Alternative Designs in Widespread Innovation Adoption: Empirical Evidence from Enterprise Architecture Implementation in US State Governments

Completed Research Paper

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Abstract

The dominant design theory posits that widespread innovation adoption, at least for product innovations, happens when a vendor shakeout occurs and subsequently a dominant design of the product emerges. This paper examines how the dominant design theory holds for non-product innovations: could we expect widespread adoption to occur with alternative designs? Through the widespread adoption of Enterprise Architecture in fifty US state governments, we illustrate that both premises of the dominant design theory do not apply well. Despite the widespread adoption of Enterprise Architecture, there is no sign of a shakeout in the vendor community, nor any sign of a dominant design implemented among state governments. On the contrary, alternative designs may have been more helpful to the diffusion process of Enterprise Architecture. The findings suggest research opportunities to look at organizational profiles that promote certain innovation designs, or to identify conditions and trajectories under which alternative designs are plausible.

Keywords: dominant design, alternative design, IT management innovations, Enterprise Architecture, US state governments
Introduction

Today, we are living in the world of choice, and it has been argued that excessive choice could paralyze our decision making, distort our expectations, even make us feel stressed and anxious (Schwartz 2004). In the innovation adoption literature, it is generally believed that at least for product innovations, the presence of a dominant design—a single design architecture that establishes dominance in a product class—could help encourage the widespread adoption of an innovation (Abernathy and Townsend 1975; Anderson and Tushman 1990; Murmann and Frenken 2006; Tushman and Murmann 1998). When an innovation is first introduced, many alternative designs subsequently emerge, representing different technological trajectories. Two events follow: First, a battle occurs between alternative designs, and a shakeout happens in the vendor community to give rise to a dominant design. Second, the dominant design would signal to potential adopters a period of stability and growth in which continuous vendor support is ensured, economies of scale are possible, and exploitation is encouraged. Subsequently, the dominant design is widely adopted across organizations (Suárez 2004).

While empirical studies have found support for the dominant design theory, most of them have identified dominant designs for product innovations—ones that are made up from assembled physical components such as typewriters, automobiles, TV tubes, microprocessors (c.f., Murmann and Frenken 2006; Utterback and Suárez 1993). However, how does the theory hold for non-product innovations such as management innovations, complex system innovations, or conceptual innovations? For instance, scholars have noted the difficulties in identifying dominant designs for complex innovations such as telecommunication systems (Murmann and Frenken 2006; Tushman and Murmann 1998) while others have observed variations in the implementation of complex innovations such as IS architectures (Bidan et al. 2012) or data warehouses (Bashein and Markus 2000). Moreover, for complex and conceptual innovations, the presence of various alternatives may actually promote the innovation (Benders and van Veen 2001). Due to the higher degree of complexity or the conceptual nature of the innovation, these innovations afford greater interpretive flexibility to adopters who may appreciate the possibility to adapt, modify, and reinvent the innovation the way they want. Thus, the various alternatives provide ambiguity, choices, and interpretive templates that enable the adaptation of those non-product innovations—something called interpretive viability (Ansari et al. 2010; Benders and van Veen 2001)—making the innovation more attractive and plausible to diffuse.

Given the unique characteristics of non-product innovations, this paper investigates how IT management innovations achieve widespread adoption. That is, whether dominant design or alternative designs occurs in the diffusion of IT management innovations. IT management innovations are a type of non-product innovation that focuses on management practice, process, structure, or technique of IT activities (Birkinshaw et al. 2008). Put differently, they are innovative ideas about how to organize and govern IT activities. Examples include IT outsourcing models, IT shared services models, or the introduction of a CIO position. Compared to product innovations, IT management innovations are tacit in nature, have high interpretive flexibility, and require external support to overcome knowledge barriers during adoption. Thus, they are susceptible to flexible adoption, providing a good setting to examine how the dominant design theory holds for non-product innovations.

Specifically, this paper investigates the widespread adoption of Enterprise Architecture (EA) in 50 US state governments. The case of Enterprise Architecture in US state governments is chosen because: first, Enterprise Architecture represents an instance of an IT management innovation, focusing on IT management issues from an enterprise perspective (Ross et al. 2006); and second, US state governments are a mid-sized population with signs of widespread adoption of Enterprise Architecture. Thus, it is an appropriate setting to investigate the research question. The findings indicate that currently, EA is widely considered and adopted in US state governments (24 states have adopted and 21 states have initiated EA). Yet, the EA vendor community is still widely promoting three different ideal EA designs, and the states themselves adopt and adapt these ideal designs into four different designs, each with its own assumptions. The adoption of EA illustrates that alternative designs may be more possible and even more desirable for conceptual innovations. Future studies are invited to validate the possibility of alternative designs in widespread innovation adoption. The possibility of alternative designs opens new research directions for future research: to examine the organizational profile that prefers certain innovation.

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1 In this study, the term “product innovation” refers to technological product innovation.
designs, or to identify conditions and trajectories under which alternative designs are more plausible than a dominant design.

**Theoretical Background**

In this section, we first revisit the dominant design theory and explain how widespread adoption occurs with a dominant design. Two premises of the dominant design theory are discussed. Next, we compare IT management innovations and product innovations to assess the likelihood of the two premises in the case of IT management innovations.

**Widespread Adoption with Dominant Designs**

Dominant design is defined as a single architecture that establishes dominance in a product class and becomes widely accepted as the industry standard (Tegarden et al. 1999; Tushman and Murmann 1998). Its occurrence is regarded as a milestone in an industry evolution when different technological trajectories converge and the innovation is stabilized, enabling mass production, standardization, and economies of scale (Murmann and Frenken 2006; Suárez 2004; Tushman and Murmann 1998). Suárez (2004) proposed a process through which dominant designs emerge; and figure 1 shows an adaptation of his model. Note that in this model the R&D phase is omitted as we are more interested in situations in which the innovations are introduced into a population rather than being developed—a condition that does not apply to non-product innovations. Five phases are included in the process:

**Phase I—Technical Feasibility:** In this early phase, a working prototype of the innovation is introduced (Suárez 2004). This early design provides a demonstration of the innovation’s technical feasibility, thus attracting the attention of investors. For both product and non-product innovations, the possibility of the innovation is illustrated during this phase, but not yet the economic value. For example, in 1991, Motorola introduced the world’s first working prototype of a digital cellular system and phones using the GSM standard in Hanover, Germany, but it was not until 1994 that it introduced the first commercial product of a handheld digital cellular system.

**Phase II—Market Creation:** As the first commercial product is introduced, a new market is created. A few first-movers gain early advantages, and new entrants have to introduce different designs or maneuver strategically to differentiate themselves. During this phase, the number of alternative designs starts to increase to compete for market share. For example, Thomas Edison introduced the direct-current (DC) system in New York City in the 1880s (Hughes 1993). The Pearl Street station, finished in 1882, was the world’s first power station that provided electrical lighting to nearby restaurants and shops in the financial district of New York City. Although it suffered from multiple technical issues such as current leaking, inefficient generator connections, or faulty wiring, the station was a testament to working central power systems, signaling the feasibility of the technology as a commercial product. Subsequently, it inspired the building of power stations in London and Berlin (Hughes 1993). A market was created for electrical power systems; and later, alternate-current (AC) systems were introduced, providing alternatives to DC systems.

**Phase III—Decisive Battle:** As the market is stabilized, more and more organizations enter into the market, introducing their own designs in order to capture market share. These organizations are product vendors, those who introduce and try to populate different technology designs—alternative designs. They are engaged in direct competition for customers, providing different designs of the same product innovation and representing different technological trajectories (e.g., VHS versus Beta format for video recording, iPod versus Microsoft Zune for portable media player, Google versus Bing search engines). During this phase, non-technological factors such as complementary assets, firm credibility, or network effects play an important role in the strength of a design (Suárez 2004). For example, the ecosystem that Apple created for the iPhone plays a pivotal role in securing Apple’s dominant position in the smart phone industry. Users are attracted by the contents provided in the Apple Store and are more inclined to buy an iPhone.

**Phase IV—Vendor Shakeout:** This phase is not originally mentioned by Suárez (2004) but can in fact be a critical event for the widespread adoption process. The dominance battle can be decided when one of the two following events occurs: a) the vendors of other designs acknowledge their defeat and abandon the battle, and/or b) a design achieves a significant portion of the market share. Examples include Sony’s acknowledgement of defeat in the battle between the VHS and Beta formats for video recording or the
significant market share of PC over Mac computers. In both events, there will be a subsequent vendor shakeout in which a number of vendors, together with their designs, plummet. As the user base of the leading design increases, other vendors exit the market, or merge to fight for survival. Eventually, when the leading design achieves a critical mass of users, it will be widely considered the dominant design, an industry standard, and will drive out other alternative designs. New market entrants can only compete on incremental improvements and competence-enhancing features rather than introducing a new design (Anderson and Tushman 1990).

The vendor shakeout represents an important milestone as users see it as a sign of convergence in the industry. The winning vendors would be regarded as successful and capable of providing ongoing technical support for users. For product innovations, such support is an important factor because if given a choice, no user would want to invest in a design that would potentially go out of business. If the system breaks, or needs a replacement, it will be costly for users who invested in an obsolete design to find technical support. Many users, therefore, prefer to wait rather than bet on the wrong horse. For example, the existence of incompatible receivers and proprietary Applications Programming Interface (API) in the German market caused inconvenience to consumers and potentially limited the acceptance rate (Borés et al. 2003). This means that before the vendor shakeout occurs, the number of adoptions will be quite low. As the number of designs decreases, public confidence increases, and the number of adoptions increases accordingly (see Figure 1).

**Phase V—Post-dominance:** The winning design, one that amasses the necessary user base, is hailed as the dominant design, the king of the hill, until the next wave of technological innovation comes along. In the post-dominant phase, the emergence of a dominant design encourages economies of scale and a period of stability (Murmann and Frenken 2006). More and more users adopt the dominant design, and widespread adoption occurs. The network effects are strongest in this phase as potential adopters perceive the increasing number of adoptions as a sign of maturity, stability, and legitimacy of the innovation. During this phase, the dominant design remains mostly stable, and competition focuses on incremental changes, product capabilities, and process innovations (Suárez 2004). This phase can last for years until a new wave of technological advancement starts a new dominance cycle.

Overall, the dominant design theory suggests two premises:

- **Premise #1:** There is a battle and a shakeout in the vendor community, which will give rise to a dominant design of a product innovation.
- **Premise #2:** The dominant design signals to prospective adopters a period of stability and growth in which continuous vendor support is ensured, economies of scale are possible, and exploitation is encouraged. As a result, the emergence of the dominant design subsequently leads to widespread adoption of the dominant design.

As a result, the adoption curve remains mostly flat in the early phases and during the battle of designs (phase III). As the battle unfolds, a dominant design emerges, a vendor shakeout occurs, adoption rates pick up, and widespread adoption commences once the industry is left with a handful of vendors that are competing on incremental changes of the dominant design (figure 1). In the next sections, we examine the
characteristics of a type of non-product innovation—IT management innovations—and assess how the two premises apply.

**Implications from IT Management Innovations**

Empirical studies have found evidence of dominant designs mostly for product innovations: typewriters, automobiles, TV tubes, microprocessors (c.f., Murmann and Frenken 2006; Utterback and Suárez 1993). How does the theory hold for non-product innovations? In this section, we look at one type of non-product innovation, IT management innovations, and assess how the dominant design theory may (or may not) apply.

IT management innovations are a subset of management innovations. Birkinshaw et al. (2008) defined management innovation as innovative management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals. Following their logic, IT management innovations can be considered as innovative management practice, process, structure, or technique regarding IT activities. In other words, they are new ideas about how to organize and govern IT activities.

Compared to general management innovations, IT management innovations have a greater speed of change as they are frequently updated and reevaluated to keep up with the fast pace of technology changes (Table 1). The impacts of these changes are often felt immediately on operational activities, which rely heavily on IT to carry out their tasks. On the other hand, due to structural inertia, management innovations tend to take longer to respond to environmental changes, and their impacts may not be felt immediately at the operational level due to the complexity of organizational structures. As a result, IT management innovations will be a useful context to assess whether a dominant design exists and persists, given the fast pace of change for these innovations.

| Table 1. Comparing Management Innovations and IT Management Innovations |
|---------------------------------|---------------------------------|---------------------------------|
| **Definition**                  | Innovative management practice, | Innovative management practice, |
|       | process, structure, or technique about organizational activities. | process, structure, or technique about IT activities. |
| **Examples**                   | Six Sigma, Total Quality        | IT outsourcing models, IT shared |
|       | Management                | services models                |
| **Impacts**                    | Immediately change organizational activities and strategic directions. | Immediately change IT operational activities and IT strategies. |
|       | More likely to trigger changes to IT management. | Can potentially impact organizational strategies in the long run. |
| **Frequency** of Changes       | Less frequent updates due to complexity of changes as well as structural inertia. | More frequent updates to keep up with technology changes as well as operational dynamics. |

Compared to product innovations, IT management innovations have distinct characteristics that make their adoption unique. They are tacit in nature, have high interpretive flexibility, and require external support to overcome knowledge barriers during adoption.

First, IT management innovations are tacit in nature (Birkinshaw et al. 2008). In other words, they contain mostly conceptual components such as business models, management principles, or organizing ideas. Their adoptions do not require intensive capital investment, and their changes are less impacted by physical boundaries (e.g., hardware requirements, system specifications). For example, IT outsourcing models do not require any physical or material artifacts to implement. Rather, they provide a different model to organize and provide IT functions using external IT vendors. Organizations who adopt IT outsourcing would be more concerned with the vendor selection process, what would be outsourced, and
how the vendor relationship would be governed. Although the implementation of IT outsourcing does impact the structure of IT artifacts (e.g., data centers, servers), they are not the essential elements of IT outsourcing models.

Due to the lack of physical and material components, adopters of IT management innovations are less dependent on IT vendors for ongoing technical support. This is different from product innovations as their adopters need to rely on their IT vendors for continuous technical support. Each time there is a vendor shakeout, merger and acquisition, or formation of a strategic alliance, user organizations follow their vendor restructuring closely for potential changes in product quality, discontinuation of services, or unfavorable conditions (Elliott 1987). That is one of the reasons why widespread adoption does not generally catch on before there has been a vendor shakeout due to the fear of betting on the wrong horse (Borés et al. 2003). No user organization would want to invest in a design that would be discontinued or become obsolete in the future for obvious reasons: costly adjustments, loss in investments, or a sense of betting on the losing team. On the other hand, IT management innovations would be more independent from IT vendors and therefore their adoption rate would potentially be less impacted by vendor shakeout. Second, IT management innovations have high interpretive flexibility (Orlikowski 1992), or the involvement of adopters to constitute the realizations of the innovation. Because IT management innovations contain mainly conceptual components, they allow more subjective interpretations from prospective adopters (Birkinshaw et al. 2008), giving them the flexibility to interpret and comprehend the innovation in ways that most fit their needs. As a result, many find it easier to adapt, modify, and reinvent IT management innovations to fit their needs. For example, it is well-known that there are many different ways to implement IT outsourcing in organizations: deploying core competency strategies, using a centralized program management office, involving customer inputs, using fixed-price contracts, or adopting hybrid strategies to leverage in-house expertise (Lacity et al. 2012; Rottman and Lacity 2004).

The higher flexibility to adapt and modify IT management innovations will typically lead to greater variations in their adoptions. Coupled with the limited restrictions from physical boundaries, adopters can exercise their subjective interpretations to a far greater degree than for product innovations. It means there is a possibility of widespread adoption of different implementation designs among adopters, not just a widespread adoption of a dominant design as in the case of product innovations. For example, the widespread adoption of the Total Quality Management (TQM) program is often characterized by three popular approaches: Deming’s approach that emphasizes statistical tools and process heuristics, Crosby’s approach that focuses on training, and Juran’s approach that utilizes quality audits (Westphal et al. 1997).

Lastly, unlike product innovations which sometimes are developed using in-house expertise (e.g., R&D department), most organizations do not have a well-established and specialized expertise in the area of management innovation, which increases the uncertainty of the innovation and results in an increased need for external support (Birkinshaw et al. 2008). In addition, due to the lack of physical and material components, adopters are often left with abstract and theoretical principles to infer their own actionable items. Consequently, this leaves a huge knowledge burden on the adopters to figure out and accumulate the necessary know-how to carry out the adoption, something Attewell (1992) terms knowledge barriers. As a result, prospective adopters seek necessary knowledge from external sources, such as consulting firms, conferences, associations, or academic research (Birkinshaw et al. 2008). Many innovations rely intensively on management consultants, and give the impression of a management fad rather than a substantial change program (Currie 1999).

The thirst for know-how and practical guidelines in IT management innovation adoption could encourage the proliferation of vendors and promoters for IT management innovations, and together with this, alternative designs. If users of product innovations perceive such proliferation negatively (Borés et al. 2003), adopters of IT management innovations could take advantage of the abundant sources of knowledge to understand and mold a version of the innovation that fits well to their needs. For example, a recent survey from Gartner found that up to 37% of Enterprise Architecture adoption used a homemade or hybrid framework in which the adopter combined best-of-breed elements from several branded frameworks to make their own (Gall 2012).

In sum, compared to general management innovations, IT management innovations experience more changes and updates, making them an ideal setting to assess the possibility of a dominant design. Moreover, compared to product innovations, IT management innovation adoption has different characteristics with unique implications for the dominant design theory (table 2). First, because of the lack of physical and material components, adopters of IT management innovations are less dependent

Thirty Sixth International Conference on Information Systems, Fort Worth 2015 6
on vendors for continuous technical support. That makes vendor shakeout less impactful to the adoption rate (premise #1). Second, IT management innovations afford a higher interpretive flexibility for their adopters, leading to a greater variation in their adoption. In addition, IT management innovation adoptions depend a great deal on external sources for know-how and practical guidelines. As a result, their adopters may welcome the proliferation of alternative designs as an abundant source of knowledge to learn how to adapt and modify the innovation to fit their needs (premise #2).

In this paper, we argue that for non-product innovations, widespread adoption could occur through alternative designs, and that the necessity of a dominant design is not the only way to encourage widespread adoption. While alternative designs may not be able to provide the stability and assurance that dominant designs do, alternative designs present choices and interpretive flexibility that help potential users navigate through adoption barriers. By having multiple alternative designs, a firm would have more flexibility to realize a design that better fits its needs (Benders and van Veen 2001)—perhaps one with less restrictive requirements—while minimizing the institutional pressure often associated with dominant designs. In the next section, we investigate the possibility of widespread adoption through alternative designs in the case of EA adoption in US state governments.

| Table 2. Comparing Product Innovations and IT Management Innovations |
|-------------------------------------------------|-------------------------------------------------|
| **Definitions**                                 | **IT Management Innovations**                   |
| "A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (Oslo Manual 2005, p. 48). | Innovative management practice, process, structure, or technique about IT activities (adopted from Birkinshaw et al. 2008). In other words, new ideas about how to organize and govern IT activities. |
| **Examples**                                    | **Examples**                                    |
| Microprocessor, smartphone (e.g. iPhone).       | IT outsourcing models, IT shared services model. |
| **Characteristics**                             | **Characteristics**                             |
| Physical and material artifacts                 | Conceptual components (e.g., models, principles, ideas) |
| Resource and capital intensive                  | Knowledge intensive with high interpretive flexibility |
| Internal development (e.g., R&D) and/or external support (e.g., vendors) | External influences (e.g., consultants) and internal appropriation |
| **Implications to Innovation Adoption**         | **Implications to Innovation Adoption**         |
| Need continuous vendors’ support                | Depend less on vendors’ support                |
| Experience lock-in after purchase, limited adaptation and reinvention | Have a higher chance of adaptation and reinvention |
| Rely on both internal and external sources for know-how | Rely on external sources for know-how |

**Method**

To understand how IT management innovations achieve widespread adoption, either through dominant design or alternative designs, we examine the widespread adoption of Enterprise Architecture in 50 US state governments. Since 2000, US state governments have increasingly embraced EA, in part due to the spill-over effect of mandatory regulations at the federal level and in part due to the encouragement of collective organizations such as the National Association of State Chief Information Officers (NASCIO).

The purpose of the analysis is to examine the two premises of dominant design theory in the case of Enterprise Architecture. Specifically, we investigate:

1. Whether EA widespread adoption is occurring across the US state governments
2. If widespread adoption exists, whether vendor shakeout is occurring among EA vendors
3. If widespread adoption exists, whether an EA dominant design exists among adopters

**Data Collection**

EA Vendors. We consider any organization that have published and actively populated an EA framework as an EA vendor. For the US public sector, eight frameworks are commonly found and mentioned by state websites, EA literature, and general reports (Gall 2012; Schekkerman 2004; Sessions
Each framework represents the efforts of an organization—an EA vendor who works to encourage the adoption of its framework. Publications for each framework were collected from vendor’s websites, their archived websites in the Internet archival database (http://archive.org), and the literature. More than 100 documents were collected with a total of more than 7,000 pages. The eight frameworks are:

1. The Zachman framework (Zachman): developed by John A. Zachman since 1987, it is often considered the framework that established the EA ontology for the field.
2. The Department of Defense (DoD) framework: developed by the US Department of Defense in 1996, it was one of the first EA frameworks in the public sector.
3. The Open Group framework (Open Group): their framework inherits the work done by the US Department of Defense to become one of the first EA frameworks in the private sector.
4. The Spewak and Hill’s framework (Spewak): the Enterprise Architecture Planning (EAP) framework developed by Spewak and Hill (1993) was one of the first academic EA frameworks.
5. The Federal EA framework (Federal EA): the official framework developed in 1999 by the US CIO Council to encourage EA development in the federal agencies.
6. The NASCIO EA framework (Association EA): the set of frameworks and guidelines developed by the National Association of state CIOs (NASCIO) in 2000 for the US state governments.
7. The MIT framework: developed by MIT Center for Information Systems Research (CISR) in 2006. The framework and approach have been widely used by both academics and practitioners.
8. The Gartner framework: developed by the consulting firm Gartner and increasingly popular after Gartner’s buyout of its competitor—the META Group—in 2005.

State EA Adoptions. For state EA adoptions, a multiple-embedded case study approach was used (Yin 2009). For each state government, we used a mixed-method to collect the data. A team of three researchers assisted in the data collection process as part of a bigger research project on IT management in US state governments. The researchers used a theory-driven template to collect all possible evidence about EA adoption in a given state. The data collection comes from three sources: archival databases (600 documents with more than 20,000 pages), public reports (e.g., NASCIO, GAO reports), academic research, and complementary interviews in four states. Further details are excluded due to space restrictions.

Data Analysis

For each state, we assessed the maturity of its EA program using six levels of maturity. These maturity levels are similar to ones found in popular EA frameworks (e.g., NASCIO) and academic research (Salmans 2010). Only states with a formal EA program were included in the analysis. Out of 50 US state governments, 24 states had adopted EA and were included in the subsequent analyses. The data were used and compared against Rogers’ (2003) framework to assess whether EA widespread adoption has occurred in the US state government population. This will answer the first aforementioned question of the analysis.

Next, the collected frameworks from different EA vendors and states were coded and compared using the seven essential elements of an EA program (table 3). Those seven essential elements are derived from EA literature (Ahlemann et al. 2012; Boh and Yellin 2007; Schmidt and Buxmann 2011; Simon et al. 2013), practitioners’ writings, and from reviewing popular EA frameworks. They capture the ideologies and mechanisms of an EA framework, thus would be useful to determine whether one framework is substantially different from others. For each framework, seven data points were qualitatively produced. Each data point is a binary variable that assesses whether a framework processes a particular element.

To answer the second aforementioned question of the analysis, frameworks from EA vendors were compared and grouped into similar clusters using the seven essential elements. This step allowed us to distinguish possible ideal EA designs—alternative designs that are promoted by EA vendors. To answer the third question of the analysis, the state EA frameworks were compared and grouped into similar clusters using the seven essential elements. Their designs were then compared to the designs from EA vendors to: 1) identify whether they are identical to the ideal-type EA design, and 2) if there are differences, how different they are from the ideal designs.

2 To test the robust of the analysis, a cluster analysis was conducted on the state frameworks. The results mostly remain the same, with four state moves from one design to another.
### Table 3. Essential Elements of EA Frameworks

<table>
<thead>
<tr>
<th>Essential Elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defining EA technical layers</td>
<td>The EA framework only specifies technical layers that define the hardware and software infrastructure (e.g., Technical Architecture), structure and relationship of information assets (e.g., Information Architecture), and the repositories of enterprise applications and their relationships (e.g., Application Architecture).</td>
</tr>
<tr>
<td>Defining EA business layers</td>
<td>The EA framework includes business layers that define business organization, strategies, and models. They are clustered into domains based on their accountabilities and similarities over business processes.</td>
</tr>
<tr>
<td>Creating EA methodology</td>
<td>The methodology outlines the guideline or general approach of how to implement EA. Examples include transition plan or migration plan to move from an as-is to a to-be architecture.</td>
</tr>
<tr>
<td>Organizing EA structure</td>
<td>The framework identifies the governance and decision-rights in order to create accountabilities and establish authorities for the program. For example, the creation of a Chief Enterprise Architect</td>
</tr>
<tr>
<td>Operating and monitoring EA</td>
<td>The framework describes processes to operate and monitor EA development such as setting up new standards, providing exceptions, and evaluating EA development.</td>
</tr>
<tr>
<td>Enforcing EA values</td>
<td>The framework suggests mechanisms that can enforce EA values such as integrating EA into a project lifecycle or investment lifecycle.</td>
</tr>
<tr>
<td>Integrating EA values</td>
<td>The framework recommends different ways to integrate EA values into strategic planning processes such as using EA documentation in the strategic planning and strategic formation processes.</td>
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</table>

### Findings

In this section, we first report the evidence of EA widespread adoption across the US state governments. Then, we examine whether the dominant design theory holds. If there is a widespread adoption through a dominant design, one would expect to find two things:

1. A convergence of designs promoted by the vendor community as a result of a vendor shakeout.
2. A convergence of designs implemented in the organizational population due to the emergence of a dominant design.

### Evidence of EA Widespread Adoption in the US State Governments

Among 50 US state governments, 24 states have already adopted and implemented EA. These states have each established a formal EA organization which has published at least one formal version of their EA framework. The other 21 states are still in an initial phase in which EA is mentioned or planned in the state IT strategic plan, or there are some initial state-wide EA developments without a formal publication of an EA framework. Figure 2 provides the overview of states’ EA initiation and adoption over time.

In Figure 2, the distribution of states’ EA initiation and adoption is also compared against Rogers’ (2003) framework of the distribution of innovation. According to Rogers, four types of adopters are found in a typical diffusion process: early adopters who account for 16% of the population, early majority adopters who account for 34% of the population, late majority adopters who account for 34% of the population, and the remaining 16% of the population who are laggards (Rogers 2003). In the state government population, eight states adopted EA by 2001 (16%); many of them did so before 2000 just when EA was first being promoted in the public sector around 1996. Thus, those states who adopted EA prior to 2001 are classified as early adopters. An early majority of state governments considered and adopted EA during the 2002-2006 period. Out of 50 states, 13 states adopted and five states initiated EA developments during that period, accounting for an additional 36% of the population. A wave of late majority states joined in during the 2007-2010 period when one state adopted EA while 9 states initiated their development. From 2011 until 2013, seven more states initiated and two adopted EA, bringing the total to ninety percent of the population.
The evidence here presents a strong case for the widespread adoption of EA across US state governments. A majority of the states did so by 2006, with 50% of state governments having initiated or adopted EA by this date. In the next section, we report on the ideal EA designs as promoted by the EA vendors.

Does Vendor Shakeout Occur? Ideal EA Designs Promoted by EA Vendors

The first premise of the dominant design theory suggests that a shakeout in the vendor community precedes widespread adoption. During the shakeout, multiple designs converge to give rise to a dominant design (Anderson and Tushman 1990; Murmann and Frenken 2006; Tushman and Murmann 1998). Given the widespread adoption of EA, if the dominant design theory holds for EA, the many EA frameworks promoted by different vendors are only variations of the same design and should bear minimal differences.

We compare eight different popular frameworks promoted by different EA vendors in the US public sector to see how different they are from each other. These frameworks are compared based on seven essential elements of EA (see above). Table 4 provides the detailed comparison of the eight frameworks. (Note that the Open group framework is presented twice since they adjusted their framework in 2003).

Overall, the eight frameworks are sufficiently different enough from each other to be classified into three ideal design types. Other studies have simultaneously found distinct EA types from branded frameworks based on their ideologies (Lapalme 2012), their management objectives and styles (Ahlemann et al. 2012),
or their citation connections (Simon et al. 2013). The profile for the three ideal design types is found in Table 5.

**Technical EA design:** Frameworks that follow this design type include the Zachman framework, DoD, Open Group prior to 2003, and the Spewak framework. Under this design, the focus is on establishing the technical layers of the enterprise, specifically the Technology or Technical Architecture. Enterprise Architecture is seen as the job of the IS/IT organization, to identify the necessary IT components of the enterprise in order to reduce complexities and increase standardization. For example, the Zachman framework includes a matrix that suggests the specification documents for IT artifacts in an organization from multiple perspectives (e.g., business, engineer, technical). The technical EA design started in the early phase of the EA field and became dominant mostly during the 1990s. This design emphasizes the establishment of a methodology and structure to allow organizations to transform from an as-is to a to-be stage. For example, the early Open Group framework consists of an Architecture Development Method that includes several transformative steps: creating a baseline, constructing gap analysis, finding opportunities and solutions, planning the migration, implementing, and maintaining the architecture.

**Operational EA design:** Frameworks that promote this design type include the current Open Group framework, the Federal EA, and the Association EA framework. Those frameworks focus on an enterprise-wide and holistic approach toward EA development, stressing the development of not only technical but also business EA layers. Typically, those frameworks would start by defining the Business Architecture—the documentation of key business processes—which in turn determines the details of subsequent EA layers such as Application, Information, and Technical Architecture. In this design, the focus has shifted from technical issues (e.g., complexity, redundancies) into establishing an IT foundation for smooth and effective operations. In addition, operational EA frameworks emphasize not only IT artifacts and models, but also IT planning, implementation, and control from an enterprise perspective. Those frameworks emerged during the 2000s when EA professionals felt that the pure technical modeling approach of Technical EA design was not enough to bring about EA’s expected outcomes (Ahlemann et al. 2012). As IT investment increases, and the impact of IT is felt throughout the enterprise, there is an increasing need to involve non-IT stakeholders in the IT decision-making process. As a result, governance mechanisms, accountability, and enforcement processes become important to manage EA developments.

**Strategic EA design:** Frameworks that fit into this design include the MIT and Gartner frameworks. The rise of strategic EA design commences at the mid-2000s until now. These frameworks view EA as one of the many management and strategic planning tools that allow organizations to take advantage of their IT investments. The focus has now been shifted from establishing a good IT foundation to using and exploiting the IT capabilities of the built IT foundation. Thus, frameworks in this design are not particularly interested in establishing EA layers and documenting and specifying requirements—although they are still a part of EA professionals’ job—but more in the applications of EA values and principles to guide and drive organizational transformation. For example, the MIT framework does not mention what EA layers need to be developed, and Gartner stresses that what framework an organization chooses is not as important as using and adapting it to its needs (Robertson and Blanton 2008). The recent Strategic Enterprise Architecture Management literature stresses only the integration of EA into change management, project lifecycle, and strategic planning. No EA layer is discussed at all (Ahlemann et al. 2012).

Did EA vendors converge into a dominant design in the public sector? Despite the widespread adoption of EA among US states, there are still at least three ideal EA designs promoted by EA vendors, each different from the others in terms of their focus, features, and objectives (Table 5). This goes against the first premise of the dominant design theory, that widespread adoption is preceded by the emergence of a dominant design. In addition, no EA vendor shakeout is evident, as new EA frameworks are still being introduced to the field, despite the widespread adoption of EA practices. (Recall that 50% of the states initiated and adopted EA in 2006 while the recent MIT and Gartner frameworks were introduced in 2005 and 2006 respectively). This suggests that despite widespread EA adoption, a vendor shakeout is still far from reality.
### Table 5. Profile of Ideal EA Alternative Designs Promoted by Vendors

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<tbody>
<tr>
<td></td>
<td>Zachman, DoD, Open Group</td>
<td>Open Group after 2003,</td>
<td>MIT, Gartner</td>
</tr>
<tr>
<td></td>
<td>before 2003, Spewak</td>
<td>Federal EA, Association EA</td>
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<tr>
<td>Technical layers</td>
<td>x</td>
<td>x</td>
<td>disinterested</td>
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<tr>
<td>Business layers</td>
<td>x</td>
<td>x</td>
<td>disinterested</td>
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<tr>
<td>Methodology</td>
<td>x</td>
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<td>Structure</td>
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<td>Strategic integration</td>
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### EA Designs Implemented in the US State Governments

Another premise of the dominant design theory is that emergence of a dominant design will lead to widespread adoption of the design in the focal community. In this section, given the widespread adoption of EA in the US state governments, we report on the EA designs implemented to assess whether there is a dominant EA design among the US state governments. The 24 states that have adopted and published their EA frameworks online were chosen and analyzed. Their frameworks were first described based on the seven essential elements of EA, and then compared against the ideal EA designs promoted by EA vendors. Overall, four distinct EA designs were found in the US state governments: technical EA design, technical-operational EA design, operational EA design, and strategic EA design (see Table 6).

#### Technical EA Design

There were seven instances of technical EA design implemented in the US state governments, although all of them are slight variations of the ideal technical EA design promoted by the EA vendors. States with a technical EA design focus on creating IT models and documenting technical layers: Technical Architecture or various technical reference models. These technical models describe the legacy, current and upcoming standards, as well as provide best-practices and current IT trends in the states. For these states, EA is the driver to reduce IT costs as state-wide IT standards and procedures are perceived to minimize redundancies and increase interoperability.

While the ideal technical EA design only emphasizes the establishment of the technical layers, these seven states also focus on the operationalization of EA frameworks in their implementation. All seven states established some limited levels of operationalization such as a governance mechanism to oversee the EA program and account for responsibilities of different stakeholders; enforcement mechanisms to ensure EA compliance in state agencies; or methodology and formal process to set up and create EA standards. Thus, they are similar to the technical-operational EA design, described below.

#### Technical-Operational EA Design

Eleven states implemented a hybrid design between the ideal technical EA and operational EA design. This design focuses primarily on establishing IT models and standards (e.g., defining technical EA layers)—a key element of technical EA—but the design also emphasizes establishing governance mechanisms, enforcement processes, standard setting processes, and methodology—the essence of the ideal operational EA design. All eleven states have a clearly defined methodology, a process to set up standards with inputs from agencies, a defined governance with clear authority, and enforcement mechanisms to check for EA compliance. The standards development often involves inputs from other agencies, even non-IT personnel. Unlike states with operational EA design, these eleven states only define technical EA layers, emphasizing the focus on IT issues.

#### Operational EA Design

Two states, Colorado and Michigan, implemented an ideal operational EA design as promoted by EA vendors. In these states, both technical and business EA layers are specified, and EA models often include Business, Solution, Information, and Technology architecture. Not surprisingly, these states often establish a set of state-wide guiding principles for EA developments, derived from states’ business objectives. EA processes are well defined to invite agency involvement, and inputs from agencies are exclusively sought. The EA teams are active in offering their assistance to agencies in order to encourage EA usage.

#### Strategic EA Design

Four states implemented a strategic EA design promoted by EA vendors, namely California, Hawaii, Minnesota, and Virginia. These states share similarities with the operational EA design...
design, setting up business layers, having a well-defined methodology, clear governance mechanisms, solid standard set up processes, as well as enforcement processes. However, in these states, EA is used or incorporated in the high-level IT strategic planning process that can drive the IT directions of the state. These states clearly focus on developing IT capabilities and deriving benefits from an enterprise-wide architecture rather than simply setting up the IT standards and procedures. Although there is not yet enough evidence to support the benefits of a strategic EA design in these states, their implementations represent attempts by states to take a strategic- and value-oriented approach to EA development. For example, in the state of California, EA strategies and tactics are included in the development of this state’s IT strategic plan to ensure consistencies.

### Table 6. EA Alternative Designs Implemented in the US State Governments

<table>
<thead>
<tr>
<th>Essential Element</th>
<th>EITA (N = 7)</th>
<th>Technical-Operational EA (N = 11)</th>
<th>SEAM (N = 4)</th>
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<tbody>
<tr>
<td>Technical layers</td>
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<td></td>
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<tr>
<td>Business layers</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methodology</td>
<td>some</td>
<td></td>
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<tr>
<td>Structure</td>
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<td>Strategic integration</td>
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</table>

The four EA designs implemented in the US state governments represent both variations and exact implementations of ideal designs promoted by EA vendors. The technical and technical-operational EA designs bear resemblance to each other as both are derived from the ideal technical EA design promoted by EA vendors. On the other hand, operational and strategic EA designs share similarities as both are based on an enterprise-wide perspective of IT strategic management. The difference between the two designs is based on whether the organization approaches EA from a strategic planning approach (i.e., EA integration in strategic planning processes) or for an operational purpose (i.e., EA execution of strategies to deliver operational value). Thus, we further conceptualize the four observed designs into two distinctive designs: Enterprise IT Architecture (EITA) and Strategic Enterprise Architecture Management (SEAM). The SEAM differs from the EITA by incorporating business layers (Business Architecture), an essential element that has been proposed to clearly distinguish EA implementations in recent studies (Bouwman et al. 2011; Ulrich and McWhorter 2010; Versteeg and Bouwman 2006). The inclusion of a business layer signifies the departure of an EA program from a technical and engineering approach toward an operational and strategic management approach. Within these two distinctive EA designs are different variations, representing different “flavors” of implementing these designs in practice.
Does convergence occur among these designs? Of the two designs, the EITA accounts for a majority of EA adoption in US state governments (18 out of 24 states). While it can be claimed that EITA is the dominant design for EA adoption, such dominance is not overwhelming, as other designs co-exist and do not go in decline but continue to be picked up by recent adoptions. For example, in recent adoptions since 2006, half of the adoptions were EITA designs while the other half were SEAM designs (figure 3). This indicates that there is no clear sign of convergence across US states, despite widespread EA adoption.

**Discussion**

In this paper, we investigate how the dominant design theory (Anderson and Tushman 1990) applies to non-product innovations. We look at the adoption of IT management innovations, one type of non-product innovations. Compared to product innovations, IT management innovations have unique characteristics that imply different adoption patterns: they contain mostly conceptual components (e.g., models, principles, ideas), have higher interpretive flexibility, and need a great deal of help from external sources to overcome knowledge barriers during adoption. Therefore, the two premises from the dominant design theory may not apply well: First, IT management innovations require less technical support from IT vendors, and therefore, a widespread adoption of IT management innovations could happen without a vendor shakeout. Second, because of higher interpretive flexibility, IT management innovations afford their adopters more adaptation and modification opportunity. Thus, their widespread adoption could also happen with alternative designs rather than a dominant design.

The case of Enterprise Architecture adoption in US state governments illustrated well how widespread adoption of IT management innovations could occur without both vendor shakeout and convergence of innovation designs. Out of 50 US states, 24 have adopted EA, and 21 have initiated EA. The evidence supports a strong case for a widespread EA adoption in the US states population. Yet, we observed three distinct ideal EA designs are currently being promoted by EA vendors in the public as well as the private sectors. What’s more, new EA frameworks with different designs are still being introduced into the community (e.g., CISR in 2006), and current EA frameworks are continuously refreshed. The vendor shakeout is still far from reality in the EA vendor community. Furthermore, the actual EA designs implemented in the US state government population are both variations and the exact ideal EA designs as promoted by the EA vendors. They represent at least two distinct EA designs; each attracts followers in recent EA adoptions. This illustrates that there is no sign of a convergence in the widespread EA adoption, either in the vendor community or in the actual user organization community.

The possibility of alternative designs encouraging widespread innovation adoption suggests theoretical implications regarding innovation adoption for non-product innovations: what makes an organization favor one design over the others?
How Organizations Select Innovation Designs

Most innovation studies are concerned with how different factors influence organizations’ choice of whether to adopt a particular innovation (Fichman 2004), but not different designs of the same innovation. In other words, an organization may indeed adopt an innovation, but the design of the adopted innovation can be different from others. The concept of alternative design suggests a possible research direction to look at how and why different organizations prefer certain innovation designs. This allows innovation studies to move beyond the dominant paradigm of adoption studies—focusing only on the factors that impact dichotomous adoption decisions (Fichman 2004)—and focus on the processes and factors that contribute to what exactly is being adopted, an area that has been largely ignored in the innovation literature.

One of the prominent factors from economic-rational models of innovation adoption that could explain the adoption of certain innovation designs is the organizational strategy and structure (Mustonen-Öllilä and Lytyinen 2003; Ravichandran 2000). The strategy-structure-performance perspective suggests that organizations have different needs and strategies, which result in different types of organizational structures (Chandler 1962). These organizational structures would dictate how innovations are implemented and used. In addition, organizational structures vary across organizations due to different strategies and purposes. As a result, many different innovation designs co-exist among organizations, fitting to their particular strategies and structures.

For instance, in the case of EA adoptions, it can be expected that states who adopted business EA layers (i.e., SEAM designs) are typically more centralized than states that only adopted technical EA layers (i.e., EITA designs). The reason is that EA is often considered an enterprise initiative that would encourage the centralization of IT management: IT standards are mapped and standardized, decision-making processes are documented and unified, and business processes are scrutinized. When business EA layers are implemented, managers of business units would feel their control is further limited and decisions are now imposed on them (e.g., required to conduct business using regional services). As a result, states who have a more decentralized IT culture would either have strong opposition from their agencies or do not feel a need to implement business EA layers. Thus, we propose that:

Proposition 1: The adopted innovation design will depend on the organizational structure (e.g., centralized, hybrid, decentralized structure) of the adopting organization.

On the other hand, social influence theories provide another possible explanation. Throughout the diffusion process, there is a social learning process by which prospective adopters learn from the prior adopters about what innovation to adopt, as well as how and why (Hays 1996; Young 2009). Across organizations, there are different adoption rationales and patterns of implementation emerge over the career of an innovation, either due to improved knowledge about the innovation, incremental changes, complementary innovations, or managerial fads and fashions. As a result, the time when an adopter embraces an innovation may have an impact on what kind of innovation design is adopted. Particularly, when an organization decides to adopt an innovation, it will more likely adopt the popular practices, often known as “best-practices,” at the time of the adoption. This is known as the Stinchcomb hypothesis (Stinchcombe 1965) which theorizes that organizations will take on the elements of social structures at the time of their formation. Once an organizational structure is formed, due to organizational inertia and resistance, the structure remains largely unchanged over time (Baum and Amburgey 1996; Hannan and Freeman 1977). For example, an organization that was founded in 1996 will have different structural elements compared with organizations that were founded in 2012.

Similarly, in the case of EA, it can be observed that an organization that adopted EA in 1996 will implement different features and components compared to an organization that adopted EA in 2012. In fact, figure 3 shows a large number of EITA designs were adopted prior to 2002 when EITA was popular and SEAM designs were barely introduced. EITA was considered a best-practice at the time to reduce IT complexity and increase efficiency of IT operations (Sessions 2007). In 2006, the SEAM design emerges more prominently, and more states (three out of six) were inclined to adopt SEAM. Especially large states that underwent financial crises (e.g., California) perceived SEAM as a more effective way to improve IT efficiency enterprise-wide and to align IT investments with the states’ business objectives. Thus, it appears that each EA design became popular and was considered a best-practice at different times and for different purposes. We suggest that:
Proposition 2: The adopted innovation design will depend on the popular design at the time of adoption.

Concluding Remarks

In this paper, we argue that for IT management innovations, the presence of alternative designs could still encourage widespread adoption of an innovation. Adopters may welcome the proliferation that provides them with a rich pool of know-how to overcome knowledge barriers, and therefore can adapt, modify, and reinvent the innovation in the way they want. This is in contrast to product innovations, which often enjoy the emergence of a dominant design that ensures adopters of ongoing vendor support and a period of stability and growth.

This study is not without limitations. It only focuses on one mid-sized population and on a particular innovation, EA adoption among 50 US state governments, and therefore generalization is limited to only theory (analytical generalization) (Yin 2009). Nevertheless, we hope to draw scholarly attention to one of the understudied areas of innovation research: alternative designs and diversity in innovation adoption. Further studies are welcome to test the proposed propositions in this study.

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