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Centralization and Decentralization Decisions: Multiple Contingencies for IT Governance in the Public Sector

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Abstract:

There is often a tension in organizations between the centralization and decentralization of IT governance, as demonstrated by Sambamurthy and Zmud’s (1999) landmark paper on IT governance and contingencies. Allocation of decision rights over IT resources and capabilities is a complex governance decision, with results that vary considerably over organizations. In this paper, we conduct a conceptual replication of the well-established Centralized-Decentralized-Federal classification scheme for IT governance. Using data from the National Association of State CIOs and the Center for Digital Government, we empirically validate the three original underlying IT governance components of IT infrastructure management, IT use management and project management. We next apply a configurational approach to assess the level of centralization/decentralization of IT governance and to link them to states' digital performance. Finally, we test the original theoretically derived IT governance constructs against the empirically derived ones to confirm existing and find emergent IT governance forms and their links with high and low performance. The results support the existing research but identify additional contingencies regarding the different domains of the studies (public versus private sector) and the evolution of IT architecture since the original study that have led to greater centralization over time.

Keywords: IT Governance, Centralization, Decentralization, QCA, Replication

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1 Introduction

Good IT governance has been found to have positive impacts on information technology's (IT) contribution to organizational performance and its measurement (Weill and Ross, 2004; van Grembergen et al., 2004). To achieve top performance, firms design their IT governance structures to match their overall organizational goals (Weill, 2004). Centralization or decentralization of decision authority falls within the broad realm of IT governance, which focuses on stakeholder needs, organizational objectives, prioritization and decision-making, and performance monitoring (ISACA, 2012). In general, centralized structures allow greater control over standards and better economies of scale while decentralized allow greater customization of solutions and improved responsiveness to business unit needs (Brown and Grant, 2005). Decentralized structures have been noted as increasing efficiency and effectiveness of organizational performance, facilitating quicker reaction to problems and improving service delivery (Faguet, 2014). In short, good arguments exist for each form.

Sambamurthy and Zmud (1999) observed the existence of three distinct spheres of IT governance activity (IT infrastructure management, IT use management and project management) that direct and control at different levels. Depending on the organization, corporate IT, divisional IT or even line management can serve as the locus of decision-making within each sphere of activity, resulting in three different forms of IT governance: centralized, decentralized and federal (i.e. having centralized and decentralized elements). This ground-breaking IT governance study has shaped thought on centralization and decentralization for two decades, with over 1300 citations at the time of this writing. However, the study is characterized by the architecture of the era, which favoured greater decentralization of IS within organization and it is not clear if these findings are consistent as the technology has changed to allowing greater centralization.

Additionally, the Sambamurthy and Zmud (1999) study took place in the private sector and focused on eight large companies. While this setting yielded excellent insights, it left open the question about the replicability of these findings to other domains, including the public sector. As early as 1986, research was done that showed that the public and private sector required different approaches to management and it was inappropriate to simply port best practices from the private sector into the public sector (Bozeman and Bretschneider 1986). In the public sector, decisions on IT have had impacts on areas such as value creation (Pang et al., 2014), size of government (Pang et al., 2015), public sector IT governance (Dawson, Denford, Williams et al., 2016) and IT-enabled innovation (Dawson, Denford and Desouza, 2016). Further, a comparison of state government CIOs found that the CIOs had more in common with other public sector CIOs than with CIOs from private industry (Dawson et al. 2015). Additionally, much of the technology work in state government is done by contracted IT staff (both individuals and from large consultancies) and these workers are highly skilled and, as a result, highly mobile (Dawson et al., 2014). This mobility presents IT staff coordination challenges that require immense skill and these challenges may be more acute in the public sector. Finally, within the public sector IT governance discourse, the debate over centralization versus decentralization has now raged for over 30 years with mixed findings (Bozeman and Bretschneider, 1986; Li and Feeney, 2014). In summary, Dawson, Denford and Desouza (2016) argue that "…utilizing best practices that are aimed at increasing profit [in private sector organizations] does not necessarily fit in the public sector and can actually be harmful to administration" (p. 301).

Over the last fifty years, the pendulum of IT governance has swung from centralized to decentralized and back again, driven in a large part by underlying dominant technologies (Evaristo et al., 2005). The concept of business enterprise IT launched in 1964 with the IBM System/360, requiring a centralized governance structure to support these resource intensive mainframe systems. The desktop networking era started in 1981 with the IBM 5150 Personal Computer while the release of the Mosaic browser in 1993 ushered in the Internet era, both of which drove the trend towards decentralization of IT governance as acquisition and support decisions could be made at business unit or local levels. Counterbalancing forces starting in the mid-1990s led to increased centralization once more with successive introductions and mass adoption of client-server architecture, thin-computing, service-oriented architecture, virtualization and, ultimately, the last decade's move to cloud computing (Denford, 2016). In particular, the late 1990s to mid-2000s saw the establishment and rapid growth of both desktop and server virtualization. For example, VMWare entered the desktop market in 1999 with VMWare Workstation and the enterprise server market in 2001 with GSX Server and ESX Server while, recognizing the threat, Microsoft acquired virtual machine pioneer Connectix and released Microsoft Virtual PC in 2003 and Microsoft Virtual Server in 2004 in response to this technology trend (Conroy, 2018). In short, different eras of technology have favored, but not necessarily completely dictated, different approaches to IT governance.

As such, in the present study, we seek to conduct a conceptual replication of Sambamurthy and Zmud's (1999) work by retaining the underlying constructs but empirically deriving them and testing them in both a different technology era (the early 2000s versus the late 1980s) as well as in a different industry setting (the public sector versus the private sector).

2 Methods

We divide the methods section into a data set description and a methodology outline.

2.1 Data Set

The Clinger-Cohen Act (CCA) was adopted by the U.S. federal government in 1996 to establish the role of the CIO within government and to task the CIO to implement specific IT-related actions in government (Liu and Hwang, 2003). Although only required for federal government agencies, U.S. state governments quickly adopted the principles of the CCA and also appointed CIOs with similar responsibilities (Rocheleau and Wu, 2002). Despite similarities in basic governance structures (e.g. Governor, CIO, agency directors), wide variation between states can be seen in how IT governance is structured and how well it performs, providing a natural experiment in IT governance for this study.

For our main analysis, we used data collected in the 2005 Compendium of the Survey of Digital Government in the States from the National Association of State Chief Information Officers (NASCIO) for our conditions; the 2006 Digital States Survey (DSS) from the Center for Digital Government (CDG) is our source for state digital performance construct. Accordingly, our unit of analysis is the state CIO office.

2.1.1 Governance

Between 2000 and 2005, NASCIO conducted three surveys to understand how state government was using IT and packaged it into the “Compendium of Digital Governance in the States”. The 2005 Compendium was the last of this series which consisted of 449 individual data elements grouped into 40 general categories which included IT governance and where the governance tasks were performed (centralized or decentralized). The 2005 NASCIO Compendium included survey responses from 45 of 50 states, representing 90% of all of the US states and 95% of the population of the US.

The governance questions focused on twelve state-wide management responsibilities of the CIO and included: architecture/standards development, budgeting, HR/hiring, outsourcing, personnel policy, planning, policies, privacy policies, procurement, project management, business process re-engineering and training. As noted by NASCIO (2005, p.10), "State CIOs rely on a variety of means to manage enterprise IT, including making recommendations for standards and practices, approving agency practices against enterprise standards and goals, and directly managing agency practices in these areas.” As such, for each area of responsibility the state CIO was identified as being responsible to recommend agency practices (R), approve agency practices (A) and/or manage the capability for agencies (M). Numerous combinations and permutations were seen across the areas of CIO responsibilities from no responsibility (-) to complete responsibility (RAM).

Greater aggregation of responsibilities at the state's CIO level is indicative of centralized governance, whereas the assignment of these responsibilities to the state agencies is indicative of decentralization. The degree of centralization was operationalized as an aggregate of the number of responsibilities vested in the CIO: no state CIO-level authority was coded as 0; R, A or M only as 0.333; RA, RM or AM as 0.667; and RAM as 1.000, as we posited that increasing responsibilities allowed greater exertion of centralized control.

We performed this coding for each state for each of the twelve state-wide management responsibilities. There was great variation in responsibilities. For example, Maine retained only “approve agency practices” (A) for eleven of the twelve responsibilities (hiring was the exception), which indicates significant decentralization. In contrast, Minnesota retained all the functions (recommend, approve and manage – RAM) for eleven of the twelve (excluding personnel), which indicates significant centralization. All the other states fell between these two extremes.

2.1.2 State Digital Performance

The 2006 Digital States Survey, produced by the Center for Digital Government, ranks the top 25 states for their effective technology usage and was applied to assess state digital performance. The survey is jointly completed by the governor and the CIO of each state and then the responses are evaluated by the Center for Digital Government in order to generate the rankings. The survey has been conducted every two years since 2000 and the focuses on 70 measurements over four broad sub-areas of state government IT performance (service delivery, architecture/infrastructure, collaboration and leadership). The scores were collected and aggregated for each area and then were further aggregated into a single overall score for each state. The survey was jointly completed by the governor and the CIO of each of the fifty states. CDG does not release the scores provided by each CIO/governor dyad nor do they release the sub-area scores. CDG identifies and ranks only the top 25 states, so those in the report were assessed as high performing and those not listed in the report were assessed as low performing – all 50 states were, therefore, included in the sample for this variable. Because the listing is rank ordered and does not include any further scoring information, it is not possible to know if there are any natural breaks within the high-performing and low-performing groups. While we believe that this dichotomization is useful, we acknowledge that greater insights could be gained by further clarity into the scores.

2.2 Methodology Outline

Stable configurations have been demonstrated to exist within organizations, with appropriate combinations of environment, structure, leadership and strategy appearing frequently in identifiable groups (Meyer et al., 1993). Equally, multiple contingencies have been identified in IT governance arrangements (Sambamurthy and Zmud, 1999). Grouping of multiple contingencies would suggest that approaches that are designed to address causal complexity would be appropriate for this research area. Scholars in strategic management (Fiss, 2007) and IS (El Sawy et al., 2010) have proposed configurational approaches for theory development and testing.

One such configurational approach is Qualitative Comparative Analysis (QCA), a set-theoretic method that combines qualitative (case-based) and quantitative (variable-oriented) techniques (Fiss, 2007). Crisp set QCA (csQCA) is a method for operationalizing set-theoretic relationships and using them to test configurational theories where causal conditions are either present (or high level) or absent (or low level) (Berg-Scholsser and De Meur, 2009). In this study, csQCA is appropriate as the causal conditions are defined as the set of responsibilities and accountabilities that are either centralized with the CIO or decentralized to the agencies and the outcome is state digital performance. Given that our dependent variable is dichotomized (effective versus not effective), csQCA is appropriate. The conditions are either completely centralized or decentralized; it is at the configuration rather than the condition level that multiple contingencies are seen.

QCA is generally divided into three steps: data table construction, truth table construction and logical reduction (Fiss, 2007). First, a data table is constructed converting the raw data into its operationalized form where a state becomes a case and a value becomes 1 or 0, representing either presence or absence of the causal condition (Fiss, 2011). The second step is designed to reduce the number of rows to a truth table, which is a table of configurations – that is, each configuration that yields a particular outcome (Rihoux and De Meur, 2009). This is done by identifying the exhaustive number of possible combinations – 2k where k is the number of conditions – and then identifying what cases fit each configuration. There were four conditions and hence 16 possible configurations, some with no observations. The third step addresses the logical reduction of the truth table into simplified combinations (Rihoux and De Meur, 2009) using the crisp set application of fsQCA 3.0 (Ragin and Davey, 2009).

Two concepts are important to consider in the evaluation of QCA solutions: consistency and coverage. Consistency is the degree to which a relation of necessity or sufficiency between a combination of conditions and an outcome is met within a given set of data (Fiss, 2007). Consistency can range from 0 (indicating no consistency) to 1 (indicating perfect consistency), where higher consistency is a configurational parallel to higher significance in correlational approaches (Ragin and Rihoux, 2004). Minimum acceptable consistency is 0.750, or three of four cases displaying the outcome; a more rigorous bar is 0.800, or four of five cases (Ragin, 2008; Fiss, 2011). Coverage is a measure of empirical relevance that captures the degree of overlap between sets or between a set and the overall solution space (Fiss, 2007). Coverage can range from 0 (no coverage) to 1 (covers the full solution space) and parallels the correlational concept of R-squared (Schneider and Wagemann, 2010; Ragin and Rihoux, 2004). Raw coverage indicates the solution space covered by a configuration and includes shared coverage with other configurations while unique coverage is specific only to the one configuration.

3 Results

The results section is divided in two parts. First, we use QCA to revisit the original Sambamurthy and Zmud (1999) study to reconceptualize it using configurational logic, a logic that we then apply in analyzing our public sector data. Second, we conduct a new analysis of the public sector data to empirically identify IT governance elements forms and then use configurational methods to test their relationship to performance. This allows us to replicate Sambamurthy and Zmud's (1999) study with different analysis methods (QCA versus case study), during a different era of technology (leading to different approaches to centralizations versus decentralization) and using a different industry (large private sector versus public sector).

3.1 Re-Analysis of IT Governance Forms

Configurational logic can be applied to Sambamurthy and Zmud's (1999) study to examine and confirm the expected configurations for each of their three IT governance forms. They identified three spheres of IT activities: IT infrastructure management, which encompasses platforms, architecture and standards; IT use management, which addresses prioritization, budgeting, operations; and project management, which includes the planning, development and implementation of systems. They conducted an analysis of the modes of IT governance and the contingencies that lead to their use, using eight detailed case studies of companies that were very competent in IT practices. Combining the three spheres of activity as configurations, their analysis can be derived into a set of Boolean equations:

If one were to arrange the Sambamurthy and Zmud (1999) cases by their mode as the outcome – centralized, decentralized and federal – we would form the data table for the study, using Corporate, Divisional or Line Management as the locus of decisions in each of the three areas of infrastructure, IT use and project management decisions, as illustrated in Table 1.

Table 1. Sambamurthy and Zmud Data Table

Case	Infra	IT Use	PM	Mode
F	Corp	Corp	Corp	Cen
B	Div	Div	Line	Dec
D	Div	Div	Div	Dec
E	Div	Div	Div	Dec
A	Corp	Div	Corp	Fed
C	Corp	Div	Div	Fed
G	Corp	Line	Line	Fed
H	Corp	Line	Line	Fed

This can then be simplified to a truth table as follows:

Table 2. Sambamurthy and Zmud Truth Table

Infra	IT Use	PM	Mode	Number	Consistency
Corp	Corp	Corp	Cen	1	1.000
Div	Div	Line	Dec	1	1.000
Div	Div	Div	Dec	2	1.000
Corp	Div	Corp	Fed	1	1.000
Corp	Div	Div	Fed	1	1.000
Corp	Line	Line	Fed	2	1.000

This would yield the following Boolean phrases:

Centralized = Infra.Corp*ITuse.Corp*PM.Corp (1)

Decentralized = Infra.Div*ITuse.Div*PM.Line + Infra.Div*ITuse.Div*PM.Div (2)

Federal = Infra.Corp*ITuse.Div*PM.Corp + Infra.Corp*ITuse.Div*PM.Div + (3)

Infra.Corp*ITuse.Line*PM.Line

The decentralized outcome in (2) can be first simplified by recognizing that Infra.Div and ITuse.Div are common between the two terms in the equation and can, therefore, be grouped.

$$\text{Decentralized} = \text{Infra.Div}*\text{ITuse.Div}*(\text{PM.Line} + \text{PM.Div}) \tag{4}$$

Given that the three states are Line, Div and Corp, the equation can be then simplified by recognizing that PM.Line and PM.Div are equivalent to ~PM.Corp. That is, as both Line and Divisional locus of decisions are present, it is the absence of the Corporate locus of decision that is important for project management.

$$\text{Decentralized} = \text{Infra.Div}*\text{ITuse.Div}*\sim\text{PM.Corp} \tag{5}$$

Finally, the equation can be logically reduced using a theoretical understanding of the case where a line management locus of authority is a greater degree of decentralization than a divisional locus. As such, while neither Infra.Line nor ITuse.Line is observed, their inclusion in the set which describes Decentralized can be inferred. Again, it is the absence of a corporate locus of decision that describes the Decentralized outcome, expressed as follows:

$$\text{Decentralized} = \sim\text{Infra.Corp}*\sim\text{ITuse.Corp}*\sim\text{PM.Corp} \tag{6}$$

The Federal outcome in (3) can first be reduced recognizing that the Infra.Corp condition is consistent amongst the three configurations.

$$\text{Federal} = \text{Infra.Corp}*(\text{ITuse.Div}*\text{PM.Corp} + \text{ITuse.Div}*\text{PM.Div} + \text{ITuse.Line}*\text{PM.Line}) \tag{7}$$

It can then be reduced by recognizing that ITuse.Div*PM.Div and ITuse.Line*PM.Line can be simplified to ~ITuse.Corp*~PM.Corp, where the key condition is not to have the corporate locus of decision in either IT use or project management.

$$\text{Federal} = \text{Infra.Corp}*(\text{ITuse.Div}*\text{PM.Corp} + \sim\text{ITuse.Corp}*\sim\text{PM.Corp}) \tag{8}$$

Additionally, using the same hierarchical argument regarding the line management being a greater decentralized locus of decision than divisional, ITuse.Div*PM.Corp can be simplified to ~ITuse.Corp*PM.Corp.

$$\text{Federal} = \text{Infra.Corp}*(\sim\text{ITus.Corp}*\text{PM.Corp} + \sim\text{ITuse.Corp}*\sim\text{PM.Corp}) \tag{9}$$

As ~ITuse.Corp is common amongst terms, it can be pulled out of the equation.

$$\text{Federal} = \text{Infra.Corp}*\sim\text{ITus.Corp}*(\text{PM.Corp} + \sim\text{PM.Corp}) \tag{10}$$

Finally, as both PM.Corp and ~PM.Corp are present in the expression, they cover the full solution space and can, therefore, be dropped from the Boolean expression. The absence of the PM term implies that any project management locus of decision can exist.

$$\text{Federal} = \text{Infra.Corp}*\sim\text{ITuse.Corp} \tag{11}$$

From the equations derived from the case studies (1, 6 and 11), we can therefore identify that centralization is a product of a consistent, dominant or reinforcing corporate locus of decision in each of infrastructure, IT use and project management while decentralization is a product of non-corporate loci of decision in the same. A federal IT governance system is a product of an inconsistent or conflicting set of loci of decision where infrastructure is corporate and IT use is non-corporate. These Boolean expressions are consistent with accepted understanding of these three IT governance models and will be used as our baseline comparator for IT governance as follows.

$$\text{Centralized} = \text{Infra}*\text{ITuse}*\text{PM} \tag{12}$$

$$\text{Decentralized} = \sim\text{Infra}*\sim\text{ITuse}*\sim\text{PM} \tag{13}$$

$$\text{Federal} = \text{Infra}*\sim\text{ITuse} \tag{15}$$

3.2 Public Sector Data Replication

In this conceptual replication, we first empirically derived high and low performing configurations of centralization and decentralization using our public sector data set. Best practice in QCA is generally to ensure between four and seven conditions (factors) for an intermediate number of cases, which is defined as around 40 (we have data from 45 states) (Berg-Schlosser and De Meur, 2009). In order to use the appropriate number of conditions (factors) empirically identifiable in our public sector data, we first conducted an exploratory factor analysis (EFA). Although we could have simply grouped the functions into the categories used in the original study, we believe that greater insights could potentially emerge from seeing how the functions were actually grouped rather than simply a priori grouping them.

Extraction was by principal components analysis and the rotated solution used varimax rotation with Kaiser normalization, resulting in three components with eigenvalues above 1 that extracted 67.4% of the variance. No item loaded higher on any other factor than the lowest-loading item on its own and all cross-loadings were below 0.40. While 0.70 is a recommended benchmark for established measures, for initial development alphas down to 0.50 are acceptable (Nunnally, 1967). Only Budget was just under the higher threshold (0.696 versus 0.700) and so it was retained as quite acceptable.

In examining the loadings of the three factors, we were able to identify patterns that were consistent with Sambamurthy and Zmud's (1999) elements, as shown in Table 3. Architecture and standards development, IT policy and privacy policy formed the first factor, which maps onto IT Infrastructure Management, which is defined in terms of architecture, standards and policies (Sambamurthy and0 Zmud, 1999). Budget and HR/personnel decisions formed the second factor, which maps onto IT use management, which is defined in terms of budgeting and day-to-day operations delivery (which we interpret to be by IS personnel) (Sambamurthy and Zmud, 1999). Project management and planning formed the third and final factor, which maps onto Project Management, which is defined by the conceptualization, acquisition, development and deployment of IS (which we interpret to require extensive planning) (Sambamurthy and Zmud, 1999). In short, our factor analysis provided empirical confirmation of the factors from the original study.

Table 3. Emergent Factors

	IT Infra	IT Use	PM
Architecture/Standards	**0.829**	0.143	0.017
IS Policy	**0.805**	0.144	0.323
Privacy Policy	**0.782**	0.117	0.076
HR/Hiring	-0.132	**0.825**	0.377
Personnel Policy	0.231	**0.768**	-0.077
Budgeting	0.275	**0.696**	0.073
Planning	0.054	0.06	**0.859**
Project Management	0.221	0.114	**0.754**

Reliability and validity checks were conducted on the data, as shown in Table 4. Reliability was demonstrated by examining the composite reliability index (CR), which reflects the internal consistency or the reliability of a construct and should be generally higher than 0.70 (Gefen et al., 2000). Convergent validity is demonstrated when the average variance shared between a construct and its measures is adequate, as shown when the Average Variance Extracted (AVE) is greater than 0.50 (Chin, 1998). Discriminant validity is established when a construct shares more variance with its measures than it shares with other constructs in a model, which is established by ensuring that the square root of a construct's AVE is greater than its correlations with other constructs (Chin, 1998). Discriminant validity is also demonstrated when all constructs' AVEs were higher than their averaged shared variance (ASV) (Fornell and Larker, 1981). All the constructs therefore demonstrated good reliability, convergent validity and discriminant validity.

Table 4. Reliability and Validity Measures

	IT Infra	IT Use	PM	AVE	SQRT	ASV	CR
IT Infra	1.000			0.649	0.806	0.606	0.847
IT Use	0.753	1.000		0.585	0.765	0.566	0.808
PM	0.803	0.751	1.000	0.653	0.808	0.604	0.790

As the original study classification was by ideal type, the fully-in/fully-out case assignment approach of csQCA was adopted for the analysis. In order to conduct the csQCA, we dichotomized factors to the ideal type by assigning those cases above the median as high and those below the median as low for each of the three factors[1]. As the factors were constructed from the EFA and therefore could not be theoretically described (unlike the original 12 items), use of the median for dichotomization was the most appropriate method. This created 8 possible combinations of the factors for the analysis. Each of the 45 cases can be represented as a one of these possible combinations (see Appendix A, table 1 for the data table for replication and validation purposes).

We constructed truth tables by enumerating all combinations of conditions, listed in descending order of the number of observations (see Appendix A, table 2).[2] What is interesting to note is that the ideal configurations at each end of the centralized-federal-decentralized continuum – full centralization and full decentralization – are most frequently seen: 16 decentralized and 13 centralized observations for state digital performance. In addition, there were six cases of the ideal federal type. This means that while over two thirds of the states in the sample fall into the hypothesized ideal configurations, almost a third do not, suggesting again that causal complexity exists.

We first confirmed there were no single independent necessary conditions and then applied csQCA to the data set for state digital performance to determine any identifiable configurations. We adopt from Ragin (2008) and Fiss (2011) the QCA notation used in Table 3. In this notation, black circles (●) indicate the necessary presence of a condition and crossed-out circles (⊗) indicate its necessary absence. The absence of a circle indicates that presence or absence of the condition does not impact on the outcome (i.e. the same outcome occurs whether the condition is present or absent).

Table 5. State digital performance configurations

Performance	**High**			**Low**	
Configuration	**1**	**2**	**3**	**1**	**2**
1 Infrastructure	●	●		⊗	
2 IT Use		●	●	⊗	⊗
3 Project Management	●		●		⊗
Consistency	0.833	0.875	0.875	0.824	0.824
Raw coverage	0.577	0.538	0.538	0.737	0.737
Unique coverage	0.154	0.115	0.115	0.053	0.053
Overall consistency	0.875			0.833	
Overall coverage	0.808			0.789	
Boolean equations	Infra*PM Infra*Use Use*PM			~Infra*~Use ~Use*~PM	

As shown in Table 5, three configurations lead to high State digital performance and two to low performance. On the high performance side, each of the configurations was the combination of two of the three elements (IT Infrastructure and PM (High 1), IT Infrastructure and IT Use (High 2) or IT Use and Project Management (High 3)). All three of these configurations encompassed the most centralized configuration (Infra*Use*PM) and one other configuration with a decentralized condition, making them highly centralized. On the low performance side, the two configurations were combinations of decentralized IT Use and either decentralized IT Infrastructure (Low 1) or PM (Low 2). There is similar high raw coverage but low unique coverage between the three high and the two low configurations, illustrating the overlap and focus on the dominant ideal centralized (Infra*Use*PM) and decentralized (~Infra*~Use*~PM) configurations respectively. It is also notable that the Federal type (Infra*~Use) was encompassed by one of the high performing (High 1) and one of the low performing (Low 2) configurations.

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[1] As QCA does not have a mechanism to deal with controls directly, any controls must be applied pre-analysis. State educational attainment and size were examined as potential control variables and it was found that the population of the state (size) was a relevant one. The three factors were thus standardized by using a log of state population.

[2] The truth table is the first synthesis of the data table, consisting of all the possible combinations, aggregating the cases by configuration and assessing their consistency (Rihoux and De Meur, 2009).

4 Discussion

As we previously highlighted, the Sambamurthy and Zmud (1999) study was done as a case study of eight large private sector companies and, by contrast, our study used data from the public sector (the fifty US states). As Dawson, Denford and Desouza (2016) discuss, IT governance in the public sector differs from IT governance in the private sector and much of the difference is due to implicit culture constraints that are seen in the public sector. One of the key constraints in the public sector is an aversion to risk and this stems from how success (or failure) is measured and visible in the public sector. Private sector firms generally have a unifying goal of profit maximization and, outside of employees or stockholders of the firm, there is generally not a huge uproar if profit is not achieved or if there is a notable IT failure.

The rules are different in the public sector where every citizen of the state has a vested interest in the successful operations of the state government and its IT initiatives. Further the public sector does not have a unifying goal like the private sector does. Rather, the state is expected to achieve the multiple goals of its stakeholders (e.g. fiscal conservatism, conservation, keep people safe, reduce jail crowding, take care of out-of-work citizens, provide a social safety net, etc.) and often times these goals conflict. Further, staffing and management of IT staff are frequently issues. While the private sector can generally simply raise the salaries of IT staff to attract more talent to accomplish a particular initiative, the public sector is burdened by civil service rules and pay grades that are virtually impossible to manipulate. Thus, many states resort to using temporary (or contract) labor for major IT initiatives rather than permanently hiring skilled staff. This has led to a revolving door of individuals and consultancies to provide services to the public sector and, while many of these individuals are talented, they move on to other projects as circumstances dictate. Thus, there is very little continuity of staffing and this presents coordination challenges in the public sector that are generally less frequent in the private sector. Finally, due to sunshine laws, all the successes (and failures) of the public sector are publicized and this increases the risk aversion of public sector management. Thus, it is important to interpret these results relative to the key differences between the public and private sectors.

Theory testing can be conducted using the Boolean equations theoretically derived from Sambamurthy and Zmud (1999) and comparing them with those empirically found through csQCA. The base principal is to apply the Boolean intersection operations to sets of theory and observation, including both theorized and not theorized, and observed and not observed configurations[3], as illustrated in Table 6. Of note, using the logic of symmetry inherent in the Sambamurthy and Zmud (1999) formulation, the theorized configurations for high state digital performance are the not theorized configurations for low state digital performance and vice-versa.

Table 6. Test Conditions

High State Digital Performance	Test Condition	Low State Digital Performance
Infra*Use*PM + Infra*~Use + ~Infra*~Use*~PM	Theorized	~Infra*Use + Infra*Use*~PM + ~Infra*~Use*PM
~Infra*Use + Infra*Use*~PM + ~Infra*~Use*PM	Not Theorized	Infra*Use*PM + Infra*~Use + ~Infra*~Use*~PM
Infra*PM + Infra*Use + Use*PM	Observed	~Infra*~Use + ~Use*~PM
~Infra*~Use + ~Infra*~PM + ~Use*PM	Not Observed	Use + Infra*PM

Using these theorized and observed configurations, four tests can be performed to evaluate and refine theory (Schneider and Wagemann, 2010). First, that which is theorized and observed supports the hypothesized theory. Second, that which is theorized but not observed fails to support the hypothesis, potentially creating boundary conditions for the theory. Third, that which is not theorized but observed is an emergent finding, potentially extending theory. And finally, that which is not theorized nor observed is consistent yet irrelevant due to the asymmetry of configurational approaches (i.e. you cannot conclude anything from the finding). The outcomes of these four tests are presented in Table 7.

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[3] The not theorized equation encompasses all terms not covered by the theorized equation. For example, if A*B*C + A*~B is theorized then ~A + A*B*~C is not theorized as the union of the two includes all possible configurations.

Table 7. Hypothesis Tests

High State Digital Performance	Hypothesis Tests	Low State Digital Performance
Infra*PM	Theorized and Observed	~Infra*~Use*PM
~Use*~PM	Theorized and Not Observed	~Infra*Use + Use*~PM
Infra*Use*~PM + ~Infra*Use*PM	Not Theorized and Observed	~Use*~PM
~Infra*~Use*PM + ~Infra*Use*~PM	Not Theorized and Not Observed	Infra*PM

Support was found for high state digital performance under the centralized configuration (Infra*Use*PM) and the federal configuration if it included the centralization of project management (Infra*~Use*PM). High performance was not observed under decentralization (~Infra*~Use*~PM) and the federal configuration if it decentralized project management (Infra*~Use*~PM); in fact, both of these hypothesized high performing configurations actually led to lower performance. There were, however, other high-performing configurations that were predicted to be low performing as they were not the ideal federal form (Infra*~Use).

Synthesizing these results would suggest that the centralized IT department does not have to control *every* aspect of IT governance in order to function effectively but it does need to control *any* two of the three functions in order to have high performance. Interestingly, it does not seem to matter which two of the three functions it controls although it is most commonly infrastructure and project management but not IT use (which includes hiring and personnel) (High 1). We suspect that this may be due to the staffing and personnel issues that are more prevalent in the public sector than the private sector. If the state is not able to hire people (due to civil service regulations, etc), it must become much more effective at project management to overcome its lack of personnel oversight. Thus, having a strong centralized IT may better promote this. We find support for this also in our low-performing states.

This finding that centralization is generally more associated with high state performance is in conflict with the original study where all eight cases– centralized, decentralized and federal – were high performing. However it is unclear if our differing results are due to changes in technology or the differences between the private and public sector but clearly differences exist.

One possible explanation for the role that centralization plays when it comes to department performance is the issue of coordination. Centralization does give on the ability to control, but we also find that it is more important that the IT function be deliberate on *how* it wants to coordinate its resource management in order to get the most value out of its investments (Denford et al., 2019). Coordination reduces duplication of effort and task assignment conflicts, and has the ability to achieve economies of scale. In addition, centralization's link to the state's digital performance also has a strategic element, specifically in public organizations having overall strategic IT plan will enable agencies to better set up the framework to decide how to seek economies of scale and coordination, while promoting innovation through more decentralized efforts (Desouza and Dawson, 2015). There is also the issue of data consolidation and evolution to cloud computing and their effect on lowering costs, etc., which can happen under centralization (Denford, 2016; NASCIO, 2017). These issues may have become dominant contingencies leading to centralization and away from decentralization.

5 Conclusion

This paper yields numerous important findings.

First, as suggested by Weill and Ross (2004), governance should not necessarily be treated as a monolithic construct: significant differences and insights were uncovered with our factor analysis. We empirically identified within our state-level public sector data three constructs that mapped directly on to those of Sambamurthy and Zmud (1999). As they were the dominant forms identified, we were able to replicate the original findings that multiple contingencies lead to centralized, decentralized and federal forms.

Second, while we found that the ideal types of centralized and decentralized accounted for over half of the configurations seen, there was a larger variation in the federalized configurations than identified in the replicated study. We surmise that the IT governance environment is causally complex and therefore there is a large variety of configurations that may be appropriate for organizations, depending on their circumstances. We did find, however, that certain combinations of resources and capabilities led to higher rather than lower performance outcomes and, therefore, organizational decisions in IT governance are critical. This finding supports that of the original study.

Third, IT organizations with centralized infrastructure and personnel locus of decisions over resources and capabilities outperformed those who had decentralized those functions. Specifically, centralization of two of three functions led to higher performance and decentralization of the same led to lower performance. This finding is at odds with findings of the replicated study, as the latter highlighted that reinforcing contingencies towards decentralization could provide good outcomes. We believe that this finding is due in some measure to the technology-driven shift towards centralization but also due to the salient differences between the public and private sectors. As we noted, effective governance in the private sector cannot simply be ported to the public sector. The public sector is profoundly different in terms of its staffing/personnel, lack of unifying goal, and higher risk aversion, among other things. Thus, while we find strong support for the functions from the original study, we find key differences in terms of what creates successful outcomes.

Fourth, while our study focuses on the differences between the public and private sector in the US as well as technology-drive changes, there are clear implications for IT governance in federated governments in other developed countries. One of the key insights from this replication study is that setting matters for the most effective governance structure and we have no doubt that the setting of the public sector in other countries may significantly impact the value of centralization versus decentralization. As an easy point, working in the public sector in the US is not always seen by young people as the most exciting career choice but we are aware that, in other countries, the case may be different. Thus, a key issue with our public sector findings is likely caused in some measure by the civil service constraints of the US governance but it is likely that these issues may not exist in other countries. Clearly more research is necessary to understand this issue and we do not automatically assert generalizability to other governments in other countries.

Some of these observations lead to future research opportunities. First, one of our main proposals was that the technology era of the original study was relevant to the relative viability of centralized, decentralized and federal forms. As we studied the difference between the late-1980s with the early 2000s, from approaching the apex of decentralization to the reverse of the pendulum swing back toward centralization, we believe that similar investigation of the late 2010s with its accelerating cloud implementation would be valuable. Second, the sample for our study was of US states, so there is the potential for research on cross-cultural differences in centralization decisions. Third, as we were focused on replicating the study in the public sector and have noted important differences between it and the private sector, further investigation of how centralization and decentralization have evolved over time in the private sector would be of value. Finally, as our results uncovered, there was a great deal of variation in the federal form, with some federal configurations leading to high performance and some leading to low. Further research into the complexities of the federal form would be warranted.

Like all studies, our study has certain limitations. First, as with all secondary data collection, we have no way to validate our secondary data but do not have any reason to believe the data to be incorrect and both secondary data sources have been used in many studies in public administration, management and IS research. Second, our data was only on 45 of the 50 states and it is possible that the missing states have significantly different results although the sample covers 90% of the U.S. states and 95% of the population. Third, regarding generalizability of results from the public sector to the private sector, we suggest caution. However, the three constructs identified (IT infrastructure management, IT use management, and project management) are consistent with previous research and exist within both public and private sectors. CIOs in both domains have the same challenges earning a seat at the table to contribute to strategy, obtaining the necessary financial and personnel resources to execute strategy, and controlling the IT program planning and management function. Further, we acknowledge that additional insights might result from breaking the data into smaller subgroups. However, we did not have sufficient insights in smaller subdivisions to make this reasonable.

In conclusion, applying the configurations identified by Sambamurthy and Zmud (1999) to public sector data, we find relationships between IT governance decisions and state digital performance. Specifically, there are configurations that have proven more likely than others to allow a public sector CIO the freedom of action needed to create success within their organizations. These configurations build upon Sambamurthy and Zmud's (1999) seminal work and resulting types but are more nuanced due to the application of QCA and configurational logic as well as differences in technology and sector. Given the emergence of configurational methods in the IS discipline, there are many more opportunities to further expand and refine theory surrounding IT governance and other IS research domains.

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Appendix A: Data and Truth Tables

Table A1 – Data Table

State	IT Infrastructure	IT Use	Project Management	State Digital Performance
AL	0	1	0	1
AR	1	0	1	1
AZ	1	0	1	1
CA	1	1	1	1
CT	1	1	1	0
DE	0	0	0	0
FL	1	0	0	0
GA	1	1	1	1
HI	0	0	0	0
IA	0	0	0	0
ID	0	0	0	0
KS	1	1	0	1
KY	1	1	1	1
LA	0	0	1	0
MA	1	1	0	1
MD	0	1	1	1
ME	0	0	0	0
MI	1	1	1	1
MN	0	1	1	1
MO	0	0	0	0
MS	1	1	1	1
MT	0	0	0	0
NC	1	0	1	1
ND	0	0	0	1
NE	0	0	0	1
NH	0	0	0	0
NJ	1	1	1	0
NM	0	1	0	0
NV	0	1	1	1
NY	1	1	1	1
OH	1	1	1	1
OR	1	0	1	0
PA	1	1	1	1
RI	0	0	0	0
SC	0	0	0	0
SD	0	1	0	1
TN	1	0	1	1
TX	1	1	1	1
UT	1	1	0	1
VA	1	1	1	1
VT	0	0	0	0

WA	0	0	0	1
WI	1	1	1	1
WV	0	0	0	0
WY	0	0	0	0

Table A2. Truth Table

IT Infrastructure	IT Use	Project Management	Number	State Digital Performance	Consistency
0	1	1	3	1	1.000
1	1	0	3	1	1.000
1	1	1	13	1	0.846
1	0	1	5	1	0.800
0	1	0	3	C(note 1)	0.667
0	0	0	16	0	0.188
0	0	1	1	0	0.000
1	0	0	1	0	0.000

Note 1: “C” refers to a contradictory configuration, which has cases falling into both the high (“1”) and low (“0”) performing states (0.800 and above or 0.200 and below respectively). These configurations are used

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