The Effects of IT Application Orchestration Capability on Performance

Research-in-Progress

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Abstract

This paper investigates the effects on performance of a firm’s capability to orchestrate its portfolio of IT applications. It conceives of IT application orchestration as a dynamic capability and develops a model where the effects of this capability on performance are mediated by an important IT-enabled business outcome: process agility. Results from an international survey of IT executives show that IT application orchestration capability has a direct positive effect on agility, which in turn improves performance. Further, we show that agility fully mediates the effect of IT application orchestration capability on performance. This paper extends prior theory by proposing and testing for the performance effects of an IT-enabled dynamic capability that has not been previously investigated. The implication of this study for practice is to show that the benefits generated by managing the portfolio of IT applications are realized at the process-level and result in increased firm performance.

Keywords: IT portfolio, IT applications, dynamic capability, IT capabilities, orchestration, IT business value, agility, performance
Introduction

Information technology (IT) provides firms with opportunities to reduce operating costs, implement new business initiatives, and improve agility (Rai and Tang 2013; Sambamurthy et al. 2003; Tallon and Pinsoneault 2011). Recognizing those potential benefits, firms are increasing their investments in IT (Gartner 2014). However, prior research shows that most firms find it difficult to realize the expected IT benefits (Rettig 2007; Ross et al. 2006). IT departments spend more than 70% of their budgets just trying to keep existing IT applications running and often take several years to implement a new strategic initiative (Rettig 2007). At the same time, the pace of IT innovation has increased, competitors act quickly to take advantage of those innovations, and IT applications that once were a source of differentiation tend to become less valuable (El Sawy et al. 1999; Lyytinen and Newman 2008; Swanson 1994; Wang 2010). Whether and how firms derive benefits from their evolving IT applications portfolio is an important area of research that warrants further investigation.

Prior literature shows that a wide variety of IT-related capabilities affect the ability of firms to realize benefits from IT (Broadbent et al. 1999a; Chen et al. 2014; Kim et al. 2013; Lu and Ramamurthy 2011; Mithas et al. 2011; Pavlou and El Sawy 2011; Piccoli and Ives 2005; Rai et al. 2006; Rai and Tang 2010). For instance, Mithas et al. (2011) show that IT-enabled information management capability affects customer and process management capabilities, which in turn enhance performance; Lu and Ramamurthy (2011) show that IT infrastructure and management capabilities enhance agility; while Wang et al. (2012) show that IT planning and use affect IT support to business processes. Despite significant advances in this literature, the focus of prior empirical studies has been primarily on planning capabilities, information management, and IT infrastructure, rather than on IT applications.

This study extends existing literature by shifting the focus from capabilities to manage the IT infrastructure to capabilities to manage the portfolio of IT applications. Teece (2007) explains that the ability to renew a portfolio of resources is an important orchestration capability that can confer significant benefits for firms.1 Sirmon et al. (2007; 2011) further explain that resources tend to lose their value rapidly because of market changes and therefore firms need to continuously and quickly add new resources to the portfolio (i.e., purchase and develop new resources) and divest less-valuable ones. Like any other portfolio of resources, the IT applications portfolio must be continuously updated and firms do so by purchasing new applications, building applications, and discontinuing those that are no longer valuable. Drawing on the above literature and prior research on IT capability, we conceive of IT application orchestration capability as the ability of firms to quickly update the IT applications portfolio by adding valuable applications and discontinuing less-valuable ones. Then, we build and test a theory of its effects on performance that takes into account the role of intermediate process-level outcomes.

This paper contributes to the body of literature that investigates the impacts of IT capabilities on firm performance. We show that IT application orchestration capability generates performance benefits and identify a key process-level outcome – that is, process agility (agility, for brevity) – that helps explain the mechanisms through which these benefits occur. Prior research argues that agility or “the ability to detect and respond to opportunities and threats with ease, speed, and dexterity” (Tallon and Pinsoneault 2011, p. 464) is a key antecedent of performance (Chen et al. 2014; Sambamurthy et al. 2003; Tallon and Pinsoneault 2011). Extending prior literature, we identify and test for the effects of an antecedent of agility that has not been previously investigated, specifically, IT application orchestration capability. We test our research model on data from an international survey of IT executives. The results show that IT application orchestration capability has a direct positive effect on agility. The results also show that agility mediates the effect of IT application orchestration capability on performance.

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1 This is often referred in strategic management literature as “asset orchestration” (Teece 2007). We use the term “resources” instead of “assets” to be consistent with IS research that defines IT capability in terms of resources (Bharadwaj 2000) and that defines resources as profit-producing assets (Drneich and Croson 2013).
Background and Hypotheses

Prior Research on IT Capability and Orchestration Dynamic Capability

IT capability refers to an organization’s “ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000, p. 171). Prior literature investigates various dimensions of IT capability. For instance, Weill and Vitale (2002) and Weill et al. (2002) examine IT infrastructure capability and infrastructure services, including security and risk management, communication, data management, application infrastructure, IT facilities management, and IT architecture and standards; Bharadwaj (2000) focuses on human IT resources, IT infrastructure, and IT-enabled intangibles; Fink and Neumann (2007) investigate IT personal and IT infrastructure capabilities; and Wang et al. (2012) examine IT planning and use. The empirical evidence in this body of literature shows that IT capability is an important enabler of performance (Mithas et al. 2011).

However, researchers have argued that the primary effects of IT occur at the level of business processes (Barua et al. 2004; Barua et al. 1995; Barua and Mukhopadhyay 2000; Melville et al. 2004; Mithas et al. 2011; Sambamurthy et al. 2003; Setia et al. 2008; Tallon 2008). This implies that process-level impacts of IT are important for understanding the link between IT capabilities and performance. For instance, Ray et al. (2005) and Setia et al. (2013) show that IT capabilities affect business process performance; and Fink and Neumann (2007), Lu and Ramamurthy (2011), and Chen et al. (2014) show that IT capabilities enhance agility which, in turn, affects performance (Chen et al. 2014; Tallon and Pinsonneault 2011).

Consistent with the argument that the primary effects of IT occur at the process-level, Pavlou and El Sawy (2006; 2011) investigate the impacts of IT capabilities to the new product development (NPD) process. They show that competitive advantage in NPD depends on IT-enabled dynamic capabilities and functional competencies. This is an important area of research for understanding the performance impacts of IT because, while a number of studies investigate IT functional competences (e.g., Bharadwaj 2000; Chae et al. 2014; Chen et al. 2014; Fink and Neumann 2007; Wang et al. 2012; Weill et al. 2002), less attention has been given to IT-enabled dynamic capabilities that are more likely to enhance differentiation (e.g., Pavlou and El Sawy 2011; Roberts and Grover 2012). For instance, we know little about whether and how IT-enabled dynamic capabilities impact process-level outcomes such as process agility and the mechanisms through which these capabilities affect firm performance.

Prior literature argues that two managerial competences are core to dynamic capabilities: search and selection, and asset/resource orchestration (Helfat et al. 2007). Search and selection involve the identification of opportunities and formulation of actions, including allocation of resources. Orchestration focuses on the assembling and structuring/re-structuring of the resource base (Helfat et al. 2007; Sirmon et al. 2011; Teece 2007). The dynamic capabilities theory argues that the identification of opportunities and formulation of actions are necessary to achieve competitive advantage and improved performance (Helfat et al. 2007; Helfat and Peteraf 2003; Pavlou and El Sawy 2011; Sirmon et al. 2011; Teece 2007; Teece et al. 1997). However, significant performance gains are more likely to occur through orchestrating organizational resources (Helfat et al. 2007; Sirmon et al. 2011; Teece 2007). This requires continuous efforts to build, maintain, and adjust the resource base to address rapidly changing market conditions (Teece 2007). Extant literature argues that orchestration is a promising area of investigation to understand how firms derive benefit from their resources (Sirmon and Hitt 2009; Teece 2007), including IT (Sharma and Shanks 2011; Wang et al. 2012).

The discussion above suggests two opportunities for extending prior IT capabilities research. First, existing literature focuses on functional competences, specifically, IT infrastructure and related management capabilities. At the same time, IT infrastructure is becoming more of a commodity and IT applications that provide differentiation tend to lose their value quickly because of market changes, an increase in the pace of IT innovation, and the shrinking of IT applications lifecycle (Rettig 2007; Ross et al. 2006; Vessey and Ward 2013). Realizing IT benefits under these conditions requires continuous efforts to build and maintain the IT applications portfolio. This is illustrated by surveys of IT executives that find IT applications such as business intelligence, collaborative systems, data management, and business process management are key priorities for managers (Luftman et al. 2012; 2013). Existing literature argues that orchestration of resources is an important competence for adapting to changing market conditions and improving performance (Sirmon and Hitt 2009; Sirmon et al. 2007; Teece 2007; Wang et
that affect the ability of firms to derive benefits from the resource base. For instance, performance can be
enhanced by building and buying IT applications but also the ability of firms to quickly respond to new market conditions. For instance, legacy IT applications are usually difficult to change. They increase IT complexity and make it difficult for firms to integrate new applications into the IT portfolio, which in turn hinders agility (Lu and Ramamurthy 2011; Nazir and Pinsonneault 2012). This suggests that agility depends not only on the ability of firms to build and buy IT applications but also their ability to act quickly and discontinue inflexible applications that are creating rigidities. Hence, we hypothesize the following:

**H1: IT application orchestration capability has a positive effect on agility.**

**Mediating Role of Agility in Performance**

IT application orchestration capability enables firms to build unique combinations of IT resources to enhance performance. According to dynamic capabilities theory, improvement in performance is more likely to occur when firms possess capabilities that act upon the resource base to produce new combinations of resources that are heterogeneous, valuable, difficult to imitate, and imperfectly mobile across firm boundaries (Eisenhardt and Martin 2000; Helfat et al. 2007; Helfat and Peteraf 2003; Sirmon et al. 2011; Teece 2007; Teece et al. 1997). Previous IT capability studies provide some evidence for this logic by showing that IT-enabled dynamic capabilities affect the amount of value firms derive from IT resources (Pavlou and El Sawy 2006; Pavlou and El Sawy 2011; Roberts and Grover 2012). Sirmon et al. (2007) explain that firms renew or restructure the resource portfolio by purchasing resources, developing resources internally, and divesting existing resources. These are key competences that affect the ability of firms to derive benefits from the resource base. For instance, performance can be
improved when firms acquire or develop resources that allow preferential access to future opportunities (Sirmon et al. 2007). This is often referred to as real options (McGrath and Nerkar 2004; Sirmon et al. 2007). By acquiring or developing IT applications as real options, firms increase their repertoire of viable IT-based responses to market opportunities (Fichman 2004), which in turn enhances process agility (Overby et al. 2006). As Sambamurthy et al. (2003) explain, “The holder of an option typically makes a small initial investment, holds it open until an opportunity arrives, and then exercises a choice to strike the option and capture the value inherent in that opportunity” (p. 247). Divesting resources can also generate significant benefits. For instance, outsourcing of functions is a key mechanism through which firms retire resources (Sirmon et al. 2007). Extant IS literature suggests that IT outsourcing can reduce IT costs, enhance support for business functions, and also enable firms to focus on idiosyncratic IT applications that enhance differentiation (Han and Mithas 2013).

Thus, we posit that IT application orchestration capability shapes and constrains the performance benefits firms derive from the IT applications portfolio. Consistent with the discussion above, we argue that it does so through improved process agility. IT application orchestration capability improves the ability of firms to create a flexible base of resources for enhancing agility across business processes. Prior literature shows that agility is a key enabler of performance (Chen et al. 2014; Roberts and Grover 2012; Tallon and Pinsonneault 2011). Drawing on the above literature and on prior research that argues IT capabilities impact performance through intermediate outcomes (Barua et al. 2004; Chen et al. 2014; Mithas et al. 2011), we hypothesize the following:

\[ H2: \text{The effect of IT application orchestration capability on performance is mediated by agility.} \]

Research Method

Data Collection

The data to test our hypotheses was collected through an international survey of chief information officers (CIOs) in 120 firms. The population of interest includes a cross section of firms in Australia, Germany, and the U.S.² From this population, we developed a sampling frame of 1,200 firms: 800 were randomly selected from the U.S. with a further 400 from Australia and Germany. In line with previous IT capability studies, we survey a flagship business unit – typically a large business unit in the firm (Lu and Ramamurthy 2011; Roberts and Grover 2012). The median business unit in our sample had 650 employees.

On average, our respondents had been in their current role for eight years. We note a broad spectrum of industry groups in our sample (Financial Services (19%), Electronics (19%), Manufacturing (17%), Wholesale & Retail Trade (12%), Energy (11%), and others such as logistics, healthcare, and engineering (22%)). As explained later in the paper, we analyzed our sample in terms of industry sector, country of origin, business unit size, and ownership structure to ensure the validity of our findings.

Responses were received from 141 firms (42% from the U.S., 40% from Germany, and 18% from Australia), yielding an initial response rate of 12%. Twenty-one responses were excluded due to missing data and so our overall response rate is 10%. While low, this is on par with response rates reported elsewhere in the IT capability literature and where respondents are senior IT executives (Ravichandran and Lertwongsatien 2005; Roberts and Grover 2012). However, the potential for non-response bias needs to be investigated. We analyzed our sample using the extrapolation procedure presented in Armstrong and Overton (1977). No significant differences were found between early and late respondents (Wilks’ lambda=0.93; F=0.61; N/S), suggesting that non-response bias is not a major concern. Further, the use of a single respondent per firm raises the potential for common method bias. Our assessment of common method bias using Harmon’s ex post one-factor test (Podsakoff and Organ 1986) and Lindell and Whitney’s (2001) marker variable test indicates that this bias is unlikely to be a major concern.

² U.S. firms were identified in S&P Compustat. Data on Australian firms came from Australian Securities Exchange 200 (ASX 200) and a contact list maintained by researchers at the Center for Information Systems Research at MIT. Data on German firms came from a contact list maintained by the Centre for Human Resources Information Systems at Bamburg University.
Measures

Where possible, validated measures from previous studies were included in our survey questionnaire. The survey design was refined using feedback from pilot tests with IT executive sponsors of member firms of the Center for Information Systems Research at MIT. Respondents were asked to rate each item on a five-point Likert scale (1: Strongly disagree; 5: Strongly agree).

To devise our measure of IT application orchestration capability, we draw on prior literature that argues firms renew the resource portfolio by (a) purchasing resources; (b) developing resources internally; and (3) divesting existing resources (Sirmon et al. 2007; 2011). Sirmon et al. (2007) explain that each one of these competences is important for renewing a resource base. The three competences above describe and form the IT application orchestration capability. They are distinct from each other and therefore changes in one of them (e.g., the ability to purchase valuable resources) are not necessarily associated with changes in the others (e.g., the ability to develop resources internally) (Petter et al. 2007). Accordingly, we assess IT application orchestration capability as a formatively modeled construct that captures the ability of firms to purchase valuable IT applications from suppliers; develop IT applications internally; and discontinue or decommission less-valuable IT applications. To measure agility, we use a series of eight items taken from Tallon and Pinsonneault (2011). These items capture agility as a reflective construct and map to Sambamurthy et al.’s (2003) conceptualization of agility in terms of customer, partnering, and operational agility. Specifically, the eight items assess the extent to which a firm can easily and quickly: respond to changes in customer demand; customize products/services; react to new product/service launches in the market; introduce new pricing schedules in response to market changes; expand into new markets; expand or reduce the variety of products/services available for sale; adopt new technologies; and switch suppliers or partners.

Past literature has measured performance using either objective measures such as return on assets, net profit, and market share or subjective measures based on respondents’ perceptions of performance relative to their competitors. Given that our unit of analysis is the business unit, data that might typically be used to assess performance relative to competitors is rarely available in objective form (Tallon and Kraemer 2007; Wall et al. 2004). Accordingly, we decided to use a series of perceptual measures. This approach is consistent with prior IT capability research investigating relative measures of performance (Chen et al. 2014; Ravichandran and Lertwongsatien 2005). Following Powell and Dent-Micallef (1997), we devised a five-item scale containing questions about market share, revenues, sales growth, and profitability relative to competitors. Four control variables were used in our analysis to account for industry type, ownership structure (public/private), size, and country of origin.

Data Analysis

Data analysis was conducted using partial least squares (PLS), a structural equation modeling technique that uses a principal-component-based estimation approach (Chin 1998). Prior research indicates that PLS is an appropriate technique when analyzing predictive research models that are in the early stages of theory development and that include formatively modeled constructs (Fornell and Bookstein 1982; Hair et al. 2011; Ringle et al. 2012).

To evaluate our hypotheses, we computed significance levels by applying the bootstrapping procedure with 1000 samples. Our research model contains potential indirect relationships. Specifically, it is subject to mediation effects. The test proposed by Sobel (1982) is a popular method that has been widely used to test for mediation (Mithas et al. 2011; Tallon and Pinsonneault 2011). However, as this test is potentially biased due to an assumed normal sampling distribution (Zhao et al. 2010), Preacher and Hayes (2004) recommend a more rigorous bootstrap test that does not assume that the data are normally distributed. This paper applies both the Sobel and bootstrap approaches to test for mediation. For the bootstrap test, we ran 5,000 bootstrap samples using the SPPS-macro given by Preacher and Hayes (2008).

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3 Research by Wall et al. (2004) that compared the use of perceptual and objective measures found evidence that subjective measures of performance are valid and reasonable for collecting business unit performance data. Tallon and Kraemer (2007) also found that subjective measures are valid substitutes if objective data are unavailable.
Research Results

Measurement Model Assessment

All measurement items were analyzed to assess construct-to-item loadings, weights, validity, and reliability. We first reviewed construct-to-item loadings for our reflective constructs. All item loadings exceeded a suggested minimum of 0.70 (Hair et al. 2011). In the case of formatively modeled constructs, one examines weights (instead of loadings), which represent a canonical correlation analysis and provide information about how each item contributes to the respective construct. We found that the three items of the IT application orchestration capability construct are significant and salient contributors to the construct index – the weights are (0.42; p < 0.05), (0.46; p < 0.01), and (0.52; p < 0.001), respectively.

In order to assess internal consistency, we examined composite reliability (CR) for each reflective construct. Table 2 below describes validity and reliability statistics and a correlation matrix for our constructs. To assess validity, we compared the square root of the average variance extracted (AVE) – seen on the main diagonal in Table 2 – with off-diagonal elements that represent the correlation between each pair of constructs. The square root of the AVE for each construct is greater than their associated off-diagonal correlations. Another standard validity concern is the potential for multicollinearity among constructs, which is known to produce unstable path estimates. To alleviate this concern, collinearity tests were performed. These tests reveal minimal collinearity among the constructs with all variance inflation factors (VIF) at or below 1.6 as against a suggested maximum of 5. Accordingly, we conclude that our construct measures are both valid and reliable.

<table>
<thead>
<tr>
<th>Research Constructs</th>
<th>CR</th>
<th>AVE</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Process Agility</td>
<td>0.88</td>
<td>0.50</td>
<td>0.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. IT Application Orchestration Capability*</td>
<td>N/A</td>
<td>N/A</td>
<td>0.43</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>3. Performance</td>
<td>0.91</td>
<td>0.66</td>
<td>0.42</td>
<td>0.23</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Notes: N/A = not applicable; The bold numbers on the diagonal are the square root of the AVE; * Formatively modeled construct.

Hypotheses Testing

The results of our analysis appear in Figure 1 (non-significant paths are shown as dashed lines).

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**Table 2. Validity and Reliability Statistics and Correlations between Constructs**

**Figure 1. Results of the Research Model**

***p < 0.001; **p < 0.01; N/S: not significant
The results in Figure 1 for H1 find a positive and significant effect of IT application orchestration capability on agility ($\beta = 0.44; p < 0.001$). H2 denotes the indirect effect of IT application orchestration capability on performance via agility. Thus, we test for mediation effects. The Sobel and bootstrap tests reveal that agility fully mediates the link between IT application orchestration capability and performance (Sobel: $z = 3.43, p < 0.001$; bootstrap 95% C.I. 0.07 to 0.28), thus supporting H2.

**Discussion and Future Research**

This paper has described an IT capability that has not been discussed in prior research, IT application orchestration capability, and developed a model that hypothesizes an effect of that capability on agility and performance. Drawing on Sirmon et al. (2007; 2011), Teece (2007), and prior research on IT-enabled dynamic capabilities (Pavlou and El Sawy 2006; 2011), we develop a measure of IT application orchestration capability and test our model using data from an international survey of IT executives. The results provide strong support for the proposed model.

This paper contributes to the literature on IT capabilities by identifying a new capability, i.e., IT application orchestration, and treating it as a dynamic capability that affects agility and performance. This is an important development in a context where research has not distinguished between the capabilities to manage the IT infrastructure and dynamic capabilities for managing the IT applications portfolio and where practice is increasingly moving towards outsourcing the IT infrastructure. It is quite conceivable that IT capabilities for managing the IT infrastructure and those for managing the IT applications portfolio have different antecedents and influence performance through different mechanisms. For instance, firms pursuing different business strategies are likely to realize different benefits from a portfolio of IT applications. As IT infrastructure becomes more of a commodity, the ability to orchestrate the portfolio of IT applications could generate strategic benefits. Firms with a focus on differentiation and innovation are likely to realize significant benefits when they build idiosyncratic IT applications to improve process agility. On the other hand, firms pursuing operational excellence can generate performance benefits when they buy IT applications that improve operational efficiency and reduce IT costs. This suggests that the capability to manage a portfolio of IT applications can vary between firms pursuing different business strategies and, as a consequence, the performance benefits different types of firms derive from that capability can also vary.

This paper also has important implications for practice. As organizations are moving towards outsourcing the IT infrastructure, an important issue for CEOs and CIOs is what IT capabilities should be retained in-house and what capabilities should be outsourced? The findings of our study suggest that IT application orchestration capability is an important capability. Whatever mix of in-house and outsourced capabilities organizations choose, it is important to ensure that IT application orchestration capability remains strong. It could be argued that since the applications portfolio is closely tied to business processes, organizations should retain strong in-house capabilities for managing the evolving IT applications portfolio.

This paper has presented initial findings from a larger study investigating the role of IT application orchestration capability on agility and performance. Further work will focus on extending the research model to include the effects of other constructs that are important for explaining agility and performance, in particular, IT support for various business processes (e.g., sales and marketing) and the moderating role of business strategy on the link between IT application orchestration capability and performance.

Further work will also focus on addressing the validity threats to the findings presented here. In particular, a key validity threat to the findings presented here is that all measures, including performance are self-reported. To address that validity threat, archival measures of performance are being collected for organizations participating in the survey. The self-report performance measures will be validated against archival measures and the model will be tested for the subset of firms for whom archival data is available.

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