Orchestrating Service Innovation Using Design Moves: The Dynamics of Fit between Service and Enterprise IT Architectures

Completed Research Paper

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Abstract

Service science perspectives highlight the central role of information technology (IT) in transforming the design and delivery of services. To discern the mechanisms through which IT impacts service innovation, we explore the dynamics of the relationship between enterprise IT and service architectures, and how these dynamics influence the performance of service innovation projects. We conducted six case studies to investigate how firms orchestrated service innovation, focusing on the design of the service architecture and its relationship to enterprise systems. We synthesize the case findings to develop a set of propositions on the antecedents and consequences of fit (or misfit) between service architecture and enterprise IT architecture. We then study how the case firms attempted to achieve congruence between the service and system architectures—both in design and in operation—by viewing the design moves they made as efforts to build and strike digital options.

Keywords: Service innovation, IT architecture, design moves, service design, digital options

Introduction

Service innovation, defined as the creation of a new or significantly changed service function through a new or significantly altered service concept, client interaction channel, service delivery system, and/or implementation technology (den Hertog 2000; Drejer 2004), has been recognized as an important value creation activity for businesses (Bitner and Brown 2008; Spohrer and Maglio 2008; Ostrom et al. 2010). Research efforts aimed at explaining how successful service innovations come about highlight the central role of information technology (IT) in engendering service transformations (Bardhan et al. 2010; Kohli 2007; Kohli and Melville 2009). Lusch and Webster (2010, p. 17) specifically note that “the ascendance of information technology and the emphasis on knowledge (not land and labor)” is the prime resource for competitive advantage in a service-oriented organizational environment.

While IT has generally been viewed as an important operant resource that enables value creation in service innovation (Spohrer et al. 2008), researchers have noted the need to explicate the underlying mechanisms through which IT influences the design, operation, and management of service. In the operations management literature, scholars have gained insights by applying concepts that have traditionally informed IT systems design, such as modularity and architecture, to the design of service systems (Menor et al. 2002; Voss and Hsuan 2009). While prior IS research has used these concepts to examine issues related to the boundaries of service activities within organizations, such as process virtualization and global service disaggregation (Mithas and Whitaker 2007), there is a need to explore in detail the linkage between the design of IT systems and IT-enabled services.

Accordingly, in this research we investigate the dynamics of the relationship between enterprise IT architecture and the architecture of IT-enabled services, and how these dynamics in turn influence the performance of service innovation efforts. Although few studies examine these issues directly, there are at least three streams of research that provide important insights that we build on. First, the literature on enterprise information system design has developed the concept of information systems architecture as a way to represent the structure and organization of systems and their relationship to the real world entities and processes they support (Zachman 1987; Tiwana and Konsynski 2010). Information systems architecture “provides a systematic taxonomy of concepts relating things in the world to representations in the computer” (Sowa and Zachman 1992). Iyer and Gottlieb (2004) applied this idea to complex enterprises, defining enterprise architecture as a framework for understanding the decomposition of an enterprise into manageable parts, the definition of those parts, and the orchestration of the interactions among those parts. They separate the desired enterprise architecture (“architecture-in-design”) from the realized one (“architecture-in-operation”) that emerges from the actual running of an enterprise.

The architecture-in-design is an abstract representation of a system’s design rules, along with principles for orchestrating its interacting elements and managing the design process (Baldwin and Clark 2000). In contrast, a firm’s architecture-in-operation emerges from the collective actions of its personnel—not just designers—and the impact of these actions on business processes, applications, and technology choices (Iyer and Gottlieb 2004). Architectural concepts have been used to study product design activities (Ulrich 1995;Baldwin and Clark 2006) and broader organizational issues such as firm boundaries (Langlois 2002; Tiwana 2008), innovation (Henderson and Clark 1990), globalization of business processes to optimize the fit between flexibility and standardization (Kettinger et al. 2010), and governance policies (Tiwana and Konsynski 2010; Tiwana et al. 2010). This body of work suggests that information systems architecture is a relevant and useful abstraction for studying the role of enterprise IT systems in influencing organizational activities related to innovation, and provides a conceptual foundation for investigating the design and configuration of IT-enabled services.

Second, the emerging literature on new service development has applied architectural concepts to service design (Spohrer et al. 2008; Voss and Hsuan 2009). Based on a service-dominant logic that defines service as “the application of operant resources (skills and knowledge) for the benefit of another party,” a service system abstraction has been proposed. A service system is defined as a “dynamic value co-creation configuration of resources, including people, organizations, shared information … and technology, all interconnected internally and externally to other service systems by value propositions” (Spohrer et al. 2008; Piccoli et al. 2009).

In this context, "service architecture" denotes the decomposition of a service system into functional elements with well-defined interfaces at the industry, service supply chain, service bundle, and service component levels. Prior work (e.g., Voss and Hsuan 2009) has developed mathematical models of service architecture design and service function modularity to aid decision-making for various service innovation activities including service customization, assessment of competitiveness, and exploitation of service innovations. Together, the emerging service science and new service development literatures based on the service-dominant logic highlight the need, relevance, and usefulness of architectural abstractions to study service innovation.

Third, research on the business value of IT has advanced a process view of the performance effects of IT investments. This view posits that the immediate effects of enterprise IT systems occur at the level of organizational processes that use the IT assets. In turn, the IT-enabled processes enable higher-order organizational capabilities such as customer management, process management, and performance management, which influence firm performance (Melville and Kraemer 2004; Mithas et al. 2011). Further, organizational managers perceive the value of IT in the context of the business processes they encounter, and these perceptions subsequently influence decisions on firm-level IT investments (Tallon 2010).

Complementing the process-oriented view, recent research focusing on the fusion of IT within products and services of firms articulates a distinct logic of digital business strategy based on the interplay between design capital— the cumulative stock of designs owned or controlled by a firm—and design moves, the strategic actions of a firm that affects design capital (Woodard et al. 2013). This logic illustrates the strategic consequences of designer's actions by highlighting the relationship between design decisions pertaining to IT and higher-level strategic capabilities and firm performance. The design-based logic and the process-oriented view of how IT investments create business value provide a starting point to explore the dynamics between business process design activities of a firm engaged in service innovation and its enterprise IT investments.

In summary, the existing technological, organizational, and operations management literatures provide a framework to study the relationship between IT architecture and service architecture. The process-oriented view of payoff from IT investments and the design-based logic of digital business strategy provide a starting point to study how the relationship between the architecture of enterprise IT systems and the services they enable might influence the orchestration of service innovation activities in an enterprise. However, significant theoretical gaps persist in integrating the different architectural abstractions and understanding how the properties of desired versus realized system and service architectures interact to influence service innovation activities. As noted by Voss and Hsuan (2009, p. 57), "there is a need to develop a combined view of the physical, organizational, and IS [Information Systems] architectures of services." Our study responds to this call by examining the dynamics of fit between enterprise IT architecture and service architecture, and the resulting influence on service innovation.

We studied six technology-enabled service innovation efforts in Singapore to answer the following research questions: (1) How does the fit (or misfit) between the enterprise IT architecture and service architecture influence service innovation activities?, and (2) How do firms involved in technology-enabled service innovation achieve congruence between IT architecture and service architecture? The organizations engaged in the service innovations we examined were major influencers of the national barometer of service satisfaction, the Customer Satisfaction Index of Singapore (CSISG 2011). The sample of service innovations in our case studies involved the use of new technologies and spanned the transportation, finance, tourism, telecommunication, and logistics sectors. In each case we investigate how the firms orchestrated the respective service innovations, specifically focusing on the design of the service architecture and its relationship to the architecture of enterprise IT systems that enabled each service. Using the findings from the within- and across-case analyses, we build a process model of service innovation that illuminates the relationship between enterprise IT architecture and service architecture. This theory-building study thus contributes to the development of a unified view of service innovation that encompasses both the "service" and "IT system" aspects of service systems.

Methodology

We conducted an embedded multiple-case inductive study (Benbasat et al. 1987; Yin 2009) involving six best-in-class service firms located in Singapore. An embedded research design implies multiple units of analyses; we conducted our investigation at four levels: (1) the cross-functional, technology-enabled service innovation project, (2) the enterprise IT systems of the firm, (3) the service architecture involved in the project, and (4) the business units or divisions of the firm responsible for information technology and/or service excellence. The embedded design provides greater richness and multiple perspectives from which to explain the dynamic relationships between the information systems and service architectures that we study. The multiple case design allows for a replication logic wherein findings from each case serve to confirm or disconfirm inferences drawn from others, thereby permitting the induction of more reliable process theories (Yin 2009).

Given our research questions relating IT architecture and service architecture, we sampled firms in the service sectors that were involved in technology-enabled service innovation projects. Beginning in December 2009, we approached more than twenty firms participating in the Customer Satisfaction Index of Singapore, a national barometer of service satisfaction, to seek their cooperation for the study. By March 2010, we garnered agreement with six firms that met the criteria set by our embedded research design.

The six firms that agreed to participate in the study were deeply involved in new technology-enabled service innovation projects, and belonged to the transportation, finance, tourism, telecommunication, and logistics industry sectors. While the operational context of the projects varied, a key similarity was that they all focused on integrating information from multiple sources and using the integrated information to enhance the service experience for customers. At the same time, the heterogeneity in the operational service context allows us to test the generalization of emergent findings from the cases through replication logic analogous to that of an experimental study.

We conducted a total of 36 interview sessions in three different rounds over 12 months. Our interview guides were derived from the process-oriented view of IT-enabled business value creation (Barua and Mukhopadhyay 2000; Mithas et al. 2011), models of fit/alignment of business strategy and IT strategy (Grant 2010; Sabherwal et al. 2001; Sabherwal and Chan 2001; Tallon 2007), the conceptual frameworks of service innovation viewed through a service-dominant logic lens (Lusch, Vargo, and O'Brien 2007; Ordanini and Parasuraman 2011), the conceptual frameworks enumerating architecture abstractions (Iyer and Gottlieb 2004; Zachman 1987) and studies applying architecture abstractions to investigate organizational issues including innovation activity (Baldwin 2008; Baldwin and Clark 2000; Ethiraj and Levinthal 2004a, 2004b).

A total of 108 personnel participated in the discussions; these included, among other employees, senior executives such as the chairpersons of the firms' boards, directors of IT and operations, vice presidents of service excellence, business unit heads, and their corresponding divisional team members. The first interview session with each firm was a pilot interview with a single senior manager involved in a service innovation project. The pilot interviews served to identify the key service innovation champions in the committees through snowball sampling, and we used these lists of influential personnel to recruit case study informants in the primary data collection interviews. In each case, we arranged at least one joint session when we met all the committee members together for a group discussion. The interviews were about 90 minutes long, and semi-structured with two basic variations: one for informants from IT divisions and other business divisions of the firms. When we interviewed multiple personnel in a group setting, we combined the two basic variants of the interview guide allowing the interview questions to flow according to the specific themes that emerged in the discussion. Some of our case study informants had significant experience in leading service innovation projects across a wide spectrum of industry sectors in multiple countries in South-East Asia; we set aside extra time for a relatively open-ended discussion with these informants to draw on their experience and insights.

We did not tape-record the interviews because several informants expressed reluctance about being tape-recorded. We were interested in true accounts of the case events and context rather than the official position of the firms, and sensed that the informants were more apt to be forthcoming in the absence of voice recording. Hence we took notes during all conversations with case informants, abbreviating phrases and paraphrasing responses as closely as possible as well as clearly marking quotes that were captured verbatim. To minimize note-taking errors, at least two researchers took notes during the interviews independently and reconciled differences after each interview. To minimize informant biases, we interviewed multiple informants in several rounds of discussion, adequately reconciling any difference in factual data as well as recording informant explanations for differing point-of-views. Although we allowed informants' interpretation of others' actions, we focused more on facts and events that informants encountered first hand in the service innovation projects. Our informants were highly experienced and knowledgeable, and held important senior management roles in their respective firms, assuring the reliability of their accounts.

We coded the interview notes and synthesized relevant archival data to build the individual case stories, constantly triangulating between the data and the emerging views. As a check on the emerging stories, other authors formed an independent view of the cases, which was then incorporated into the case stories. When coding the interview notes, our approach was to use a first-order analysis (Van Maanen 1988), developing codes based on informants' own language and terms, and repeatedly comparing data across informants to discern the major concepts of interest. These were then applied to the entire set of interview notes to form a set of informant-centric concepts. On certain occasions when we sensed that coding would violate confidentiality agreements with the informants, we paraphrased verbatim quotes, masked any sensitive data or opinion that was not relevant for our enquiry. We organized all case stories, interview text and our codes using a text analytics software package that facilitated easy searching, consolidating, and cross-referencing across our codes and case stories. Apart from the interview data, we also collated data from external sources such as the customer satisfaction data from the national Customer Satisfaction Index of Singapore, and archival data including company annual reports, press releases related to the service innovation projects, online news sources and consumer forums, and data relating to consumer complaints and feedback on the services offered by the firms that we studied. We then proceeded to conduct within- and cross-case analyses.

Case Study Findings

Antecedents of Fits and Misfits

The opportunity and need for service innovation in our cases came from a variety of sources including institutional pressure from regulatory bodies, competitor actions, feedback from customers, and new emergent technologies. Table 1 shows the origins of the service innovation projects in the six case companies.

In all the six cases, service innovation projects were handled by cross-functional teams, which had formed well-defined project selection and governance procedures. Not all ideas were approved and funded, and the service innovation projects that gained committees' approval were perceived to be aligned with the organizational strategy that the firms were pursuing at the time.

A similarity in the service innovation selection criteria across the cases relates to the emphasis on the "customer experience" dimension of service. The emphasis by the project selection committees on how a proposed service innovation addresses the enablement of an engaging or enriching customer experience resonates with the overall institutional climate that the firms were experiencing and the various observations of scholars that many leading service firms are positioning themselves to sell experiences in the service economy in order to command a higher fee than traditional service offerings (Pine and Gilmore 1998; Stuart and Tax 2004).

As the teams started designing the implementation of the service innovation, discussions on several sub-parts of the project ensued. These discussions often included practitioner and firm-specific language and centered around concepts such as business processes, database design, workflow procedures, user interfaces, transactions, and business rules (similar to multiple faces of codification reported by Vaast and Levina 2006). We abstract away from these sub-parts and the interactions between them in order to focus on their architecture as a whole. Further, following Iyer and Gottlieb (2004), we separate the designers' view of the architecture (i.e., architecture-in-design) from the actual realized architecture (i.e., architecture-in-operation). Both the in-design and in-operation architectures include distinct service and IT system sub-parts.

Case 1: Rail transport
Competitor actions: "We are very much aware that another public transport operator has been providing real time arrival information for more than two years now…" ***Institutional Pressures:*** "Land Transport Authority [Government Agency] has been expanding dissemination of live public transport information through display boards, the internet and mobile channels, via the PublicTransport@SG portal and we had to supply them the necessary information from our side" ***Customer feedback:*** "We have been regularly bombarded by the question: the other operator has the NextBus service, where is yours?"
Case 2: Bank
Competitor actions: "Competition in the credit payment products is intense. Card issuers are on overdrive and we want to offer the best value in terms of privileges and rewards by embracing innovative technology" ***Emergent Technology:*** "We were the first in Singapore to integrate credit payments and public transport fare payments in one card using the near field technology and Contactless ePurse Application Standard"
Case3: Animal reserve
Customer feedback: "While we are a top tourism attraction in Singapore, local customers are major source of our revenue sustainability. Our guest experience program is now focused to take into account local residents feedback such as increasing bus frequency, car park over flows, integrating programs with local holidays, local educational programs…" ***Emergent Technology:*** "We think time is ripe for increased use of RFID technology for educational group programmers and real-time digital signage throughout our parks"
Case 4: Postal agency
Institutional Pressures and Competitor actions: "With the liberalization of the mail services since 2007, we now face competition from four multinational players. We also need to fight the threat of e-substitution and stay relevant to lifestyle changes"; "Large and globally influential credit card issuers compete with us in the electronic bill payment services and are in direct partnership with our logistics competitors for global shopping and shipping arrangements" ***Emergent Technology:*** "We could see the electronic channels as a threat or opportunity. Our mail volumes have dropped by 50% since 2000, but we have also grown our electronic channel revenues by that amount in the past five years"
Case 5: Resorts
Customer feedback: "We listen to customers when they say you got 22 packages to choose from. Which one to choose? We want to provide more guidance and flexible options"; "Families and young professional groups need different options, and experience. Our guest experience improvement need is to provide such a customized experience for our focus segments" ***Emergent Technology:*** "Our tickets are RFID-enabled, but we make no use of it in operation; our partners don't use it as well. We want to maximize the use of the technology we have spent on and integrate information available from all partners…"
Case 6: Telecom operator
Institutional Pressure and Competitor actions: "We have benefitted from the liberalization of the local telecommunications industry in the past, but now face intense competition due to further liberalizations and amendments across the info-communications spectrum [examples: mobile number portability and cross-carriage of content for pay TV]. We expect our competitors to compete aggressively with us, driving up our acquisition and retention costs; the best way to keep ahead of competition is to constantly look at innovative ways to service customers; it is crucial, now more than ever, to focus on offering the best service experience to customers" ***Emergent Technology and Customer Feedback***: "We are very aware that today people's perception is driven by what they hear from their friends. This is why we have been carefully listening to the voice of our customers in a variety of ways, including Facebook, Twitter, and broader social media. Our main commitment is to listen and look at ways where we can have our services closer to the customers"

Table 1. Origin of Service Innovation Projects at the Case Sites

The service architecture includes the decomposition of the service function into various service bundles, service components (business processes, workflows) and definitions of interfaces to various players in the service supply chain (Voss and Hsuan 2009). The IT architecture deals with the implementation view of the service decomposition through enterprise IT and includes elements such as database design, user interfaces, and application programming interfaces. Thus, as the service innovation project teams deliberated on the design and implementation activities, they were formulating the architecture-in-design, i.e., the framework that provides the desired design rules and principles for structuring and organizing the interactions of the various sub-parts of the proposed service innovation implementation.

Given the technology-enabled nature of the service innovation projects, the cross-functional project team in all six cases included the head of the information technology division of the firm along with the heads of other relevant business units, business process owners, and key IT personnel. Decisions on all important aspects of service innovation including investments and resource allocation, and principles governing the design of service and systems, were jointly taken by the heads of business units and IT organization along with adequate representation from each unit's key personnel. Thus, the business process owners and IT personnel jointly established the architecture-in-design for each service innovation.

However, the implementation and day-to-day operation of the individual components of the service innovation (i.e., the instantiation of the architecture-in-design for both the service and its associated information systems) was left to the actions of the respective service function or IT team. Therefore, the governance structure of service innovation projects in our cases can be characterized as the "federal governance archetype" (Weill and Ross 2004, pp. 59-83). While the capacity for joint decision-making enabled by the federal form of governance has been characterized as a best practice (Weill and Ross 2004, pp. 135-136), the autonomy provided to the individual business units and IT teams to pursue their own strategies to instantiate the architecture-in-design is a key source of variation in the observed fits and misfits between the architectures in our cases.

The level of requirements ambiguity (i.e., the extent of uncertainty faced by designers while deriving specifications) heavily influenced the specific formulations of the architecture-in-design developed by the service innovation project teams. The sources and extent of requirements ambiguity varied across the cases. The rail transport and animal reserves teams faced relatively higher levels of requirements ambiguity on both the service and IT design. In both of these cases, the main source of ambiguity stemmed from the idiosyncratic features of their current architecture-in-operation and there were no simple ways to refactor the existing architecture-in-operation in light of the new requirements of the service innovation projects. Hence these teams typically relied on recommendations from service supply chain partners, external regulatory agencies, or solutions available from prior technology suppliers in order to define important aspects of their desired architecture-in-design.

In contrast, the resorts and telecommunication operator teams faced relatively lower requirements ambiguity, and were incrementally working toward internally defined and agreed upon longer-term architectures-in-operation. Thus, they were able to formulate architectures-in-design for their new services by taking into account broader internal requirements for the planned evolutionary migration path, which went beyond the specific service innovation projects we studied.

The postal agency and bank teams faced mixed levels of requirements ambiguity in designing the architectures for their service innovation projects. While both teams had a deep understanding of their IT architecture-in-operation and well-defined plans for longer-term architecture evolution, the decomposition of the new service functions of their projects was highly ambiguous because of the complex involvement of external partners in the service supply chain design. The design of the new integrated credit card offering from the bank, which attempted to combine generic credit-based payments with the bus and train public transportation ticketing mechanism in a single card, involved consideration of activation, deactivation, and operational rules of the public transport ticketing card from the government-affiliated card provider. The various options to seamlessly integrate these mechanisms in order to provide an enriching experience for a customer was not fully clear to the bank project team as it started to design the service innovation implementation. Similarly, in the postal agency case, actionable information on the various options to integrate processes from various overseas shopping and shipping agencies (for example, Amazon UK and USA) were not fully available to the project team. As a result, the bank's and postal agency's desired architectures-in-design were influenced both by internal knowledge about the current IT architectures and by the vague and uncertain requirements and recommendations of their respective external service supply chain partners.

Fits, Misfits, and their Consequences

As the project teams proceeded to operationalize their architectures-in-design, they encountered several challenges because of the misfits between their prevalent service and IT architectures. These misfits were typically not known or not well understood during the design stage because of the various requirements ambiguity factors that stemmed from complex internal systems or ambiguous interface requirements of their partners.

Table 2 presents detailed information of the various fits and misfits of the architecture-in-design and architecture-in-operation (both service and IT) of the six cases. Cell 1 in Table 2 portrays the level of fit (or misfit) between the desired service architecture-in-design and the current IT architecture-in-operation. Cell 2 presents the level of fit between the service architectures in-design and in-operation. The fit between IT architectures in-design and in-operation is shown in Cell 3. Finally, Cell 4 presents the level of fit between desired IT architecture-in-design and current service architecture-in-operation. (For brevity we have included only one sample evidence, per firm, per cell in Table 2.)

For a complementing visual representation, we recast the data from the four cells of Table 2 graphically in Figure 1. The figure shows the relative extent of fits/misfits observed in the six cases, and maps the costs of misfits in four distinct categories: (1) cost of upgrading or modifying IT systems, (2) cost of business process disruption, (3) cost of IT system disruption, and (4) cost of redesigning business processes.

To reduce a high misfit between the desired service architecture-in-design and current IT architecture-in-operation (as in the rail transport and animal reserve cases), firms incur costs related to upgrading or extensive modifications of IT systems, which are the indirect costs of the service innovation project that were not fully anticipated at the start. Similarly, a misfit between the desired IT architecture-in-design and existing service architecture-in-operation, as faced by the rail transport, bank, postal agency, and resorts teams, leads to unanticipated costs associated with redesign of business processes as an indirect outcome of the service innovation project. On the other hand, misfits between service architectures in-design and in-operation (as in the case of animal reserves and rail transport) or between IT architectures in-design and in-operation (as in the case rail transport) lead to hidden costs associated with unanticipated disruptions to otherwise stable business processes and IT systems as the changes brought about by the service innovation project begin to percolate through the firms.

Firms responded to the uncovered misfits and the associated costs to varying degrees. To deliver the service innovation to the market within the planned project timeframe, the project teams overcame the challenges presented by the misfits through workarounds that typically included modifications of the service and/or IT architecture components in-operation.

Architectures-in-Design *(desired)* / **Architectures-in-Operation *(current)***	**IT Architecture**	**Service Architecture**
Service Architecture	**Cell-1** **Rail transport: High Misfit** "Our integrated bus operating system was not originally designed to share information on many channels; it is primarily a fleet management system. We need lots of enhancements and workarounds" **Bank: Good fit** "As approved bank for public transport ticketing we had all the necessary process integration in place before thinking of an integrated credit payment product" **Animal reserves: High Misfit** "Cross-functional information sharing is mostly a manual and ad hoc procedure" **Postal agency: Low Misfit** "Some parts of diversified business are still standalone and needs integration with our mainstream systems" **Resorts: Low Misfit** "The building blocks of platform are in place; they need to be cemented together and used as one whole system" **Telecom operator: Low Misfit** "longer term the end-point architecture is in place, and we have advanced well in migrating to the end-point"	**Cell-2** **Rail transport: High Misfit** "What happens when we provide inaccurate arrival information? We don't know if that will increase unnecessary crowd flow from the buses to trains" **Bank: High Misfit** "We are usually an "instant" bank – instant cards, credit, etc – now we are saying wait for 14 days" **Animal reserves: Good Fit** "integrated pricing and flexible ticketing options are great – we can alter pricing on rainy days, think about program bundles, all sorts of creative marketing" **Postal agency: High Misfit** "We have set high standards – customers expect 100% delivery in the promised time frame; for the new service that is close to impossible with uncertainty at different points overseas - warehouses, vendors, internal shipping, and customs" **Resorts: High Misfit** "we work in silos; island partners are not integrated with our programs – they are on a rent/lease mentality" **Telecom operator: Good fit** "we thrive on convergence; we want responsive service that reaches customers more closely"
IT Architecture	**Cell-3** **Rail transport: Low Misfit** "the integrated bus operating system is robust; enhancements are tedious but risk of corrupting existing modules is minimal" **Bank: Good fit** "we don't have to change anything exclusively for this new program" **Animal reserves: High Misfit** "We have to build from scratch; everything is going to be new in the next few years" **Postal agency: Good fit** "we are on our way of finalizing our enterprise architecture, that is going to support new technologies and managed services" **Resorts: Good fit** "focus is on using, not building" **Telecom operator: Good fit** "we began consolidation in 2005, in 2009 the end game was near; now we are on our way to finish all migration"	**Cell-4** **Rail transport: Low Misfit** "We are well tuned for today's needs. For more rapid development, structural changes are needed that will give us more scale and scope benefits – in integration of bus and train services, different bus operation geographies, etc" **Bank: Good fit** "Focus of refinements is on role and responsibility of customer to finish final steps in a transaction ; no changes needed for systems" **Animal reserves: Good fit** "We think collecting and reporting data through an integrated backend system for coordinated programming and decision making will be an easier approach" **Postal agency: Good Fit** "Cloud-based solutions with customized interfaces to different services of our partners will enhance our business-to-business backend process and in turn will help improve new business-to-customer services" **Resorts: Good Fit** "Integrating systems will help data-driven decision making for our service managers" **Telecom operator: Good Fit** "consolidation will allow us to have a more detailed and comprehensive, an immediate and up-to-date view of each of our customers across all our service platforms; picture of all the services our customers have with us"

Table 2. Desired Architecture-in-Design Vs. Current Architecture-in- operation

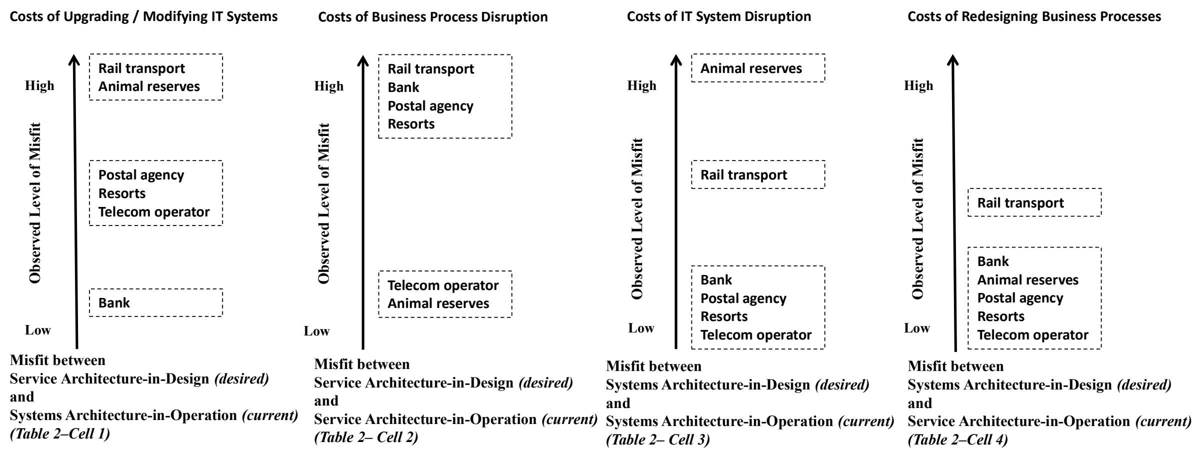

Figure 1. Misfits in Architectures

Two different, but interrelated factors bounded the set of possible workarounds for the misfits uncovered in each of our cases. First, while the propensity to address the misfits through costs of upgrading IT systems were dependent on the return-on-asset trajectories of any major investments that the firms had incurred, the propensity to implement specific alterations (different from upgrading) to IT assets were dependent on the current position of a firm in its path toward a planned, longer-term end-point architecture (the target enterprise IT systems infrastructure that the firm wants to achieve at the end of a chosen planning horizon). For example, the rail transport team decided to address the observed misfits through extensive modifications to the integrated bus operating system that the firm had started to put in place since 2004 (a 3-year project at a direct cost of more than $20 million per year). Although the system was technologically advanced at the time of purchase, the requirements of the new service innovation in 2009-10 (disseminating real-time arrival timings via mobile application programming interfaces, for example to be used by Apple iPhone and Google Android developers) were not available in the system. The extensive investments in the system in the recent past prompted the rail transport team to provide crude workarounds for data collection from the old system rather than upgrading the entire platform with in-built mobile application programming interfaces. On the other hand, the project teams of the telecom operator addressed the misfits between desired service architecture design and IT architecture-in-operation by applying workarounds in their service architecture (service scope and process workflow) rather than meddling with the IT architecture. This was because the telecom operator was cruising along a planned migration path towards an end-point architecture and did not want the specific service innovation projects to derail the complex migration effort (a 4-year project costing more than $100 million in direct costs). Thus, specific path dependencies (from past and towards a future), which the firms encountered provided boundary conditions for the possible set of workarounds available to address the misfits uncovered between the architectures in-design and in-operation.

A second factor influencing the set of possible workarounds for the observed misfits stems from the ability (or inability) of service supply chain partners to accommodate the proposed solutions. For example, when the bank team discovered misfits between their designed service architecture for the integrated credit card and current service architecture-in-operation that supported their other credit payment products, the potential set of service function modifications was influenced by what the key partner in the service supply chain, namely, the public transport ticketing agency, agreed to. Critical elements of the service architecture design in the bank project such as the separate activation and deactivation of stolen/expired cards and two-week waiting time for administrative processing were imposed by the decisions of the service partner. Similarly, the postal agency team was constrained by the actions of their overseas shipping and warehousing partners to address the misfits that they observed between their service architectures in-design and in-operation.

Thus, using the bounded set of possible workarounds available to them, project teams addressed the uncovered misfits to varying degrees. These activities resulted in the evolution of the service and IT architectures-in-operation as the firms attempted to instantiate the originally conceived service innovation design. Given that the designed and realized services (and supporting IT systems) differed to varying degrees across the cases, it is not surprising that the services' fulfillment of their customer expectations varied as well.

Table 3 describes the extent to which the realized architecture-in-operation that instantiated the service innovation in each of the case firms fulfilled customer expectations. The results in Table 3 show that except in the case of the telecom operator, none of the other service innovation projects met the expectations of customers fully, resulting in rapid adoption during the timeframe of our case study. The bank project was partially successful as the firm and its service supply chain partner rapidly responded to address the initial gaps in customer expectations. In the case of the other service innovation projects we examined, the gaps between customer expectations and the functionality offered by the realized architectures-in-operation continued to be large, which precluded any easy fixes and point towards the need for major investments to fix the misfits in the poorly performing configurations.

Case	Gaps with Customer Expectations of Service Innovation Benefits	Evidence (Interview quotes)
Rail transport	Did not meet expectations; persistent large gaps	"current arrival information is inaccurate to large extent" "we still lacking direct dissemination of information to public via mobile and internet channels" "public application developers cannot hook on to our integrated business information systems" [no public Application Programming Interfaces]
Bank	Partially met expectations; initial large gaps, but rapidly narrowing over time.	"the card is attractive on the rewards aspect, but has recognized inconvenience for handling special situations" [example: loss of card, damage to stored-value, lengthy replacement and activation process] "competitors are imitating our innovation, and we know their customers are asking for it" "queries about activation, deactivation, and replacement have reduced by as much as 50% over the past year"
Animal reserves	Did not meet expectations; persistent large gaps	"customers don't see a difference- which is success of the change management – but, they can't realize any additional benefits yet" "we can't tailor price bundles / program bundles per group of visitors" "we can't treat repeat customers in any special ways"
Postal agency	Did not meet expectations; persistent large gaps	"delivery time, package losses, and complaints are all at undesired high levels" "we are not able to respond to customers on time due to lack of data and follow-up action from customers" "process is complicated and case management solution does not fully handle case resolutions; it is mostly handled manually now and involves several exchanges with customers" "we are aware of losing loyal customers to newer offerings from other global shopping and shipping players"
Resorts	Did not meet expectations; persistent large gaps	"it is difficult for a queuing customer to choose from 22 packages" "customers have not seen the benefits yet - flexible pricing, program bundles, crowd control are still problem areas" "Our partners are still operating in silos"
Telecom operator	Largely met expectations; initial small gaps, but rapidly narrowing over time	"We have finally delivered what customers wanted for long time - one customer, one account number, one bill across all of our services, not to mention optional paperless billing" "internal billing errors have reduced since migration" "collective volume on billing-related enquires online, contact center, and customer service centers has dropped in spite of growth in new customers"

Table 3. Architecture Misfits and Customer Expectations

Figure 2 visually overlays the architectural misfits observed in each case and the extent to which customer expectations were met. From this figure, we can draw a causal linkage between the architectural misfits that occurred during the service innovation project and the performance of the service innovation project in terms of the extent to which customer expectations were met. The telecom project, which had a good fit (or consciously chosen low architecture misfits) was more successful than the bank's project, which suffered from a critical misfit between the service architectures in-design and in-operation. The postal agency and resorts projects suffered high misfits along the service architectures in-design and in-operation as well as some misfits between service architecture-in-design and IT architecture-in-operation, which resulted in more sustained customer complaints than satisfaction with their service innovations. In the rail transport and animal reserve cases, service innovation projects encountered significant misfits along all of the architectural dimensions, and the teams faced the challenge of overcoming them through large-scale capital investments. These typically required a lengthy approval process, including board-level involvement, and necessitated extensive redesign of both service and system architectures.

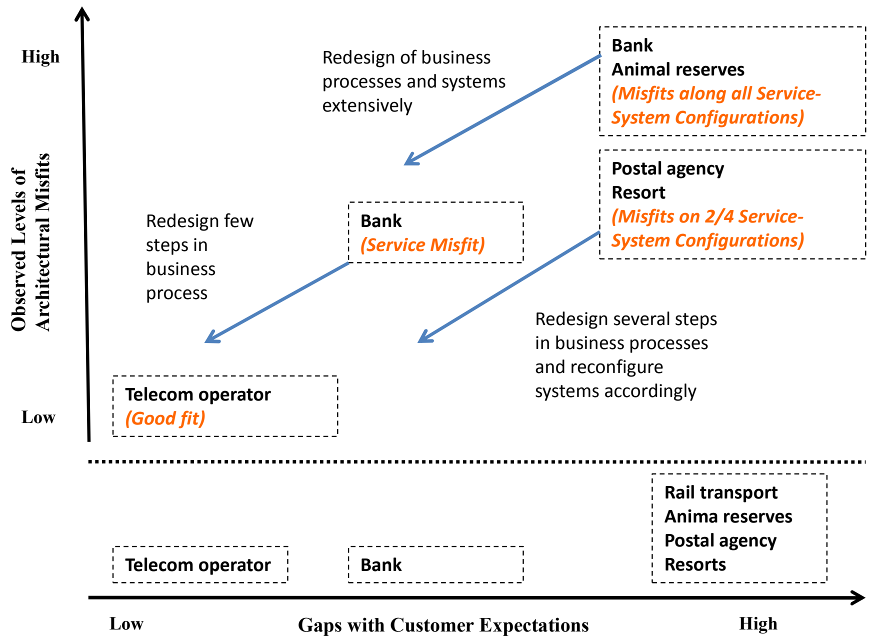

Figure 2. Misfits in Architectures and Customer Expectations

Achieving Congruence between Architectures through Design Moves

Figure 2 highlights the required interventions to fix the performance gaps of the service innovation projects. In the rail transport and animal reserve cases, significant redesign of both business processes and IT system configurations were needed in order to reduce the significant misfits between the service and system architectures in-design and in-operation. While the changes due in the case of the postal agency and resorts projects were not as severe as those faced by the rail transport and animal reserve firms, several steps in the business processes needed a redesign along with the necessary reconfigurations to the IT architecture. Among the more successful service innovation projects, the bank project team had to tweak its business process workflow with its key service partner, and the telecom team continued to optimize its service and system migration plans to a desired end-point architecture configurations.

As the service innovation project teams attempted to overcome misfits and narrow the expectations gaps with customers, IT system designers employed various design actions on the resulting architecture-in-operation from the service innovation project in order to sustain the realized service innovation in the short-term. In the rail transport and animal reserves cases, teams were constantly firefighting to simultaneously overcome the IT and business process disruptions arising from their architectural misfits and to meet the demands of providing integrated information such as real-time arrival timings (rail transport) and cross-functional attendance and profitability reports (animal reserves) in order to sustain their new service innovations. As a result, much of the design activity in these teams was related to building ad hoc and interim convenient interfaces to the IT architecture-in-operation using trial and error mechanisms. Mechanisms from successful trials were often repeated to newer problems that came up without detailed analysis and design because of constant time pressures ("cookbook recipe design"). Thus, the rail transport and animal reserves teams were sometimes caught in a vicious cycle of constant ad hoc modifications that lead to even more unpredictable behavior, often causing system and service disruptions.

The design response from the bank team was to incorporate traceability mechanisms in the IT architecture that helped service managers keep track of the variations in customer behavior, especially when customers failed to complete a step in a transaction (for example, activating a card) due to negligence or disinterest. While these interim design actions added to the indirect service innovation implementation costs, the service team was able to narrow the gaps in customer expectations and improve adoption and usage rates by allocating more resources for follow-up calls and accurate dissemination of relevant information to new customers. Further, the interim traceability design response was viewed as a step toward a product-line architecture that would standardize the rules and interfaces for all credit payment products.

Although the postal agency and resorts teams encountered similar challenges in redesigning several steps of their business processes and reconfiguring IT systems to address the uncovered misfits, their design responses were diametrically different. The postal agency team took measures to improve compatibility between its disparate service partners through a loose coupling design that emphasized standardized and well-tested interfaces. Thus, the postal team adopted a design strategy to preserve the stable parts of the service architecture (and IT architecture) by decoupling the experimental and problem parts of the service innovation that required extensive redesign. While this approach did not directly yield performance benefits for the service innovation, it allowed the project team to experiment several process and IT redesigns systematically without causing any disruptions to the stable parts of the business. In contrast, the resorts team adopted a tight coupling design that emphasized custom developed interfaces to narrow the misfits between the desired and operational services and IT. The tight coupling design helped the resort project teams to progress toward a mature composite platform for IT applications and intensify the climate for an integrated service operation with more than a hundred different partners who typically worked in silos—a key detriment to providing an enriching and engaging customer experience.

Finally, after successfully deploying its integrated billing and rewards project, the telecom operator continued on its evolutionary path toward an end-point architecture following a design strategy that emphasized simultaneous tight coupling of service and IT sub-parts that were desired in the end-part architecture, but decoupling unstable, experimental parts of the architecture in separate sandbox area through simple interfaces. For example, the telecom team tightly integrated its core billing and CRM systems, but separated out new social media (Facebook, Twitter) marketing business process—considered essential to provide service that was “closer” to consumers—in a separate unit that was loosely integrated with the core service system.

In summary, our case study findings shed light on the collective role of technology, customer tastes, and regulatory factors in triggering service innovation projects, and the impact of governance mechanisms, requirements ambiguity, path-dependent technology investments, and specific design actions of firms in shaping the trajectory and performance of their service innovation projects. We find that originally conceived service innovation designs often lead to misfits with and between existing service and IT architectures-in-operation, which lead to significant performance degradations if not addressed adequately. Addressing these misfits to sustain realized service innovations, organizational process and IT designers respond with actions spanning both loosely and tightly coupled designs, which are bounded by path-dependent technology investments of firms as well as the constraints enforced by service supply chain partners. We next discuss these findings while enumerating propositions and commenting on their implications.

Discussion

The findings from our case studies provide a rich basis for inductive theory-building. In this section, we synthesize these findings to develop a set of testable propositions on the antecedents and consequences of fit (or misfit) between service architecture and enterprise IT architecture. We then address the problem of achieving congruence between the two types of architectures—both in-design and in-operation—by viewing the design actions undertaken by the case firms as efforts to build and strike digital options.

As Iyer and Gottlieb (2004) note, the architecture that results from a design process necessarily differs from the actual structure of interactions among service and system components in operation; the former is an abstract representation created to guide the implementation process, while the latter reflects the more complex (and often messy) reality of the enterprise. Ideally, the abstraction is expected to be faithful to the reality in ways that matter for the successful implementation of the new service. However, we observed numerous cases of misfit, as illustrated in Table 2. Four types of misfits occurred, corresponding to the four quadrants of Table 2 (service and system architectures-in-design and service and system architectures-in-operation). This leads to the following propositions:

(P1) The extent of fit between the new service architecture-in-design and the existing service architecture positively affects the realization of the architecture-in-operation for the service innovation; misfits lead to increased occurrences of business process disruptions due to service innovation and increased project costs.

(P2) The extent of fit between the new service architecture-in-design and the existing enterprise IT architecture positively affects the realization of the architecture-in-operation for the service innovation; misfits lead to a vicious cycle of IT instability, which need large technology capital expenditures to be curtailed.

(P3) The extent of fit between the new enterprise IT architecture-in-design and the existing enterprise IT architecture positively affects the realization of the architecture-in-operation for the service innovation; misfits lead to increased occurrences of IT disruptions due to service innovation and increased project costs.

(P4) The extent of fit between the new enterprise IT architecture-in-design and the existing service architecture positively affects the realization of the architecture-in-operation for the service innovation; misfits lead to a vicious cycle of service instability, which need large expenditures on business process redesign to be curtailed.

Despite the best intentions of innovators, the service innovations we studied fell short of meeting the expectations and needs of customers in various ways. To a large extent these shortcomings can be attributed to misfits identified at earlier stages of the process model. However, the evidence presented in Table 3 suggests that there may be additional sources of performance drivers beyond architectural misfits, thus suggesting a final proposition:

(P5) The extent of fit between the realized architecture-in-operation and the expectations and needs of the target customers positively affects the success of the service innovation project.

Dynamics of Achieving Fit: Design Moves and Digital Options

The above propositions highlight the importance of achieving congruence between the various aspects of a service innovation project, both internally and externally. Managers and designers are by no means passive observers of this process. On the contrary, our case studies provided ample evidence of the active role played by each project team in improving the fit between the new service and its environment. This was almost always an over-constrained problem, leaving some misfits unaddressed due to forces beyond the immediate control of the project team. Some misfits, however, were not only avoidable but avoided due to the proactive efforts of project team members.

We focus on the subset of these efforts related to aligning the service architecture with the enterprise IT architecture, and the architecture-in-design with the architecture-in-operation. Many of the efforts in this subset can be classified as design moves, which we define as strategic actions that effect a change in the structure or function of a service or IT artifact. Some of these design moves directly affected the fit between the desired and realized architectures, while others created digital options (Sambamurthy et al. 2003) that could be exploited to enable other design moves in the future. Figure 3 illustrates these relationships in more detail.

A design move normally acts directly on the architecture-in-design, and subsequently affects the architecture-in-operation as the specified design changes are implemented and deployed in a working service system. Over time, a series of well-chosen and well-executed design moves can improve the fit between the desired and realized service architecture. Design moves can also help to reconcile misfits between new service architectures and existing IT systems, and vice versa.

All design moves take place against the backdrop of an existing architecture that is itself evolving, sometimes (notably in the telecom operator case) according to an established plan. In other words, architecture is a moving target, and designers are not always able to “hit” it immediately to effect the changes they desire. Rather than holding up the project, savvy designers can make design moves that create options to make additional design moves in the future. For example, the telecom operator invested in a modern platform architecture that facilitated tight coupling between its future core billing and CRM systems, even while its existing pay TV and mobile billing and rewards service functions remained loosely coupled (or tied together in shallow ways, such as links from a common corporate web site). While some of these changes were deployed in the interim, thus affecting the architecture-in-operation before full integration took place, they only make sense in the context of the new applications and services they were intended to support, some of which may not have even been imagined yet.

Figure 3 illustrates the creation of digital options as a feedback loop in which design moves add to a stock of existing digital options (option building), which in turn convey the right but not the obligation to take design moves in the future (option striking). Alternatively, designers can abandon these options (or simply let them expire) if they decide that the additional investment required to strike them is not worth the cost. Several other features of the diagram are also notable.

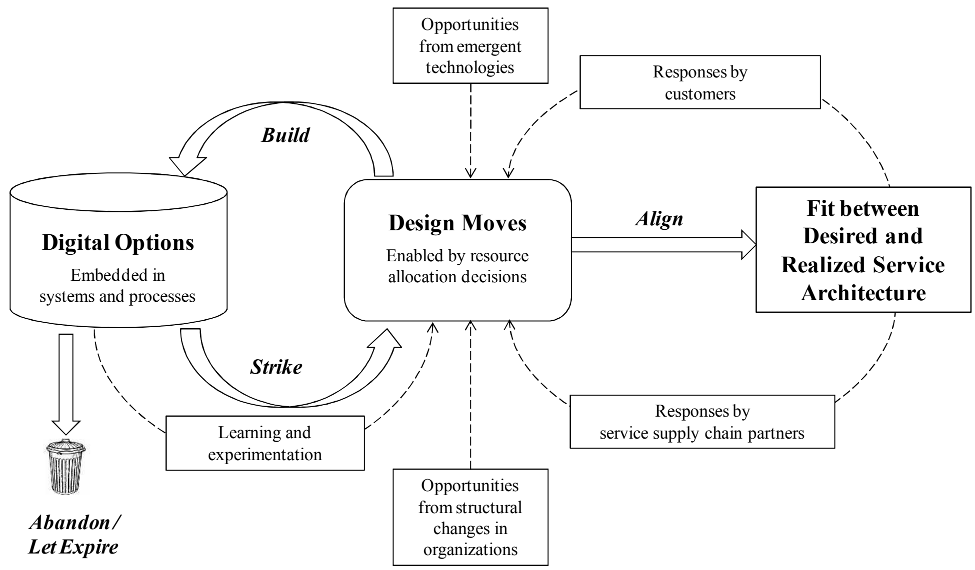

Figure 3. Achieving Congruence Between Architectures Through Design Moves

First, firms can benefit from the insights gained through digital option creation even without formally striking an option; thus learning and experimentation provide another feedback mechanism that influence the execution of design moves. For example, the postal team learned important ways to handle a future migration to managed and hosted service providers from their experience gained through the design move to decouple problematic sub-parts relating to service supply chain partners. Second, many design moves are enabled not by an organization's existing stock of digital options but by opportunities that arise through emergent technologies and organizational changes. For example, the emergence of new techniques to import and export data from legacy systems helped the rail transport team to build malleable and convenient interfaces to the integrated bus operating system in order to deliver real-time bus arrival information to external agencies.

Third, feedback on the fit between the desired and realized service architecture also influences the choice and timing of design moves; this feedback can come from customers or service supply chain partners (as well as competitors, regulators, and other channels). The postal agency and bank cases provide specific illustrations of the effect of feedback from service supply chain partners. Once the designers at the postal agency understood the problem areas of their service supply chain partners, they decoupled stable sections of the architecture from those dealing with problem areas to prevent disruptions from experimentation. The bank project designers invested in traceability mechanisms to help service supply chain partners keep track of heterogeneity induced due to unpredictable customer behavior at their ends. The powerful relationship between designs and options has been noted by others (e.g., Baldwin and Clark 2000) but their specific role in service innovation has remained underexplored and our case findings provide a rich starting ground to further explore the relationships illustrated in Figure 3.

Orchestrating Service Innovation in the Digital Age

Creating value through service innovation requires the ability to coordinate, or "orchestrate," complex IT-enabled business processes. The term is apt, as it suggests the need to assign overlapping melodic themes (services) to distinct groups of instruments (IT systems), which are intended to be brought together in real time into a harmonious ensemble. Just as musical orchestration is an art with a large body of technique behind it, IT-enabled service orchestration is an active area of research that has generated a growing body of IS management and technical literature (Bardhan et al. 2010; Peltz 2003). While a full review of this literature is beyond the scope of this paper, we want to comment on two types of technical issues that surfaced repeatedly in our case studies and commanded the attention of the senior managers we interviewed.

First, the service innovation projects we studied were undertaken at a time when the rhetoric of loosely-coupled design paradigm for enterprise IT systems has intensified. Loose coupling has a long history in the managerial literature (Weick 1976), and is closely related to the concepts of near-decomposability (Simon 1962), information hiding (Parnas 1972), and separation of concerns (Dijkstra 1982, pp. 60-66) in engineering and computer science. Well-known benefits of loose coupling include adaptability, extensibility, and robustness. But as our case studies illustrate and companies that have invested heavily in service-oriented architectures are well aware, IT systems endorsing loose coupling design is not a panacea. Systems become tightly coupled to each other for good reasons (e.g., the need to share information that is not easily converted to a standardized format, as seen in the resorts case), and breaking those links can be costly and technically challenging. Moreover, systems may be loosely coupled in design but tightly coupled in operation (e.g., due to hidden interdependencies among components or undocumented process flows, as seen in the Singapore Post case). Many instances of tight coupling only reveal themselves in non-routine situations (e.g., system failures or process exceptions), making them difficult to anticipate and correct at the design stage.

Second, coordination between service and enterprise IT system elements—whether tightly or loosely coupled—takes place through interfaces that need to be defined and continuously managed. A system interface may be formalized and documented (e.g., as a traditional application programming interface or a web service), or informally specified (e.g., as a file or message format that is generated by one system and must be read by others). Similarly, process interfaces range from structured and explicit (traditionally codified using paper forms, now often through workflow management software) to fluid and tacit (embodied, for example, in a supervisor's knowledge of whom to call when certain kinds of problems arise). This is another area where the architecture-in-operation may differ from the architecture-in-design in subtle but important ways. Service orchestrators must pay particular attention to the design of both service and system interfaces, which in turn can raise tricky governance issues: who has the authority to define or change an interface, and who is responsible if a change to an existing interface "breaks" a system or service component? Our study takes a first step in addressing these issues by enumerating a grounded process model of service innovation that specifically takes into account the dynamics of fits and misfits between the service and IT architectures.

Conclusion

This study develops testable propositions to guide further enquiry into the effects of architectural misfits on service innovation. We point to the centrality of design moves to build and strike digital options and to achieve a fit between desired and realized architecture of IT systems and service. Our case findings and the conceptualization of design moves to alleviate the architectural congruence problem in service innovation contribute to an understanding of "how [technology-enabled] service innovation comes about" (Bitner and Brown 2008, p. 43) and what managers can do to influence technology-enabled service innovation outcomes.

For broader generalization, the limited case-based findings of this study need to be verified in other geographical and industrial contexts. There are two important ways in which theoretical perspectives on achieving architectural congruence between "service" and "IT system" aspects of service systems developed in this paper can be extended by future research. First, future research can validate the propositions of the process model through a larger-sample empirical study, specifically accounting for the proposed interaction effects of architectural misfits on project-level and firm-level service innovation performance using customer satisfaction and IT investments data. Second, future research can further explore the short-term and long-term evolutionary dynamics of architectural fit in service systems and their impact on service design and organizational governance mechanisms. We see these as promising directions that can contribute to a more comprehensive theory of technology-enabled service innovation and service science, and look forward to pursuing them in future work.

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