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Enterprise architecture: A competence-based approach to achieving agility and firm performance

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ABSTRACT

As information technology (IT) proliferates across functional units, manufacturers that lack a coherent strategy for integrating, standardizing and leveraging their IT resources and capabilities are more likely to end up with fragmented systems that do not properly support business processes and hinder performance. One strategic approach to facilitating standardization and integration among IT resources is enterprise architecture (EA). As the representation of an enterprise's business processes and IT systems, EA underpins decisions relating to data, applications, IT infrastructure (technical and human), and management responsibilities in order to inform business strategies that enable organizations to accomplish their business objectives. In this research, we leverage competence-based theory to introduce EA strategic orientation and EA assimilation as dynamic and operational capabilities, respectively. Data collected from 190 manufacturers and seemingly unrelated regression are used to test hypotheses related to a nomological network consisting of EA strategic orientation, EA assimilation, agility and firm performance. The findings suggest that EA-based capabilities can enhance agility, and indirectly increase firm performance. As the first study to assess the value of EA from a non-IT-centric perspective, this work serves as a pivot point for examining the reach and range of EAbased capabilities, particularly in operations management. The findings provide operations and IT managers with evidence of how enterprise IT initiatives are ultimately linked to firm performance by way of EA-based capabilities.

1. Introduction

The ability to leverage information technology (IT) is a key determinant of manufacturing operations performance (Ake et al., 2016; Davenport, 2013). Unfortunately, it is not always clear how manufacturers can leverage IT to enable such capabilities to improve competitiveness (Mithas and Rust, 2016). This is evidenced by the trend over time of decreasing return on investment for firms that adopt new IT (Theis and Philip Wong, 2017; Richey et al., 2009; Mcafee, 2006). The failure of IT investments to translate into improved firm performance may be due in part to the fact that companies are often focused on the technology itself and not how it transforms operations to create competitive differentiation through improved capabilities (Marabelli and Galliers, 2017; Wu et al., 2006).

Manufacturers employ a wide variety of IT throughout their organizations to coordinate their production efforts (Dong et al., 2014; Bardhan et al., 2007). Many forms of enterprise systems have aided in standardizing IT and business processes across business functions in an effort to facilitate improved operational performance (McAfee, 2002; De Haes and Van Grembergen, 2015). Despite their linkage to improved process performance, the above-mentioned systems are not necessarily capable of integrating the totality of a firm's business and IT processes in a dynamic production and manufacturing environment (vom Brocke and Rosemann, 2015). This can be partially attributed to the fast pace of technological advancement, costs and complexities involved in adopting and integrating IT solutions, ongoing business process changes, and the ad-hoc adoption of technological solutions (Davenport et al., 2004; Kenney, 2007; Ross et al., 2006). Therefore, firms have turned to various forms of enterprise architecture (EA) to facilitate integration of IT resources with business processes in an effort to leverage IT capabilities to respond quickly to market opportunities and threats and obtain an advantage over competitors (Ross, 2003; Ross and Beath, 2006; Gill, 2015).

EA refers to the definition and representation of a high-level view of

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an enterprise's business processes and IT systems, their relationships, and the level of standardization and integration, with respect to these elements, throughout the enterprise (Tamm et al., 2011). EA underpins decisions relating to data, applications, IT infrastructure (technical and human), and management responsibilities. It also informs and enhances strategies (business, operations, and IT) that enable organizations to accomplish their objectives. Despite the allure that has often accompanied EA initiatives (especially from those in the IT sector), operations managers still struggle to capitalize on the promised benefits touted by IT executives and enterprise architects. Practitioners cite a number of reasons as to why EA initiatives fail to deliver value and drive performance, many of which surround lack of capabilities associated with positioning EA as a strategic imperative and assimilation throughout the organization (Kabai, 2013; United States Government Accountability Office, 2012). Research is starting to address ways through which EA can enhance measures of performance (Hinkelmann et al., 2016; Lange et al., 2016). The current research extends this line of inquiry, where we proffer two EA-based capabilities (EA strategic orientation and EA assimilation) and examine how these capabilities might evoke firm agility and, indirectly, firm performance.

Although literature suggests the strategic importance of EA and purports means through which EA can enhance organizational benefits (Tamm et al., 2011), there remain knowledge gaps that are of interest to both practitioners and academicians. First, evidence that EA evokes any tangible performance impact is scant (Bradley et al., 2012; Espinosa et al., 2011). Second, where there is evidence of EA-based benefits, most of it is limited to IT functions and capabilities. Such a view can be somewhat limited when one considers that EA initiatives are not solely the responsibility of the IT function. Rather they are jointly owned initiatives aimed ultimately at improving business operations (Ross et al., 2006). As such, this second knowledge gap is especially troubling for those employed in operations, where pressure is felt from senior leaders and IT department personnel to change business processes or otherwise support enterprise IT initiatives, yet there is little evidence to support that doing so will benefit operations-based activities or performance. This research seeks to help fill these gaps by taking a non-IT-centric view of EA initiatives to examine how EA-based capabilities can evoke firm-level benefits. The research question examined herein is: *How are EA-based capabilities associated with firm performance?*

By examining this question, this study contributes in several ways to the literature at the operations management and information systems interface. First, by taking an operations-relevant and firm-wide view with respect to EA, this is the first study to assess the value of EA from a non-IT-centric perspective. This research also introduces the notion of EA-based capabilities, and examines how they are indirectly linked to firm performance via agility. The research also contributes to competence-based theory by suggesting EA-based capabilities as firm-specific and durable capabilities that can lead to distinct competitive advantage. By examining how EA-based capabilities influence both digital and non-digital capabilities, this research contributes to the discourse regarding mechanisms through which IT investments can fundamentally change firm-level value creation. As such, the research adds to the discussion of IT's role in supporting operations management capabilities (Heim and Peng, 2010; Setia and Patel, 2013; Saldanha et al., 2013) and provides operations managers with evidence that supporting and assimilating EA into their functions is associated with benefits relevant to their area of responsibility.

The remainder of this paper proceeds as follows. First, we provide a brief background of related EA literature. We then introduce the theoretical basis of this research and describe the key constructs considered. Third, we use theory and literature to support the proposed hypotheses and conceptual model. Next, we describe the research method and data analysis procedures, which leads to the presentation of our results. Finally, we discuss the contributions of this study and implications for theory and practice.

2. Theory and construct development

Scholars build theories in order to explain of how and why some firms outperform others (Drnevich and Croson, 2013). Theories based upon firm competencies, for example, were introduced in the 1980s and stressed the importance of organizational resources and capabilities in determining competitive outcomes among rival firms. The most popular of these theories, the resource-based view (RBV) (Barney, 1986, 1991) has seen tremendous growth in the strategy and IT research areas (Drnevich and Croson, 2013; Newbert, 2007; Piccoli and Ives, 2005).

Although virtually all studies using a competence-based approach have used RBV, some researchers have exclaimed that competitive advantage is possible with resources and capabilities that have properties other than being rare, valuable, inimitable, and non-substitutable. For example, Collis and Montgomery (2008) present a framework that promotes the notion that resources and capabilities that are durable (persist over a long period of time), appropriable (legally or otherwise bound to the firm), and superior (offer greater security) also can result in a better firm performance. Therefore, additional theories that promote these properties can be utilized instead of or in conjunction with the RBV that is common in IT performance studies.

Competence-based theory is based upon the underpinnings of theories such as the RBV, the knowledge-based view (KBV) (Drnevich and Croson, 2013; Grant, 1991; Kogut and Zander, 1992), strategic assets (Amit and Schoemaker, 1993), and competitive heterogeneity (Hoopes et al., 2003) that emphasize the importance of organizational resources and capabilities in creating value and competitive advantage for firms (Freiling, 2004: Freiling, Gersch, and Goeke). Organizational resources are assets that are owned or controlled by organizations and that use other assets and processes to convert them into final products and services (Amit and Schoemaker, 1993). They include patents and licenses, technological machinery and equipment, human resources, and similar properties of an organization (Amit and Schoemaker, 1993; Grant, 1991).

Capabilities, on the other hand, are "information-based, tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm's resources" (Amit and Schoemaker, 1993, p. 35). One distinctive property of capabilities is that they are typically based on creating, utilizing, and exchanging information within organizational human resources (Amit and Schoemaker, 1993). Organizational capabilities are often divided into two categories, operational capabilities, and dynamic capabilities.

Operational capabilities are associated with the day-to-day activities and connected to the efficient exploitation of organizational resources (Pavlou and El Sawy, 2011). Dynamic capabilities, in contrast, are used to extend, change, or reconfigure operational capabilities, or even other dynamic capabilities, normally in response to changing internal or external environmental forces (Eisenhardt and Martin, 2000; Pavlou and El Sawy, 2011; Teece et al., 1997). Although dynamic capabilities were once thought of as abstract concepts that were difficult to articulate or observe (e.g., Nerkar and Roberts, 2004; Pavlou and El Sawy, 2011; Simonin, 1999), they have now been revealed as having structure and even having the nature of routines. Yet, these high-level organizational routines are actually related strategies that when working together provide an environment to quickly respond to internal or external stimuli in a specific domain to alter their resource base (Eisenhardt and Martin, 2000). As the pace of change in most industries has accelerated over the last couple of decades, the importance of dynamic capabilities has grown. Organizations must be able to respond very quickly to changes and adapt their day-to-day activities to any new realities that threaten their competitive landscapes.

As a means of better describing the underlying themes behind these related theories, competence-based theory supposes that firms differ in their resources and capabilities and that organizations with resources and capabilities with certain qualities may gain a competitive edge over their rivals. These desired qualities include value, scarcity, inimitability, limited substitutability, appropriability, durability, overlap with strategic

industry factors, superiority, and complementarity (Amit and Schoemaker, 1993; Barney, 1986, 1991; Collis and Montgomery, 2008; Hoopes et al., 2003; Newbert, 2007). Some of these qualities make the resources and capabilities difficult to buy, sell, imitate, and substitute (Amit and Schoemaker, 1993). Others involve the match between the resources and capabilities of the firm with those of the industry factors or with other critical resources and capabilities within the firm. In addition, resources and capabilities that are firm specific, durable, and scarce as these may not only be difficult to imitate but also may require smaller investments as more experience is gained with them (Amit and Schoemaker, 1993).

This study contributes to the discussion on competence-based theory and dynamic capabilities to help explain how EA adds value to the firm. As capabilities refer to the capacity of an organization to deploy resources, we posit EA strategic orientation and EA assimilation as dynamic and operational capabilities, respectively. This approach extends prior works in this space by not simply viewing EA as a competitive advantage-yielding resource, but rather elucidating how a firm's strategic orientation toward and assimilation of EA are capabilities that can evoke firm performance. We further describe these capabilities in the following subsections.

2.1. EA strategic orientation (EASO)

A strategic orientation refers to a firm's deliberate posture towards a phenomenon (Anderson et al., 2015; Slater et al., 2006). As such, an EASO refers to a firm's strategic posture towards EA, and like other managerial-based orientation constructs is a dynamic process construct that concerns the methods and practices that are used to obtain such a posture (Richard et al., 2004; Lumpkin and Dess, 1996). This conceptualization of EASO is grounded in the strategic choice perspective, which characterizes managerial-based orientations as process capabilities that are not just imposed by top management, but reflect a posture exhibited by multiple layers of the organization (Stevenson and Jarillo, 1990).

The first-order factors of EASO enable this dynamic capability to properly implement an EA among executives, managers, employees, and other internal and external stakeholders that are crucial to the success of an organization over time. A higher degree of EASO not only sends the message that the embodiment of the principles outlined in the EA into the overall fabric of the organization is of utmost importance, but provides the organizational mechanisms to do so. EASO thus provides the firm with the foundational capability to operationalize the sought-after business process performance objectives embodied by the EA. These factors that comprise EASO include (although are not necessarily limited to): (1) having the support of top management, (2) providing adequate funding to support EA and EA initiatives, (3) creating an appropriate governance structure for the EA, and (4) viewing EA as a strategic asset. In aggregate, these six factors comprise EASO, which serves as a strategically configured dynamic capability that enables additional capabilities within the organization (Stratman, 2007).

Top management support is recognized as a critical ingredient in implementing adopted innovations into an organization (Liang et al., 2007). Although the idea of EA is not new to the literature or in practice, it is examined herein from a diffusion of innovation perspective, which defines an innovation as a product or process that is new or perceived as new to a unit of adoption (Rogers, 2003). The importance of top management has been seen in studies featuring all types of IT implementations from enterprise systems (Liang et al., 2007) to web technologies (Chatterjee et al., 2002), and others (Preston and Karahanna, 2009; Thong et al., 1996). Closely related to top management support is the allocation of adequate funding. In fact, some have argued that adequate funding must become part of the normal budgeting process for an innovation to be implemented successfully in the long-term (Yin, 1981; Hazen et al., 2012). The same is true for EA, where the obligation of long-term funding signals commitment to the strategies encompassed by the EA.

Governance also plays a role in the strategic orientation of an innovation like EA (Yin et al., 1978; Tiwana and Konsynski, 2010). Governance is associated with practices in organizations that set decision rights and accountability for IT implementation and management (Weill and Ross, 2004; Xue et al., 2008). The establishment of a governance structure is often one of the earliest signs that an organization is serious about the ongoing implementation and success of an initiative. Implementing a complicated initiative such as an EA requires sound guidance and leadership for the best chance of success and it has been shown that IT governance is linked directly to IT value and firm performance (Weill and Ross, 2004).

A strategic resource has the potential to enable a firm to conceive of and implement strategies that improve efficiency and effectiveness (Barney, 1991) and can be assessed by its value, rarity, inimitability, non-substitutability, as well as durability, appropriability, and superiority (Barney, 1991; Nevo and Wade, 2010; Collis and Montgomery, 2008). Mata et al. (1995) note that managerial capabilities may possess most if not all of these qualities and thus have the potential to give a competitive advantage to an organization. An EA may encompass or help create these or even other managerial capabilities such as IT relatedness (Tanriverdi, 2005), IT-business partnership (Piccoli and Ives, 2005), and change management (Clark et al., 1997) that have been associated with providing competitive advantage in other studies. However, without proper recognition of the strategic nature of EA, the strategies embodied by the EA might not be given sufficient attention and such benefits might not be achieved during implementation. Therefore, EASO is itself a dynamic capability that embodies the recognition that EA is a strategic resource that can help create other important managerial capabilities for the firm. Thus, recognizing EA as a strategic asset is an important facet of EASO.

2.2. EA assimilation (EAA)

Implementation and use of EA can occur as a multi-stage maturity process (Ross, 2003; Ross and Beath, 2006). In less mature stages, EA lays the foundational planning for how an organization will integrate strategy, business processes, and IT. In more mature stages, the tenets of the EA are operationalized to such an extent that planned alignment is actually attained (Ross, 2003; Ross et al., 2006). To capture this degree of EA diffusion, we consider an EAA construct, which describes the extent to which the desired capabilities encompassed within the EA are actually operationalized throughout the firm. Organizations that operationalize IT—business process planning consistent with their EA to such a high degree that all aspects of their IT implementation and utilization enable integration, standardization and sophistication of business processes with IT applications have EAs that can be labeled as highly assimilated. Therefore, EAA is proposed as an operational capability because it describes the organizational routines that enable the execution of IT and business process alignment (Pavlou and El Sawy, 2011) for the purpose of achieving the business objectives described within the EA.

Consistent with the literature on assimilation, EA use is described along multiple dimensions, including diversity, breadth, and depth (e.g. Purvis et al., 2001; Liang et al., 2007; Fichman, 2001; Zhu and Kraemer, 2005). Diversity refers to the amount of differing IT and business processes and relationships that the EA affects. Breadth describes how widely the EA is used over the entire organization, that is, how many functional areas, intra-organizational, and even inter-organizational teams and groups make use of the EA. Depth is related to how many vertical levels the EA is communicated and utilized. These dimensions capture the degree of day-to-day use of technologies that support of business processes in accordance with EA. In other words, EAA is the organizational capability that links the integration and standardization of business processes with prescribed IT applications.

2.3. Firm agility

Competence-based theory emphasizes the importance of organizational resources and capabilities in creating value and competitive

advantage for firms (Freiling, 2004; Freiling et al., 2008). One such capability is firm agility, which is defined as an organization's ability to not only sense change, but also adapt, respond, and perform well in the face of rapidly changing environments (Sambamurthy et al., 2003; Weill et al., 2002). Firm agility is often cited as a critical competency that can enhance performance across many settings (Ismail et al., 2011; Blome et al., 2013; Sanchez and Nagi, 2001). For example, higher levels of firm agility have been associated with higher levels of supply chain performance (Tarafdar and Qrunfleh, 2017), green performance (Mirghafoori et al., 2017), and in several settings, overall firm performance (Chan et al., 2017; Verma et al., 2017).

3. Hypotheses development

3.1. EASO and firm agility

Rapid and timely responses to the demands of customers often require the ability to quickly change and redesign existing organizational processes that create, produce, and deliver products and services to these customers. The primary purpose of dynamic capabilities is to configure or reconfigure organizational resources, especially in turbulent environments. Eisenhardt and Martin (2000) note that dynamic capabilities are similar to "combinative capabilities" (Kogut and Zander, 1992) and "architecture competences" (Henderson and Cockburn, 1994) because they are concerned with the ability of firms to quickly achieve new resource configurations as new markets emerge or old markets are destroyed. A higher degree of EASO allows a firm to act on the tenets of alignment drawn out in its EA, thereby configuring resources to respond to change. As markets become highly turbulent, organizations find themselves more in need of this type of capability.

EA literature also describes the relationship between activities associated with EASO and firm agility, noting that these activities are highly influential and directly evoke agility (Carvalho and Sousa, 2014). To this end, Galunic and Eisenhardt (2001) find that dynamic capabilities in a large multi-business firm facilitate resource recombination and, thus, increase the agility of the firm. This finding is consistent with other studies linking dynamic capabilities to the ability to quickly change resources in an organization (e. g. Zahra et al., 2006; Zollo and Winter, 2002; Eisenhardt and Martin, 2000).

H1. *EASO will be positively associated with firm agility*.

3.2. EASO and EAA

EAA is categorized as an operational capability in that it is composed of organizational routines that focus on the execution of day to day activities (Pavlou and El Sawy, 2011). EAA is the operationalization of the diffusion of the EA architecture in the firm. An organization with a high degree of EASO would necessarily embrace a strategic, systematic view of EA, which includes operational and strategic capabilities. This unified view is likely to decrease the possibility of a fragmented effort in assimilating EA into the organization. This focused effort supported by components of EASO such as top management support of the EA, education of the stakeholders on the EA, and the development of sound governance structures should increase EA's assimilation throughout the organization (Bala and Venkatesh, 2007; Liang et al., 2007). These arguments are in line with the findings of Pavlou and El Sawy (2011), who state that dynamic capabilities like EASO are directly related to target operational capabilities like EAA. While dynamic capabilities are related to exploiting new opportunities, operational capabilities exploit existing resources to create efficiency competences in an organization.

H2. *EASO will be positively associated with EAA*.

3.3. EAA and firm agility

A firm's IT capability is composed of factors such as IT infrastructure capability (the technological foundation), IT business-spanning capability (business-IT strategic thinking and partnership), and IT proactive stance (opportunity orientation partnership) (Lu and Ramamurthy, 2011; Ross et al., 2006). Pavlou and El Sawy (2010) demonstrate that such IT capability in new product development (NPD) is positively related to organizational agility in the form of dynamic capabilities for NPD. Lu and Ramamurthy (2011) empirically examine the relationship between IT capability and two types of agility, market capitalizing agility and operational adjustment agility, and find that IT capability does have a direct effect on these two types of organizational agility. Similarly, a high degree of EAA is likely to lead to a high level of standardization and modularity of both the IT capability and business process capability in the organization (Ross et al., 2006; Sambamurthy et al., 2003). A high degree of EAA would mean that more personnel are using EA to drive IT and business alignment across functional and organizational boundaries. Under this scenario, more functions are collaborating and coordinating their IT and business processes together and organizations are increasingly partnering with outside customers, suppliers, and others. As the diversity, breadth, and depth of use of an EA are increased in an organization, standardized business modules that could be easily connected to create new business processes would emerge (Ross et al., 2006). Technologies facilitating the collaboration and cooperation among inter-functional and inter-organizational partners (again likely in organizations where EAA is high) has also been linked to firm agility (Sambamurthy et al., 2003; Vickery et al., 2010).

H3A. *EAA will be positively associated with firm agility*.

The next question is that since EASO is hypothesized to have a positive effect on EAA and EAA is hypothesized to have a positive effect on firm agility, what role does EAA play in the nomological network? The literature on diffusion of innovations theory has long held that assimilation of an element (e.g. artifact, technology, innovation, phenomena) creates a situation in which the extent of use of the element of interest is likely to have a greater effect on organizational-level outcomes than the presence of the element alone (Rogers, 2003; Hazen et al., 2012).

Literature suggests that *operational capabilities* (EAA in this case) are associated with the efficient exploitation of organizational resources, and thus can ultimately influence ensuing dynamic capabilities (such as agility) (Pavlou and El Sawy, 2011). *Dynamic capabilities* (EASO in this case), in contrast, can reconfigure operational capabilities (thus indirectly influencing ensuing dynamic capabilities), or even other dynamic capabilities (Pavlou and El Sawy, 2011; Eisenhardt and Martin, 2000). Hence, we argue that the introduction of EAA (an operational capability) as a predictor of firm agility (a dynamic capability) is likely to diminish the direct effect of EASO (a dynamic capability) on firm agility.

H3B. *EAA will mediate the relationship between EASO and firm agility*.

3.4. Firm agility and firm performance

IT may be able to enhance capabilities, but IT alone cannot directly evoke competitive advantage in the marketplace (Carr, 2003). Instead, IT must be used to complement existing processes to improve capabilities, such as collaboration or agility (Fawcett et al., 2011). Therefore, we propose that gains in financial performance that may be garnered via EA are a function of the enhanced capabilities, such as firm agility, which are induced by EASO and EAA. Indeed, agility has previously been linked to improved firm performance via firms' ability to sense and respond quickly and appropriately to changes in their internal and external environment (Vickery et al., 2010; Tallon and Pinsonneault, 2011).

H4. *Firm agility will be positively associated with financial performance*.

In summary, our conceptual model (Fig. 1) proposes EAA as an operational capability through which EASO (a dynamic capability) elicits higher levels of agility and, then, firm performance.

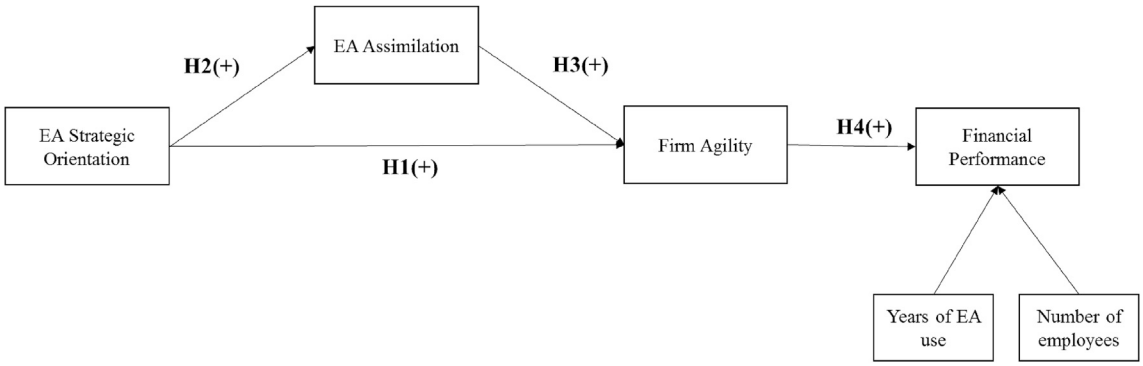


Fig. 1. Conceptual model.

4. Method

Because of the latent nature of the constructs under consideration, we chose a survey method for data collection (Fawcett et al., 2014). We used a survey to collect data with respect to each of the constructs considered in this study, which were then used as the basis for our variance-based structural equations modeling (SEM) approach to data analysis, which will be described in further detail in the Analysis and Results section. In this current section, we now describe our measures and data collection procedures.

4.1. Measures

All items used in this study can be found in Appendix A. The items used to measure firm agility are based on those used by Vickery et al. (2010), with modifications based on items employed by Tallon and Pinsonneault (2011). Items used to measure financial performance were based on a measure employed by Inman et al. (2011), which was derived from Claycomb et al. (1999). The above-mentioned measures were adapted to fit the context of this study. Although we introduce EASO as a second-order construct, the items used to measure each first-order construct are based on existing measures and conceptual definitions found in the extant innovation routinization and acceptance literature (Yin, 1981; Zmud and Eugene Apple, 1992; Venkatesh et al., 2003). Similarly, we used existing measures and conceptual definitions (Massetti and Zmud, 1996; Liang et al., 2007) as the basis to create our measures of each dimension of assimilation. Consistent with Liang et al. (2007), assimilation was treated as a second-order construct consisting of diversity, breadth, and depth. Finally, we controlled for firm size in terms of number of employees, and time since adoption of EA (Rogers, 2003).

4.2. Sample frame and data collection

We collected data for our study via an online questionnaire. Prior to data collection, we developed the survey instrument using the measures shown in the Appendix. We completed two pretests on the instrument. In the first pretest, we discussed the measures and the instrument with based on four academicians who have published work on EA and IT assimilation. Their feedback helped us to clarify and contextualize the instrument further. In the second pretest, we solicited 30 industry participants who have experience managing EA and its related processes. The data collected in this pretest was used to examine the performance of the instrument. We found no cause for concern, and did not make any subsequent edits to the instrument.

Our sample frame consists of management executives and senior IT managers who are intimately familiar with EA, work within an organization that uses EA, are able to assess how well EA is assimilated into their organization, and have insight into organization's capabilities and performance, as compared with its rivals. We were reached our sample frame via use of Qualtrics Panels, which is a survey distribution firm. Although their specific recruitment methods are proprietary, Qualtrics solicits panel participants from a variety of registries based upon researchers' needs. We included filter mechanisms throughout the instrument to ensure that respondents were knowledgeable regarding both EA and the organization. Data were collected over a two-week period during the winter of 2012. Of the 1006 participants initially solicited, the number of usable responses was 190, representing an 18.9% response rate (see Table 1 for participant demographics).

We analyzed response bias using wave analysis (Rogelberg and Stanton, 2007; Armstrong and Overton, 1977) in which we compared data from late responders (those who responded in the second week of data collection) to those of early responders (those who responded in the first week of data collection). Comparison of the survey items via t-tests indicated no significant differences in responses. We assessed whether common method bias existed by using the single-common-method-factor approach (Podsakoff et al., 2003), in which a latent common methods variance factor was added in the confirmatory factor analysis (CFA) model and all manifest variables were allowed to load onto it. The square of the common methods variance factor of each path (i.e., common variance estimated) was 0.30 (i.e., 30%) below the threshold of 50%, indicating that a common methods variance factor does not account for

Table 1
Participant demographics.

Demographic	Count	Percent
Gender		
Male	145	76.3%
Female	45	23.7%
Age		
26–35	59	31.1%
36–45	61	32.1%
46–55	44	23.2%
56–65	21	11.1%
66+	2	1.1%
Years of experience with EA		
<5	50	26.3%
5–10	86	45.3%
11–20	40	21.1%
21–30	9	4.7%
31+	4	2.1%
Affiliation with target organization		
Senior IT management position in organization	146	76.8%
Executive management position in organization	33	17.3%
Other	11	5.8%
Years of experience with target organization		
<5	55	28.9%
5–10	84	44.2%
11–20	34	17.9%
21–30	12	6.3%
31+	4	2.1%

Note: N = 190; not all participants provided all demographics; not all counts sum to 190; not all percentages add to 100% because of rounding.

the majority of the variance of constructs. These findings together suggest that common method bias is not a significant threat to this study (Williams et al., 2003). Further, we assessed sample representativeness by comparing individual- and organizational-level demographics to industry statistics via Chi-square tests for homogeneity. Comparisons of examined demographics were found to be significant at the 0.10 level, indicating homogeneity (see Table 2).

5. Analysis and results

We analyzed the research model using SmartPLS 2.0 M3 (Ringle et al., 2005) software, which is a path modeling tool that is well-suited for complex and predictive path models (Hennig-Thurau et al., 2007; Vance et al., 2008). We employed chose to use PLS in lieu of covariance-based SEM because of noted advantages for use in exploratory research (Gefen et al., 2011).

5.1. Measurement validation

We began our analysis by assessing convergent and discriminant validity of all first-order reflective constructs via CFA and then evaluated the overall CFA model, which includes 2 s-order constructs, firm agility, and financial performance. AMOS 20.0 was used to obtain maximum likelihood estimates of our measurement model. We first examined the loadings of items on their respective latent variable. The CFA results in Table 3 suggest acceptable fit (Kline, 2011; Hazen et al., 2015). As shown in Table 3, the composite reliability scores for all scales exceed 0.70 and the average variance extracted (AVE) for each construct exceeds 0.50 (Henseler et al., 2009).

Discriminant validity of all first-order reflective constructs was assessed via AVE, maximum shared variance (MSV), and average shared variance (ASV) (Hair et al., 2010). Based on the AVE, evidence of discriminant validity occurs when the square root of the AVE is greater than the correlations between first-order constructs (see Appendix B). As shown in Appendix B, the square root of the AVE for each reflective construct is greater than its respective inter-construct correlations. Further, the AVE for each reflective construct is greater than its respective MSV and ASV. These results lend support to the discriminant validity of all the first-order reflective constructs.

Table 4 shows the results of validity evaluation of all the constructs (i.e., EASO, EAA, firm agility, and firm performance) used in the research model and the fit of the overall CFA model ($\chi^2 = 657.493$, $df = 337$, $\chi^2/df = 1.951$ $p < 0.0001$, CFI = 0.938, RMSEA = 0.071). The fit indices provide evidence to the goodness of the overall CFA model. For the convergent validity of second-order constructs, their construct reliability scores and AVEs are above 0.7 and exceed 0.5, respectively. The AVEs of EASO and EAA are greater than their corresponding MSV and ASV, indicating the discriminant validity. These results together lend support to the validity of all the second- and first-order constructs used in this research.

Table 2
Organizational demographics.

Demographic	Count	Percent
Employees		
<100	19	10.0%
101-1000	72	37.9%
1001–10,000	74	38.9%
10,001–100,000	22	11.6%
>100,000	3	1.6%
Gross profit		
< $100,000	6	3.2%
$100,000 - $1 Million	23	12.1%
$1–10 Million	33	17.4%
$10 Million - $100 Million	40	21.1%
> $100 Million	54	28.4%
Unknown/unsure	34	17.9%
Annual sales		
< $100,000	9	4.7%
$100,000 - $1 Million	22	11.6%
$1–10 Million	30	15.8%
$10 Million - $100 Million	34	17.9%
$100 Million - $1 Billion	44	23.2%
> $1 Billion	32	16.8%
Unknown/unsure	19	10.0%
Years since adopted EA		
<5	55	28.9%
5–10	101	53.2%
11–20	24	12.6%
21–30	8	4.2%
31+	2	1.1%

Note: N = 190; not all participants provided all demographics; not all counts sum to 190; not all percentages add to 100% because of rounding.

5.2. Results of hypothesis testing: structural model

We conducted PLS-SEM analysis to investigate the relationships among EASO, EAA, firm agility, and firm performance as detailed in H1–H4. All models in Fig. 2 show the results of SEM analysis with standardized parameter estimates. The first two hypotheses addressed the effect of EASO on firm agility and EAA. Our analysis revealed that EASO is positively associated with firm agility ($\beta = 0.80$, $p < 0.001$) and EAA ($\beta = 0.89$, $p < 0.001$), providing evidence for H1 and H2 (see Model A in Fig. 2). In H3A, we posited that EAA would be positively related to firm agility. The results showed support for the positive association between EAA and firm agility ($\beta = 0.70$, $p < 0.001$; see Model B in Fig. 2); hence, H3A is supported. Testing for H4 demonstrated support for a positive relationship between firm agility and financial performance ($\beta = 0.28$, $p < 0.001$; see Model C in Fig. 2).

5.3. Examination of the mediating role of EAA

To further explore the mediating role of EAA in the relationship between EASO and firm agility, we followed steps recommended in prior studies in establishing mediation (Baron and Kenny, 1986; Kenny et al., 1998). First, we established that there is a path that may be mediated by showing that the initial independent variable, EASO, has a significant effect on the dependent variable, firm agility ($\beta = 0.80$, $p < 0.001$; see Model A in Fig. 2). Second, we established that EASO has a significant effect on the proposed mediator, EAA, ($\beta = 0.89$, $p < 0.001$; see Model A in Fig. 2). Third, we established that EAA has a significant effect on firm agility ($\beta = 0.70$, $p < 0.001$; see Model B in Fig. 2), while controlling for EASO ($\beta = 0.15$, $p = 0.20$; see Model B in Fig. 2). Based on Kenny et al. (1998), when these steps are met we can conclude that EAA mediates the effect of EASO on firm agility (total effect = 0.972; direct effect = 0.198; indirect effect = 0.774). Our findings indicate that the association between EASO and firm agility is fully mediated by EAA; hence, H3B is supported.

To validate these findings, we employed product of coefficients strategy, which is shown to be more robust than the casual step approach because the number of inferential tests is minimized, thus reducing the likelihood of a Type 1 error (Preacher and Hayes, 2004, 2008). The product of coefficient approach does not rely on the assumption of a normal sampling distribution, which scholars suspect does not hold when mediation is present (Preacher and Hayes, 2004, 2008). As such, prior studies (Anagnostopoulos et al., 2010; Preacher and Hayes, 2004, 2008) recommend and use bootstrapping, a nonparametric resampling procedure, to test the significance of the indirect effect. In accord with the aforementioned studies, we conducted our mediation analysis with the latent variable scores obtained from our PLS analysis as input for the SPSS macros provided by Preacher and Hayes (2004, 2008). We used summated scores derived from the average of the items for each construct. These scores were used as the basis to apply the indirect test via the SAS macro provided by Preacher and Hayes (2004), which is argued to be more reliable than the Sobel test (Zhao et al., 2010). The

Table 3
CFA for first-order reflective constructs.

Constructs	Items	Standardized loadings	Estimated loadings	Standard error	*p*-value	Reliability and convergent validity
Agility	Agility1	0.934	1.423	0.084	16.951	CR = 0.952;
	Agility2	0.909	1.325	0.082	16.156	AVE = 0.799
	Agility3	0.876	1.404	0.092	15.193	
	Agility4	0.860	1.269	0.086	14.745	
	Agility5	0.888	1.32	0.085	15.535	
EAStr	EAStr1	0.915	1.372	0.085	16.176	CR = 0.897;
	EAStr2	0.924	1.362	0.083	16.448	AVE = 0.745
	EAStr3	0.738	1.133	0.097	11.633	
EAFund	EAFund1	0.897	1.338	0.087	15.404	CR = 0.897;
	EAFund2	0.887	1.382	0.091	15.129	AVE = 0.743
	EAFund4	0.799	1.335	0.103	12.900	
EAGov	EAGov1	0.865	1.334	0.092	14.495	CR = 0.885;
	EAGov3	0.909	1.348	0.086	15.669	AVE = 0.720
	EAGov4	0.766	1.182	0.098	12.099	
EATMS	EATMS2	0.750	0.929	0.081	11.520	CR = 0.818;
	EATMS3	0.908	1.290	0.087	14.823	AVE = 0.693
AssmBr	AssmBr1	0.849	1.359	0.095	14.334	CR = 0.916;
	AssmBr2	0.941	1.488	0.087	17.006	AVE = 0.785
	AssmBr3	0.865	1.298	0.088	14.774	
AssmDep	AssmDep1	0.930	1.532	0.094	16.209	CR = 0.874;
	AssmDep2	0.830	1.505	0.11	13.658	AVE = 0.777
AssmDiv	AssmDiv2	0.784	1.463	0.119	12.341	CR = 0.846;
	AssmDiv3	0.925	1.565	0.101	15.553	AVE = 0.735
FinPerf	FinPerf1	0.858	1.132	0.077	14.661	CR = 0.951;
	FinPerf2	0.874	1.165	0.077	15.089	AVE = 0.796
	FinPerf3	0.925	1.141	0.069	16.635	
	FinPerf4	0.914	1.186	0.073	16.298	
	FinPerf5	0.889	1.107	0.071	15.545	
CFI Model Fit Index		$\chi 2 = 605.489$, $df = 314$, $\chi 2/df = 1.928$ $p < 0.0001$ GFI = 0.823, CFI = 0.943, NFI = 0.890, TLI = 0.932, RMR = 0.091, RMSEA = 0.070				

Notes. CR = composite reliability; AVE = average variance extracted; *df* = degrees of freedom; GFI = goodness of fit index; CFI = comparative fit index; NFI = normed fit index; TLI = Tucker–Lewis index; RMR = standardized root mean square residual; RMSEA = root mean square error of approximation.
Key: Agility = Firm Agility; EAStr = EA Viewed as Strategic Asset; EAFund = EA Funding; EAGov = EA Governance; EATMS = Top Management Support of EA; AssmBr = Breadth of EA Use; AssmDep = Depth of EA Use; AssmDiv = Diversity of EA Use; FinPerf = Financial Performance.

Table 4
Validity evaluation of all constructs used in the model.

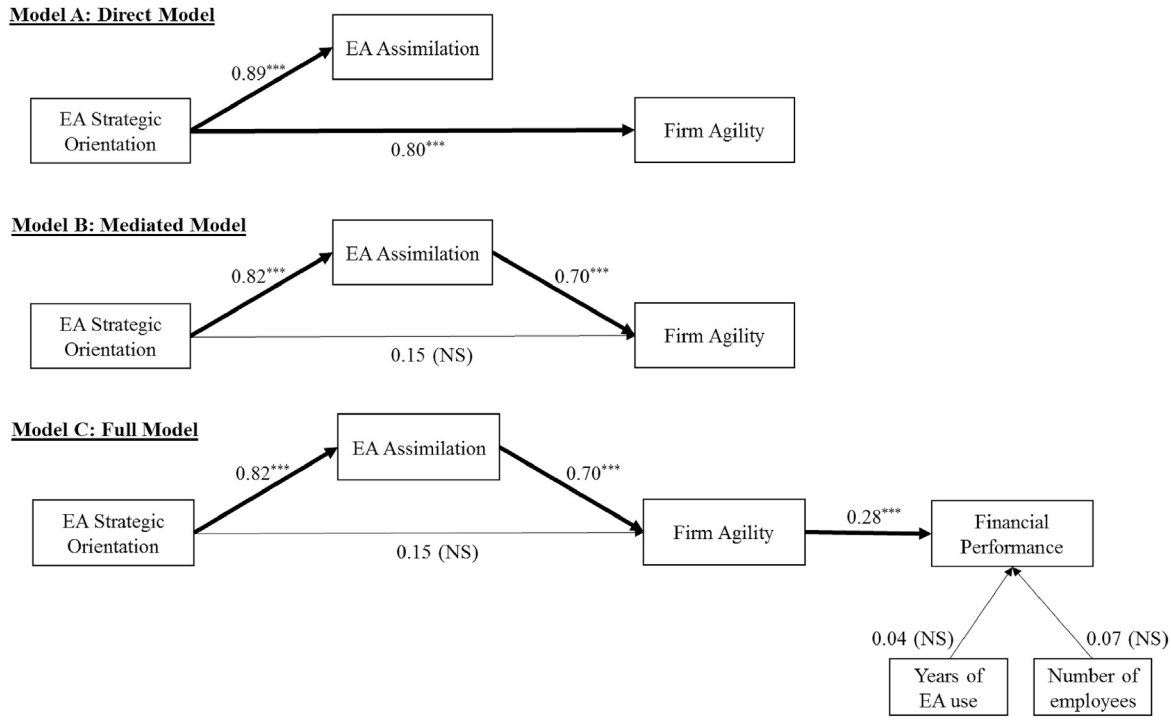
Construct	CR	AVE	MSV	ASV	EASO	Agility	FinPerf	Assm
EASO[1]	0.906	0.708	0.704	0.466	**0.841**			
Agility	0.952	0.799	0.714	0.452	0.751	**0.894**		
FinPerf	0.951	0.796	0.129	0.104	0.359	0.281	**0.892**	
Assm[2]	0.921	0.796	0.714	0.508	0.839	0.845	0.325	**0.892**
Model fit	$\chi^2 = 657.493$, $df = 337$, $\chi^2/df = 1.951$ $p < 0.0001$, GFI = 0.809, CFI = 0.938, NFI = 0.881, TLI = 0.930, RMR = 0.115, RMSEA = 0.071							

Notes. CR = Composite Reliability; AVE = average variance extracted; MSV = maximum shared variance; ASV = average shared variance; bold diagonal elements represent the square root of the AVE for each reflective construct.
EASO[1] is a second-order reflective construct that includes EA viewed as strategic asset, EA funding, EA governance and top management support of EA.
Assm (i.e., EA Assimilation)[2] is a second-order reflective construct that includes breadth, depth, and diversity of EA use.

results of this test further confirmed the full mediation hypothesis, as reported above.

6. Discussion

As firms focus on operationalizing and initializing EA activities, it behooves them not to lose sight of the intermediate value that can be derived from EA, such as increases in agility. Literature on EA typically suggests a link to enhanced levels of flexibility, agility, and adaptability (Lankhorst, 2009; Choi et al., 2008; Chae et al., 2007). However, very few studies have actually empirically tested how such outcomes might be achieved (Tamm et al., 2011). The current research contributes by suggesting relevant EA-based capabilities as mechanisms for achieving these outcomes, and providing evidence that they actually do so. Furthermore, outcomes that have been demonstrated in the literature are often granular in nature, and focus on enhanced performance of information systems (e.g. Schmidt and Buxmann, 2011), but not necessarily organization-wide outcomes (Espinosa et al., 2011). Our study is one of few to offer empirical evidence linking EA to organizational-level outcomes. In this remainder of this section, we describe how the



Notes. $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$; NS = Non-significant at $p = .05$.

Fig. 2. Results. *Notes.* $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; NS = Non-significant at $p = 0.05$.

outcomes of this research can inform theory and practice.

6.1. Implications for theory

The findings suggest that organizations that are able to adequately capture the intermediate effects of EA activities are more likely to realize the ensuing, and often allusive, benefit of increasing firm performance. This complements extant research and theory by demonstrating the role of EA-based capabilities in evoking benefits (Foorthuis et al., 2015), and extends the bounds of the extant literature by showing a broader range of outcomes than are typically considered. These results could perhaps explain why organizations often cite mixed outcomes with respect to their EA initiatives, and why scholars have called for more in-depth studies of how organizational benefits can be realized (Espinosa et al., 2010). The competence-based approach to examining EA in terms of ensuing capabilities allowed us to investigate how benefits are realized to a greater extent, and contributes to the discussion on why some firms might get more value from their EA initiatives while others do not. By further examining these (or similar) EA-based capabilities through the lens of the theory-based model proposed herein, additional research can expand the discussion started in this article to test how additional dynamic and operational capabilities like flexibility, absorptive capacity, process flow-times, time to market, and others can be realized.

The findings also contribute to competence-based theory by suggesting EASO and EAA as firm-specific and durable capabilities that can lead to a distinct competitive advantage. Managerial IT-based capabilities develop over a long period of time and are distinct to the firm (Mata et al., 1995). These are valuable skills that are likely to come about from IT and operations managers working together while making many large and small decisions regarding the integration of IT and business processes. Valuable side-effects like trust, friendship, and interpersonal relationships often require years of working together (Mata et al., 1995). The skills and the interpersonal relationships are causally ambiguous and socially complex and are not easily identifiable by outside organizations (Mata et al., 1995). Therefore, the findings suggest that any advantage gained from EASO and EAA can persist over an extended period of time. Additional research using competence-based theory to examine how capabilities like EASO and EAA can sustain benefits and competitive advantage can help to confirm and extend this unique theoretical contribution.

By examining EA's enhancement of both digital and non-digital capabilities, our research contributes to the discourse regarding mechanisms through which IT investments can fundamentally change business-level strategic alternatives and value creation opportunities (Moller et al., 2008; Rico, 2006). Drnevich and Croson (2013) report that most of the past research on firm competencies has focused on functional-level activities. They further comment on the flaw of doing research where functional-level activities are expected to statistically impact a firm's business level performance and declare that such a view indicates a considerable theoretical disconnect. Drnevich and Croson (2013) conclude that although IT investments are integral to operations at the functional-level of the firm, they also play an important and largely under-theorized role in creating and operationalizing organizational-level strategies for facilitating improved firm performance through enhancing non-digital capabilities and enabling digital capabilities to create and capture value. The current research establishes that a strategic orientation with respect to EA goes beyond offering functional-level improvements and can quite possibly result in improved firm-level performance by way of increased agility.

Research has shown that EAs across organizations contain core business processes, shared data driving processes, key IT, and the key customers (Ross et al., 2006). Therefore, by examining the relationship between EA and firm performance through EA's enhancement of non-digital and digital capabilities, our study answers the call by Drnevich and Croson to investigate IT investments that can fundamentally change business-level strategic alternatives and value creation opportunities. For instance, a high-level (in terms of EASO and EAA in this study) EA in a firm with a performance advantage is in line with the qualities of

competence-based theories. A high-level EA has certainly been shown to be a *valuable* asset to an organization (Ross et al., 2006). A high-level EA has been linked to such organizational benefits as reduced IT costs, increased IT responsiveness, reducing IT risk and making the IT environment more manageable, increased management satisfaction, and enhanced strategic business outcomes (Ross et al., 2006). In this study, we show that a high-level EA can be linked to firm performance.

6.2. Implications for practice

This research contributes to practice by taking a broader view of the influence of EA, examining how EA-based capabilities, such as assimilation of EA across an organization, is associated with outcomes outside of the IT function. This research also suggests that a technology-centric focus on EA activities, without consideration of the capabilities that can emanate from them, can cause an organization to overlook or misapply EA-based capabilities. EA-derived outcomes that have been demonstrated in the literature are often granular in nature, and focus on enhanced performance of information systems (e.g. Schmidt and Buxmann, 2011), but not necessarily operations-based or organization-wide outcomes (Espinosa et al., 2011). This research shows how EA can add value beyond the firm's IT department and is the first to offer empirical evidence linking EA-based capabilities to agility and, ultimately, firm performance. This non-IT-centric view of EA-related benefits extends the discussion of EA into the operations management domain.

By using a competency-based approach to examine dynamic and operational capabilities, this research shows how EA initiatives can be of value to operations managers, who are often leery of new firm-level IT initiatives, and don't feel like their interests and operational concerns are adequately considered. The purpose of EA is to be a mechanism for standardizing and integrating business processes to achieve enterprise-level goals (Boh and Yellin, 2011). Therefore, operations managers, enterprise architects, IT personnel, and executive management need to collaborate to ensure that EA initiatives benefit all aspects of the business. The findings in this research suggest that operations managers can benefit from EA initiatives when their firms have the appropriate strategic posture and assimilate the tenets of the firm's EA. Thus, operations managers can use these findings as a basis to support further involvement with EA initiatives that will build capabilities and ultimately support firm-level performance.

6.3. Limitations

Although our study links EA-based capabilities with organizational-level outcomes, the overall scope of this research could be expanded. For instance, there are additional capabilities suggested in the literature that may be equally salient as firm agility to investigate, such as inter- and intra-organizational collaboration, stability, and decision-making (Tamm et al., 2011). Future research may wish to examine our research model, exchanging or supplementing firm agility with these other proposed capabilities to test whether or not EA-based capabilities can enhance these capabilities, and whether or not they can also lead to increased firm performance.

Similarly, EAA was considered as the only mediator of the relationship between EASO and firm agility in this study. There may be other factors that mediate or moderate this relationship. For instance, it has been suggested that complementary resources may heighten levels of performance derived from the adoption of information resources (Nevo and Wade, 2010; Hazen and Byrd, 2012). Thus, we recommend that future research examine resources that may compliment EASO, such as collaborative culture and absorptive capacity, among others. We propose that complimentary resources may heighten the degree to which EASO enhances performance. Finally, although studies have confirmed the validity of subjective measures of firm performance (Wall et al., 2004), future research should consider the employment of objective measures to further test the relationships examined herein. Regardless of these limitations, this research contributes to the discussion of IT's role in supporting operations management capabilities and expands the line of research on the impact and value of integrative strategic IT initiatives on operationally-relevant capabilities and firm performance.

Appendix A. Measures

Participants were asked to rate their level of agreement with each of the following items using a 7-point, Likert-type scale ranging from “Strongly Disagree” to “Strongly Agree.”

EA Strategic Orientation (Measures based on Yin, 1981)
- *EA Viewed as Strategic Asset*
  - EA is driven by our organization's strategy
  - EA is positioned as a strategic asset in the organization
  - In my opinion, the strategic plan for our organization is encompassed by the EA
- *EA Funding*
  - EA and its facilitating systems are completely supported by routine funding
  - Funds to support EA initiatives are readily available in the organization
  - Requests for additional funding are not required to support EA
- *EA Governance*
  - The organization's governing regulations address use of EA
  - Applicable organizational policies direct use of EA
  - Referring to EA when making decisions regarding IT is mandatory in the organization
- *Top Management Support of EA* (Based on a measure employed by Venkatesh et al., 2003)
  - Influential people in this organization believe that EA should be used (dropped)
  - Those who I believe to be important believe that EA should be used
  - The senior management of the organization has been helpful regarding use of EA

Assimilation of EA (Based on definitions and measures employed by Liang et al., 2007; Massetti and Zmud, 1996)
- *Diversity of Use*
  - All functional areas of the organization are integrated within EA (dropped)
  - EA is considered when modifying any business process within the organization
  - EA guides usage of all of the information technologies used in the organization
- *Breadth of Use*

EA is used to guide collaboration with outside organizations
EA is used to foster inter-organizational relationships
EA ties together different organizational units

Depth of Use

Employees at all levels consult EA for appropriate guidance
Everyone in the organization knows about EA
The lowest organizational levels (e.g. operational) refer to EA (dropped)

Participants were asked to compare their organization's performance relative to the organization's closest competitors using a 7-point, Likert-type scale ranging from "Far Worse" to "Far Better."

Financial Performance (Based on a measure employed by Inman et al., 2011)

Average return on investment over the past 3 years
Average profit over the past 3 years
Profit growth over the past 3 years
Average return on sales over the past 3 years
Average operating ratio over the past 3 years

Firm Agility (Based on measures employed by Vickery et al., 2010; Tallon and Pinsonneault, 2011)

Amount of time required to introduce new products or services
Production lead-time
Speed of delivery for products or services
Flexibility to modify existing products or services
Responsiveness to customers

Appendix B. Validity evaluation of first-order reflective constructs

	CR	AVE	MSV	ASV	1	2	3	4	5	6	7	8	9
1. Agility	0.952	0.799	0.627	0.436	**0.894**								
2. EAStr	0.897	0.745	0.686	0.470	0.670	**0.863**							
3.EAFund	0.897	0.743	0.579	0.387	0.600	0.761	**0.862**						
4. EAGov	0.885	0.720	0.518	0.394	0.660	0.720	0.659	**0.849**					
5. EATMS	0.818	0.693	0.686	0.373	0.653	0.828	0.622	0.642	**0.833**				
6. AssmBr	0.916	0.785	0.694	0.476	0.792	0.708	0.620	0.711	0.630	**0.886**			
7. AssmDep	0.874	0.777	0.694	0.462	0.734	0.735	0.668	0.660	0.550	0.833	**0.881**		
8. AssmDiv	0.846	0.735	0.648	0.407	0.754	0.626	0.610	0.603	0.500	0.775	0.805	**0.857**	
9. FinPerf	0.951	0.796	0.133	0.091	0.281	0.312	0.365	0.207	0.354	0.311	0.305	0.247	**0.892**

Notes. CR = Composite Reliability; AVE = average variance extracted; MSV = maximum shared variance; ASV = average shared variance; bold diagonal elements represent the square root of the AVE for each reflective construct.

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