as such. However, we hope our study sparks more interests in digital transformation in the US state governments, a topic that is often overlooked in the literature.

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Appendix A: Data Collection Example for the State of Alabama

Initiatives in DT v1.0:

Initiatives	Start date and Progress
Consolidation of data centers	• 2017: Consolidated 25% of data centers, eliminating an estimated $70K of redundant expense annually • 2018: outsource mainframe to IBM which saved $5M in hardware refresh
Centralization of IT governance	Central IT unit and responsibilities: • 1996 Information Technology shared services were delivered by the Department of Finance • 2013 new central IT unit created (OIT), first focus on governance

	• 2013 statewide CIO position created • 2017 OIT took over IT service offerings from Department of Finance Project oversight and threshold for review • 2016 created the IT Project Governance policy • 2016 projects exceeding $15,000 must be documented with OIT for visibility; projects exceeding $500k and involving more than one agency or exceeding $1M must be subject to OIT governance Technology standards • 2011 Information System Architecture created • 2018 more standards added
Consolidation of IT services	• 2016 IT shared service model adopted. Offered services include access management, process automation, communication, core computing, governance, professional service, security, storage, and support

Initiatives in DT v2.0:

Initiatives	Start date and Progress
Cloud computing	• 2012: first private cloud computing adoption • 2014: first public cloud computing adoption • 2018: entered NASPO Value Point outsourcing contract; avoided over $500,000 dollars in maintenance and setup costs by moving to a cloud environment
Business data analytics	• 2018: first Chief Data Officer appointed
Security	• 2017: first Chief Information Security Officer appointed • 2018: started a Security Operation Center
Others (e.g., AI, blockchain)	• 2019: initiated a taskforce on AI

IT Performance Over Time:

State	2022	2020	2018	2016	2014	2012	2010
Alabama	B-	B-	B-	C+	C	C	C
	7 points	7 points	7 points	6 points	5 points	5 points	5 points

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