Enterprise Architecture Resources, Dynamic Capabilities, and their pathways to Operational Value

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Abstract

The strategic role of Enterprise Architecture (EA) in deploying and managing information technology (IT) and business resources has a longstanding research tradition. In this particular domain falls the research on EA-based capabilities and their contribution to organizational benefits. This study conceptualizes and defines EA-based capabilities, following the dynamic capabilities view (DCV), and proposes a research model that tries to explain how dynamic enterprise architecture capabilities enable operational capabilities within firms. Data is collected from 299 CIO's and IT managers to test hypotheses associated with the research model. The findings show that dynamic enterprise architecture capabilities enhance operational capabilities and the firms' EA resources are essential in the process of cultivating dynamic enterprise architecture capabilities. The current study advances our understanding of how to efficaciously delineate dynamic enterprise architecture capabilities in enabling the firms' operational capabilities and living in the present, as a foundation to enhance competitive firm performance.

Keywords: Enterprise architecture (EA), EA resources, dynamic capabilities, dynamic enterprise architecture capabilities, operational capabilities, competitive firm performance

Introduction

In the current dynamic and unpredictable markets, competitive advantage can no longer be achieved through high product quality or efficient processes alone. Many firms face intense pressure to transform their current business model and operations toward more sustainable, and innovation-driven and competitive organizations (Eisenhardt and Martin 2000; Seidel et al. 2013). Modern firms should align and integrate their information systems (IS), information technology (IT) assets, and resources with business processes to efficaciously respond to changing environmental and market conditions (Aral and Weill 2007; Hitt and Brynjolfsson 1996). Firms, therefore, embrace Enterprise Architecture (EA) as a strategic asset to achieve this and to obtain an advantage over competitors (Gong and Janssen 2019; Hazen et al. 2017). Many scholars regard EA to be a blueprint of the organization that describes both the current and desirable future states of firms' IS/IT infrastructure, data, systems, and critical business processes and provides a roadmap to achieve this (Ross et al. 2006; Shanks et al. 2018). Recently, the literature in the EA domain, particularly emphasizes on strong theoretical foundations and empirically unfolding the mechanisms behind EA value creation (Gong and Janssen 2019; Lange et al. 2016). This particular evolvement in the literature is legitimate. Many contributions to the current literature on EA and EA-based capabilities—that orchestrate and employ the firm's resources using EA while simultaneously trying to align strategic goals, objectives with the usage of IS/IT—are conceptual and therefore lack strong empirical foundation (Foorthuis et al. 2016; Hazen et al. 2017; Korhonen and Molnar 2014).

As can be gleaned from the introductory remarks and literature synthesis, our current knowledge on how EA can be leveraged to create value for firms remains quite limited, and substantial gaps remain in the literature. This paper, therefore, addresses two crucial unanswered questions. First, this study tries to unfold the question of how EA resources—that focus on the development and deployment of EA artifacts—enable EA-based capabilities, conceptualized as dynamic capabilities. Addressing this question is important, as these capabilities are considered cornerstones of EA deployment that drive decision-making processes, IT and business capabilities (Brosius et al. 2018; Hazen et al. 2017; Shanks et al. 2018). By grounding the research within the dynamic capabilities view (DCV), the current work employs a strong academic foundation that is accompanied with a wide range of empirically validated constructs and items (Hazen et al. 2017; Shanks et al. 2018; Van de Wetering 2019). The second question is related to the value-creating path using EA resources and EA-based capabilities in the process of enhancing operational capabilities and firms' competitive performance in the economic environment. Unfolding the pathways to operational value using empirical data is very relevant for both scholars and practitioners as the importance, and the impact of EA can be demonstrated, and EA investments can be justified (Schryen 2013). This study's objective is, therefore, to answer and respond to these particular questions and the persisting gaps in the literature.

This work is structured as follows. The first section outlines the theoretical development, demonstrates the the research model of this study. Also, it develops the hypotheses that are associated with the model. This study, then, continues with the methods and data, drawn from 299 CIOs, IT managers, and lead architects. After presenting the main results, this study continues with a post-hoc analysis to unfold the contribution of EA on competitive firm performance. After a discussion that includes both practical and theoretical implications, this study ends with some concluding remarks.

Theoretical development

This study's research model is shown in Figure 1. Based on the logic from the resource-based view of the firm (RBV) and DCV, the current study claims that firms' EA resources are positively associated with dynamic enterprise architecture capabilities. These particular capabilities, in turn, have a positive association with capabilities on the operational level (Aral and Weill 2007; Pang et al. 2014).

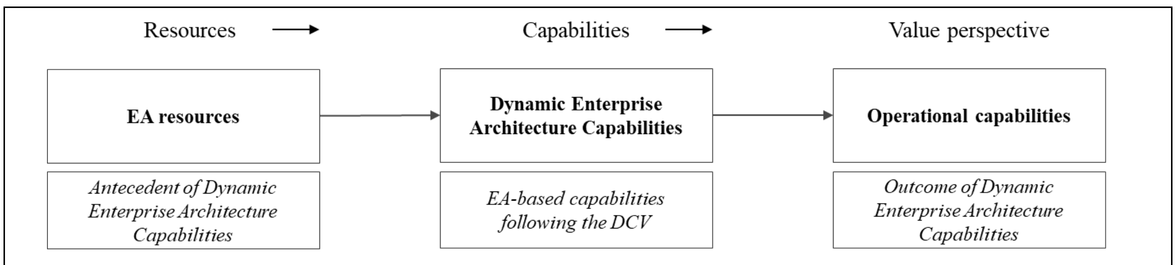

Figure 1. The research model

Resources-based theories

Much of the current IT-business value scholarship base their conceptualizations and arguments on the RBV (Barney 1991; Wade and Hulland 2004). The RBV is considered by many to be an influential theory in the IS that explains how firms can realize and maintain a competitive edge by the use of the firms' IT and business resources (Barney 1991; Bharadwaj 2000). This particular theory seems to be a fitting 'lens' when investigating firms that try to leverage EA resources, and capabilities to enhance operational capabilities, innovation, and competitive performance. The extant IS, and management literature make a clear distinction between the process of deploying resources and capability-building. These are the two core elements of the RBV (Makadok 2001; Wade and Hulland 2004). Amit and Schoemaker (1993) define a firm's resources as stocks of assets owned or controlled by the firms. Capabilities, on the contrary, are considered as firm-specific capacity to deploy these particular resources, typically together with other organizational capabilities to achieve specific goals (Amit and Schoemaker 1993; Bharadwaj 2000). Syntheses from IS and management studies that use the RBV shows that firms that use particular resources that can be considered valuable, rare, inimitable and also non-substitutable (VRIN) ought to perform better in terms of competitive advantage. So, drawing from the RBV logic, this study argues that the specific deployment of a firms' EA resources and capabilities will result in operational and strategic benefits of the firm (Pavlou and El Sawy 2006; Someh et al. 2016; Wade and Hulland 2004). Hence, firms that do not actively invest in their (VRIN) EA resource portfolio may cause the deprivation of resources and the capabilities that build on these resources (Van de Wetering et al. 2018). These insights are crucial for firms that want to excel with their EA practice so that they can invest conscientiously. In that regard, the RBV acknowledges that the single investment in EA is not a sufficient condition for operational efficiencies and enhancing the firm's competitive nature. It can be deduced that it is thus more pertinent to identify the organizational capabilities that EA should be targeted in enabling or strengthening (Kim et al. 2011; Kohli and Grover 2008). It seems that the literature requires a new theoretical perspective from which pathways to operational benefits can be systematically examined. This study, therefore, continues with key literature on EA resources and EA-based capabilities, using the DCV as its theoretical 'lens.'

The notion of EA resources and dynamic enterprise architecture capabilities

In recent years, the literature shows a wide variety of empirical work involving surveys, case research, and expert perspectives, demonstrating the reach and range of the use of EA in organization's strategy implementation processes (Ahlemann et al. 2012; Gong and Janssen 2019). As such, the literature has put greater emphasis on deploying EA resources and assets so that they can be leveraged for business transformation (Shanks et al. 2018; Someh et al. 2016). EA resources primarily aim at developing and deploying EA artifacts. These particular artifacts can be considered unique documents that collectively describe various aspects of the entire EA within the organization (Kotusev 2019; Winter and Fischer 2006). This study follows (Aral and Weill 2007; Frampton et al. 2015; Someh et al. 2016) and conceives EA resources as the EA deployment practices (or routines) and knowledge competencies (or skills) that jointly enable firms' capacity to gain benefits from the use of EA (Aral and Weill 2007; Milgrom and Roberts 1990). Hence, this firm's EA resources are an essential antecedent of EA-based capabilities, i.e., capabilities that are enabled by the use of EA, so that they can actively share assets, and reconfigure and renew organizational resources (Someh et al. 2016). In the context of strategic management and IS literature, recently, some researchers claim that these particular capabilities add value to the firm throughout a wide range of IT/business processes, organizational routines that ultimately drive business benefits (Gong and Janssen 2019; Hazen et al. 2017; Shanks et al. 2018). For instance, through a recent survey among CIOs, it was demonstrated that firms that are capable of leveraging EA services through EA-based capabilities outperform their competitors in terms of project- en and organizational benefits (Shanks et al. 2018). In a similar vein, Hazen, Bradley, Bell, In, and Byrd (2017) found evidence for the hypothesized relationship between EA-based capabilities and the firm's level of agility. These particular results seem to be consistent with foundational work done by Foorthuis et al. (2016). Hence, in their empirical study among architects, they unfolded the staged contributions of EA that lead to the achievement of the firm's strategic goals and objectives. Synthesis from the extant literature, therefore, shows that the particular use of EA-based capabilities in practice allows the firm to exploit their EA (Frampton et al. 2015; Tamm et al. 2011), to gain operational efficiencies and IT benefits (Schmidt and Buxmann 2011). Moreover, EA-based capabilities can enhance the level of fit between IT and business synchronization, i.e., alignment (Hinkelmann et al. 2016).

This current study conforms to this particular perspective and considers dynamic enterprise architecture capabilities as a dynamic capability (Teece 2007; Van de Wetering 2019). These capabilities help organizations to sense possible business and IT opportunities (as well as threats) as well as to transform and deploy these initiatives and opportunities while making sure that the firm's assets and resources are in line with the strategic goals and the market needs (Shanks et al. 2018; Teece 2007; Van de Wetering 2019). Such a capability highlights the particular value of EA usage and deployment in organization-wide decision-making and business process improvement (Mikalef et al. 2016; Pavlou and El Sawy 2011), as well as to strengthening the firm's reactive and proactive strength in the business domain (Mikalef et al. 2016; Overby et al. 2006; Pavlou and El Sawy 2011). The DCV has emerged as prominent theoretical management framework within the IS, and management scholarship (Pavlou and El Sawy 2011; Schilke 2014), and the domain is being built from a multiplicity of theoretical roots (Di Stefano et al. 2014). These 'dynamic' capabilities go by many definitions in the literature. Hence, this study follows Eisenhardt and Martin (2000) and Teece (2007) and defines them as general organizational routines to integrate, build, reconfigure, gain and release internal competences and resources to address the market demands and the changing business ecosystem (Eisenhardt and Martin 2000; Teece et al. 1997). The theories' foundation goes well beyond the RBV principles and attempts to explain how firms can obtain and maintain a competitive edge within the business ecosystem (Teece et al. 1997). The extant literature claims that under the condition of high environmental turbulence traditional resource-based capabilities (or operational capabilities) do not provide firms with the needed competitive weaponry (Drnevich and Kriauciunas 2011; Teece et al. 2016; Wilden and Gudergan 2015). Instead, the literature argues that firms should employ a strategy where they remain stable in the process of delivering current business services distinctively, and mobile so that they can anticipate and effectively address market disruptions and business changes (Teece et al. 2016). Based on this conception, a distinction can be made between dynamic capabilities and operational capabilities (Protogerou et al. 2012; Winter 2003). The former, thus, represents the firm's ability 'to act' under changing circumstances, while the latter allows the firm to earn a living in the present (Cepeda and Vera 2007; Winter 2003). The assets and (VRIN) resources a firm owns or controls are of crucial importance to the process of capability-building and how to gain value from it. Recently, IS and management scholars investigated how firms can infuse their IS/IT, and EA artifacts in organizational routines and capabilities to transform and renew their operating mode (Hazen et al. 2017; Mikalef and Pateli 2017; Pavlou and El Sawy 2006; Van de Wetering et al. 2018).

Although conceptualizations of dynamic capabilities may seem abstract and even lacking consistent definitions (Di Stefano et al. 2014), a growing consensus emerges that describes these capabilities sets of measurable and identifiable routines that have been widely validated through empirical investigations (Mikalef and Pateli 2017; Shanks et al. 2018; Van de Wetering 2019). The present study follows the DCV. Hence, it contends that firms that leverage EA with success are the ones that exploit the dynamic capabilities that infuse EA in the process of sensing strategic opportunities (and threats), mobilize resources accordingly and transform in line with strategic goals and business needs. This study defines and conceptualizes dynamic enterprise architecture capabilities as "*an organization's ability to leverage its EA for asset sharing and recomposing and renewal of organizational resources, together with guidance to proactively address the rapidly changing internal and external business environment and achieve the organization's desirable state*" (Van de Wetering 2019, p. 224).

This study conceptualizes and forms a dynamic enterprise architecture capability construct from three underlying capabilities. These are (1) an EA sensing capability, (2) a firms' EA mobilizing capability, and finally (3) an EA transformation capability following the DCV and critical contribution to the field of EA-based capabilities. The first capability, i.e., the EA sensing capability, highlights the EA value in firms deliberate posture to spot, interpret and pursue new IS/IT and technological innovations (e.g., cloud, IoT, big data analytics, AI, business intelligence), business and process opportunities or identify potential threats (Overby et al. 2006; Pavlou and El Sawy 2011). Also, an EA sensing capability accentuates the deployment of EA resources to improve business processes and review EA services (e.g., providing content, EA standards, skills, and knowledge) while maintaining close alignment with (internal and external) stakeholders needs and wishes (Mikalef et al. 2016). The second capability (EA mobilizing capability) concerns the firm's capability to consciously direct investments in adaptiveness of the firm, use EA in the process of evaluating, prioritize and select potential IT and business solutions and mobilize firm resources accordingly (Overby et al. 2006; Sambamurthy et al. 2003; Shanks et al. 2018; Yu et al. 2012). This construct, thus, focusses on seizing opportunities using EA when the present themselves (Wilden et al. 2013). Firms can leverage such a capability by engaging in enterprise-wide business activities through information sharing and promoting collaboration among stakeholders within the organization and beyond its boundaries (Yu et al. 2012). An EA-mobilizing capability is, thus, an essential ingredient for firms that want to adapt its resources and assets to the continually evolving customer wishes, demands and market, and technology trends and shape their business environment (Teece 2007). A firms' EA transforming capability helps firms to use the EA to successfully reconfigure and re-engineer business processes, service operations, and the technology landscape (Van de Wetering 2019). Also, EA transforming capability allows firms to engage in recombination and re-deployment of resources, change collaboration within the enterprise and to adjust for and respond to unexpected changes and the need for change (Drnevich and Kriauciunas 2011; Mikalef et al. 2016; Pavlou and El Sawy 2006; Shanks et al. 2018). Hence, this capability accentuates the importance of using the EA to enable high-level routines that facilitate the flexible adaptation of human resources and align interests among various stakeholders and actors across different levels within the firm (Brosius et al. 2018; Korhonen and Molnar 2014; Yu et al. 2012).

The influence of EA-resources on Dynamic Enterprise Architecture Capabilities

By building upon the RBV, it can be argued that competence in leveraging EA resources, by an EA-based capability, together with other complementary firm resources will likely result in competitive advantage (Bharadwaj 2000; Pavlou and El Sawy 2006). Wade and Hulland (2004) argued, however, that firms should actively invest in all the necessary resources so that they can cultivate potent EA resources. The literature argues that EA resources are an important antecedent of EA-based capabilities, and thus, dynamic enterprise architecture capabilities (Shanks et al. 2018). Specifically, the literature contends that leveraging EA knowledge competencies as well as effective EA deployment processes will collectively contribute to better EA-based capabilities (Aral and Weill 2007; Frampton et al. 2015; Shanks et al. 2018). EA resources use EA artifacts (e.g., state and data diagrams, business process models, roadmaps, and frameworks) to represent the current (and future, to-be) business and IT and hence improve the relationships and communication between various Business/IT stakeholders in the firm (Kotusev 2019). These EA resources can also facilitate processes to identify business problems and opportunities as well as various inefficiencies associated with current business processes and IT and prioritize the various improvement opportunities (Korhonen and Molnar 2014; Toppenberg et al. 2015). Moreover, EA resources enhance the firms' architectural insight, that is considered a key results from EA resource orchestration (Foorthuis et al. 2016). So, using these particular EA resources, firms can enhance the mutual understanding of the interrelationships between IS/IT, business processes, the strategic direction of the firm, and possible challenges that might even constrain the relationships (Foorthuis et al. 2016). It is to be expected that this will lead to transparency in business administration, common ground, and understanding of growth path (Lange et al. 2016) and better communication with the senior IT and management staff about IT-based business transformation options and the firm's strategic direction (Ross et al. 2006). So, the combination of EA deployment practices and knowledge competencies enhance the effective use of EA and thus also what Foorthuis et al. (2016) call as the '*….correct use of EA*' (Italics are used by Foorthuis et al., 2016).

Given the above, it is likely that EA deployment practices (next to efficaciously deployed EA knowledge competencies) drive dynamic enterprise architecture capabilities. EA competency and practices are, thus, key in the process of achieving intermediate and also intangible EA-driven results and business value (Schryen 2013). This study expects that EA resources will help develop dynamic enterprise architecture capabilities that are essential to enhance the firm's operational capabilities. Given the above, the current study proposes the first hypothesis:

H1: *EA resources will be positively related to the firm's dynamic enterprise architecture capabilities.*

Dynamic Enterprise Architecture Capabilities and Operational Capabilities

Following the robust DCV, it is suggested that dynamic enterprise architecture capabilities enable firms' sustained competitive in complex and volatile external environments (Teece 2007). However, it has been suggested by previous literature that dynamic capabilities not necessarily influence competitive performance directly (Protogerou et al. 2012). Rather, studies argue that firms' competitive edge comes from configurations of resources and by facilitating changes in (substantive) operational capabilities (Cepeda and Vera 2007; Wilden and Gudergan 2015). Hence, dynamic enterprise architecture capabilities provide firms the ability to use EA in decision-making processes and support competencies to change the position of IS/IT and other firm resources geared toward the operational functioning of the firm (Korhonen and Molnar 2014; Lapalme 2012; Roberts et al. 2012; Shanks et al. 2018). Firms can, therefore, use dynamic enterprise architecture capabilities to progress their capacity to transform and exploit customer and industry knowledge, technological competence in key business processes and facilitate innovative work practices (Korhonen and Halén 2017; Prajogo and Sohal 2003). By leveraging EA deployment practices and knowledge competencies—and thus, having a clear overview of the EA artifacts such as EA content, EA standards, services—firms can further strengthen the process of integrating IS/IT assets, resources, processes and services (Foorthuis et al. 2016; Someh et al. 2016). Thereby, firms can also maintain and improve technological competences and complementary firm assets (Real et al. 2006; Teece 2007). A substantial body of EA literature suggests that EA-based capabilities can enhance levels of technological advancements, organizational, and market responsiveness (Korhonen and Molnar 2014; Ross et al. 2006). In this process, dynamic enterprise architecture capabilities facilitate firms to gain access to previously unavailable EA assets, resources and sets of decision options which can enhance their capacity to drive business change beyond normal activity levels with ease, speeds, and competence (BolíVar-Ramos et al. 2012; Eisenhardt and Martin 2000; Vickery et al. 2010). Finally, Wilden and Gudergan (2015) empirically demonstrated that firms' sensing and transforming capabilities have a positive effect on technological and market-oriented capabilities. This study, therefore, argues that the particular capability to cultivate the firm's EA in the process of successfully transforming the IS/IT and the business process landscape, orchestrate resources and anticipate unexpected market changes is an essential driver for firms' operational capabilities. This study hypothesizes the following:

H2: *Dynamic enterprise architecture capabilities will be positively related to the firm's operational capabilities.*

Methods

The current study embraces a positivistic paradigm to reach the study objectives. Therefore, claims are based on theory, and this study also focuses on the development of persuasive arguments to substantiate these claims. This study needs a considerable number of cases to test this study's hypotheses.

Data collection procedure

An online survey was developed that included all the main questions covering the constructs in the research model. The applied survey was pretested on multiple occasions by three Master students and ten senior scholars and practitioners, i.e., two EA and MIS scholars, three enterprise architects, and five IT/business consultants and managers, in order to improve the validity (i.e., both face and content) of the survey items. Each of these experts was familiar with EA, had the appropriate knowledge, skills, and experience to assess the included items and provide valuable suggestions to improve the survey. The pretesting lead to clear and consistent survey statements. Appendix A shows the final survey that includes 39 items across various constructs, the respective item-to-construct loadings (λ), mean values (μ) and the standard deviations (Std.). This study used seven-point Likert scales (1: strongly disagree to 7: strongly agree) for each survey items. The final cross-sectional data were collected during a field study. Based on the study objectives and the nature of the research model's constructs, respondents had to be senior IT and business managers and staff (e.g., IT managers or CIOs, enterprise architects, and CEOs). Students of an advanced business process management and IT course of a Dutch University were asked to participate in this study. These Master students match our profile as they are experienced business or IT managers, consultants, and senior practitioners. The students (N=235) were invited to take part in the survey. Upon participation, the student had to fill in the survey from the perspective of the organization where they currently work. Also, the students were kindly asked to reach out to two knowledgeable professionals with adequate EA knowledge and experience from other organizations, and provide them with the survey as well.

This study implemented various controls during the data collection to make sure that each participating organization is unique. The data collection phase lasted from October 17^{th,} 2018, to November 16^{th,} 2018. The survey administration system recorded a total of 669 unique respondents that started the survey. Cases with either (partly) incomplete (N=290) or unreliable values (N=80) were removed from the data. Hence, this study could use a total of 299 complete and suitable survey. Most respondents[1] work in the private sector (i.e., 57%) and the public sector (i.e., 36%) and were high to executive managers, i.e., CEOs, CIOs and IT management (approximately 70%). Approximately 60% of the included 299 respondents had working experience of more than 11 years. Of all the participating firms, 72% had more than 300 employees, and 59% had more than 1000 employees. This study accounted for possible non-response bias through the use of t-tests. The results of the t-tests group analyses showed no significant differences between the early respondents (first two weeks) and responses that came in later, i.e., during the final two weeks of the data collection. Possible method bias was accounted for per suggestions of (Podsakoff et al. 2003; Richardson et al. 2009). This study applied a pretesting procedure, as outlined earlier. The reliability and construct validity of each particular construct were enhanced during the pre-testing. The survey provided proper definitions and was structured logically. As a final test, this study applied Harman's single-factor analysis to show that there was not a single exploratory factor that attributes to the majority of the variance. This

[1] 7% of the respondents come from firms that can be classified a private-public partnerships, and non-governmental organizations.

outcome shows that the current study sample is not affected by common method biases. The final analyses were done using IBM SPSS Statistics™ v24.

Constructs and items

Consistent with (Aral and Weill 2007), this study conceptualized *EA resources* using two dimensions. These are EA deployment practices, and EA knowledge competencies, that collectively form EA resources. They are measured based on past empirical work and conceptual work. Specifically, the selection of items for EA resources was done on the basis that they were suitable for firm-level analyses. This study adopts four measures from Foorthuis et al. (2016) for EA knowledge competencies. Important aspects include the degree to which the organization has a shared interpretation of the EA norms and knowledge of the complexity of the organization. Hence, these measurements also represent the firm's effective use of EA assets (e.g., representations of IT and business capabilities, systems, information sources and IT infrastructure) and EA people, that emphasizes the significance of collective skills, knowledge, practical communication skills and shared interpretation of the EA norms (Foorthuis et al. 2016). EA deployment practices highlight the significance of the use of particular EA methods and also deliberate deployment approaches (to have projects comply with norms) (Cameron and McMillan 2013), but also the pivotal role of EA principles for the strategic usage of the firm IS/IT and business resources across the enterprise (Lindstrom 2006; Proper and Greefhorst 2010). Moreover, EA deployment practices foster firms to develop context-relevant enterprise architectural artifacts (e.g., models, business/IT mappings), across various architectural layers (e.g., business, information, and infrastructure layer) (Schekkerman 2004). Hence, this study proposes these three measures as a minimum baseline for EA deployment practices. Dynamic enterprise architecture capabilities' conceptualization starts from the core notion of the previously outlined dynamic capabilities. This study initially assigned each of the measurement items to one either the EA sensing, EA mobilizing or EA transformation capability following of a structured review of relevant empirical studies to conceptualize this higher-order construct (HOC). Therefore, each of the included measurement scale items was adopted from either conceptual or previously empirically validated work in key IS, organization, and management studies (Drnevich and Kriauciunas 2011; Mikalef et al. 2016; Overby et al. 2006; Pavlou and El Sawy 2011; Sambamurthy et al. 2003; Shanks et al. 2018; Wilden et al. 2013). The constructs' conceptualization was put to a rigorous validation process that comprises various consecutive steps in the scale development process (MacKenzie et al. 2011). These original items were, then, validated through item-sorting analysis (Nahm et al. 2002) by three Master students, so that the reliability and construct validity of survey items could be improved (Moore and Benbasat 1991). Hence, these essential steps form a strong basis to empirically validate the measurement properties of the research model's constructs and test the hypotheses of this study. Dynamic enterprise architecture capabilities were finally measured using 16 indicators across three first-order constructs. These three first-order constructs are, thus, EA sensing capability, EA mobilizing capability, and EA transformation capability.

Previous research conceptualized operational capabilities as a HOC, consisting of output-oriented competencies and technological (or transformation-based) competencies (Mikalef et al. 2018; Protogerou et al. 2012; Real et al. 2006; Wilden and Gudergan 2015). In this study, market agility represents a firm's output-oriented competencies. This competency can be considered a firm's ability to serve certain customers and particular market demands (Spanos and Lioukas 2001; Tallon and Pinsonneault 2011). 'Agility' comes with many definitions and the IS scholar have even defined and conceptualized 'agility' using the DCV (Park et al. 2017; Roberts and Grover 2012; Sambamurthy et al. 2003; Vickery et al. 2010). Recent scholarship, however, favors an argument central to this research and argues that the particular contribution of firms' dynamic capabilities can be unfolded based on identifiable market agility enhancements (Mikalef and Pateli 2017; Queiroz et al. 2018) and operational, technological competencies (Protogerou et al. 2012). Therefore, this study concurs with these views and argues that market agility is effectuated and realized through firms' dynamic capabilities (Teece et al. 2016). Market agility is, therefore, conceptualized at the operational capability level in the value pathway. This study adopts four questions to measure market agility drawing on previous empirically validated work (Tallon and Pinsonneault 2011). Technological competence reflects a firm's ability to utilize firm-wide technological advancements to effectively transform inputs (e.g., information, labor, investments) into outputs, e.g., specific products or services (BolíVar-Ramos et al. 2012). Five measures are adopted from BolíVar-Ramos et al. (2012) to measure technological competence.

The included three HOCs in this study (i.e., EA resources, dynamic enterprise architecture capabilities, and operational capabilities) are all modeled as reflective first-order constructs. The second-order factor, on the other hand, is modeled in a formative modus. This type of modeling is justified based on existing guidelines, theoretical and empirical considerations (Becker et al. 2012; Jarvis et al. 2003). First, the first-order items are interchangeable—as they share a mutual concept—and also, subsequently leaving out items (e.g., based on low loadings or low convergent validity) does not change the meaning and signature of the particular constructs. However, the construction of the second-order constructs follows a different line of reasoning (Petter et al. 2007). First, these constructs are formed by their underlying first-order factors. For instance, EA sensing, EA mobilizing and EA transforming capabilities highlight unique traits of a higher-order capability, they are not interchangeable and removing one of them from the equation would certainly alter its meaning as increases in each of them would increase the degree to which firms have dynamic enterprise architecture capabilities. This logic also applies to the EA resources construct. It is, thus, not hard to imagine that variation in EA knowledge competencies and EA deployment practices (as first-order constructs) causes variation in the EA resources construct. The Structural Equation Modeling (SEM) literature calls these type of models reflective-formative type II models (Becker et al. 2012).

Model estimation

This current study uses a Partial Least Squares (PLS) SEM application, i.e., SmartPLS version 3.2.7. (Ringle et al. 2015), to estimate the research model and run parameter estimates. PLS is used exploratory, and for the objective of theory development Also, PLS allows researchers to integrally validate both the measurement model—so that each construct's reliability and validity can be assessed—as well as the model's structural components that guide the hypotheses testing (Hair Jr et al. 2016; Marcoulides and Saunders 2006). PLS is considered a better alternative than the more strict form of SEM, i.e., covariance-based modeling SEM (using, e.g., AMOS, LISREL). This study emphasizes prediction as to which PLS maximizes the proportion of explained variance (R^2) for all dependent constructs in the research model (Hair Jr et al. 2017). Moreover, PLS-SEM can process both formative, reflective, and combined constructs and measures (Hair Jr et al. 2017). Thereby, it provides researchers with the tools to estimate the model's latent components as well as the hypothesized associations among them (Chin 1998; Hair Jr et al. 2017). Also, PLS establishes latent constructs from the factor scores. It, thereby, seemingly avoids factor indeterminacy (Hair Jr et al. 2017), so that these scores can subsequently be used in the following analyses (Lowry and Gaskin 2014). Finally, the PLS approach is less strict in terms of particular data distributions.
The estimation procedure makes use of the general recommended path weighting scheme algorithm (Ringle et al. 2015). This study employed the available non-parametric bootstrapping approach in SmartPLS 3.2.7. to readily calculate the significance levels of the established (regression) coefficients among the constructs (of the structural model). In doing so, the recommended total of 5000 subsampling bootstraps was used (Hair Jr et al. 2016). As a final procedural remark, the obtained sample size (i.e., 299 organizations) in the dataset exceeds minimum thresholds to get stable results (Hair et al. 2011).

Empirical validation

Measurement model assessment

The measurement model was evaluated successively by assessing the internal consistency reliability—using the classic Cronbach's alpha measure (CA) and the composite reliability estimation (CR)—, and convergent validity—using the average variance extracted (AVE)—of the first-order latent constructs (Ringle et al. 2015). Also, all the construct-to-item loadings were investigated. The established AVE-values for each construct exceeded the lowest recommended mark of 0.50 (Fornell and Larcker 1981). Then, discriminant validity was established through the use of complementary assessments. The first assessment concerns the analyses of cross-loadings that measurement items might have on other constructs (Farrell 2010). Secondly, the well-known Fornell-Larcker criterion is used (Fornell and Larcker 1981). Scholars can compare the square root of the AVE with cross-correlation values. So, each square root value should be larger than the cross-correlations (Hair Jr et al. 2016).

Table 1 shows that this is the case in this research. The third and final test uses the now recommenced heterotrait-monotrait ratio of correlations (HTMT) (Henseler et al. 2015). In general, acceptable outcomes of this analysis are HTMT-values that are below 0.90 (upper bound). Then, discriminant validity is established between constructs. The HTMT analyses show that all values are well below the 0.85. Table 1 summarizes the entire assessment. Hence, the measurement model with the latent constructs is reliable and valid. To further validate the formative HOCs, this study assessed the presumed and conceptualized relations between the HOC and the lower-order constructs using Edwards' adequacy coefficient (R^2_a) (Edwards 2001). This adequacy coefficient is obtained by first adding up all squared correlations between the focal HOC and the lower-order constructs. This total is subsequently divided by the number of underlying dimensions. Hence, values above 0.50 represent valid constructs (MacKenzie et al. 2011). Table 2 shows the formative construct validation. All respective weights are significant, and the R^2_a values are well beyond the 0.50 mark.

Table 1. Convergent and discriminant validity assessment

HOC	FOC	AVE	CA	CR	EAKC	EADP	EAS	EAM	EAT	TC	MA
EAR	EAKC	0.639	0.812	0.876	**0.800**						
	EADP	0.796	0.872	0.921	0.491	**0.892**					
DEAC	EAS	0.686	0.885	0.916	0.559	0.664	**0.829**				
	EAM	0.734	0.909	0.932	0.466	0.621	0.782	**0.857**			
	EAT	0.710	0.918	0.936	0.554	0.577	0.784	0.780	**0.843**		
OC	TC	0.678	0.881	0.913	0.435	0.290	0.354	0.305	0.421	**0.824**	
	MA	0.575	0.794	0.870	0.244	0.035	0.213	0.196	0.289	0.437	**0.758**

Note: EAR—Enterprise architecture resources; EAKC—EA knowledge competencies; EADP—EA deployment practices; DEAC—Dynamic enterprise architecture capabilities; EAS—EA sensing capability; EAM—EA mobilizing capability; EAT—EA transforming capability; OC—Operational capabilities; TC—Technological competence; MA—Market agility. The diagonal line within Table 1 shows the square root of the AVEs of all constructs.

Also, the assessed variance inflation factors (VIFs) values for each formative construct are below a conservative threshold of 3.5. These outcomes indicate that no multicollinearity exists within the research model (Kock and Lynn 2012).

Table 2. Validity assessment of the formative constructs

HOCs	Measures	Weight	*p*-value	VIF	R^2_a
EAR	EAKC	0.598	<0.001	1.53	0.74
	EADP	0.560	<0.001	1.87	
DEAC	EAS	0.330	<0.001	3.25	0.85
	EAM	0.347	<0.001	3.22	
	EAT	0.404	<0.001	3.23	
OC	TC	0.715	<0.001	1.39	0.68
	MA	0.479	<0.001	1.23	

Hypotheses testing using the inner (structural) model

Through the structural model analyses, this study investigated the significance of each of the hypothesized paths in the research model as well as the coefficient of determination (R^2). The coefficient of determination is considered to be a representation of predictive power (Hair Jr et al. 2016). This measure can, thus, be used to assess whether or not (and to what extent) the dependent constructs can be predicted from the antecedent constructs. This study found support for the first hypothesis (EA resources → dynamic enterprise architecture capabilities). EA resources positively influences dynamic enterprise architecture capabilities (β = 0.714; t = 23.230; p < 0.0001). This study found additional support for the second hypothesis, i.e., dynamic enterprise architecture capabilities → operational capabilities (β = 0.276, t = 3.439, p < 0.0001). The included control variables showed non-significant effects: 'size' (β = 0.004, t = 0.087, p = 0.931), 'age' (β = -0.068, t = 1.264, p = 0.206).

Based on the structural analyses, this study confirms that 51.2% of the variance for dynamic enterprise architecture capabilities (R^2 = 0.512) can be explained by the model. This level of predictive accuracy is considered moderate to substantial (Chin 1998). Results show that the total explained variance for operational capabilities is 17,1% (R^2 = 0.171). This coefficiency level is considered a less strong effect (Chin 1998). This study uses a blindfolding procedure to assess predictive power and calculated Stone-Geisser (Q^2) values (Hair Jr et al. 2016). Q^2-values for the endogenous latent constructs that are above zero indicate predictive relevance. The blindfolding procedure shows that the Q^2 value (for dynamic enterprise architecture capabilities) is well above zero (Q^2 = 0.494). The same accounts for operational capabilities (Q^2 = 0.159). These particular results, once more, confirm the model's predictive relevancy (Hair Jr et al. 2016). Figure 2 shows the results of the structural model assessment. This study follows a step-wise procedure for mediation assessments (Hair Jr et al. 2016) to address the question whether or not dynamic enterprise architecture capabilities mediate (fully or partially) the hypothesized relation between EA resources and operational capabilities.

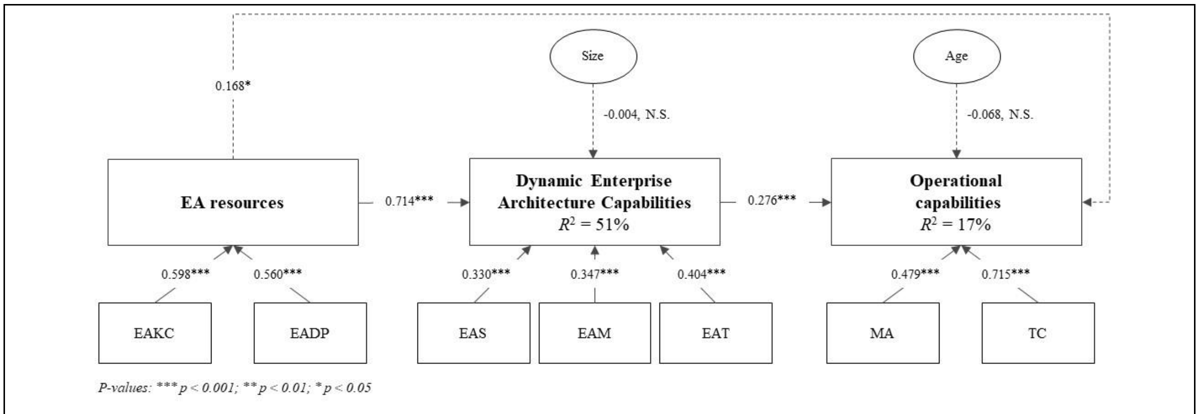

Figure 2. Results of the structural model assessment

When dynamic enterprise architecture capabilities were removed from from the structural value path, the direct effect of EA resources on operational capabilities changed and was further strengthened (β = 0.374, t = 7.989, p < 0.0001). So, the direct, as well as the indirect effect of EA resources, aim in the same direction. Both estimates are also significant (significance was once more obtained through bootstrapping). It can be concluded that there is a partial mediating relationship. This study, therefore, finds support for the two hypotheses. Table 3 additionally shows the estimated effect, the bias-corrected confidence intervals (Low., 2.5%, – Up., 97.5%), p-values, and the t-statistic (two-tailed) of the structural model analyses.

Table 3. Overview of structural model assessment

Model path	Path effect	Ratio to total effect	Confidence interval	*p*-value	*t*-value	Outcome
EAR → DEAC	0.714	-	CI (0.65 – 0.77)	< 0.001	23.230	H1 Supported
DEAC → OC	0.276	-	CI (0.12 – 0.44)	< 0.001	3.439	H2 Supported
EAR → OC	0.168	46%	CI (0.02 – 0.30)	0.022	2.281	Significant
EAR → OC (via DEAC)	0.197	54%	CI (0.09 – 0.32)	0.001	3.354	Partial mediation
Total effect	0.365	100%				

Post-hoc analyses: linking operational capabilities to competitive firm performance

This study contributes to the IS, and management literature, by showing that dynamic enterprise architecture capabilities, driven by EA resources, strengthen a firm's operational capabilities. Hence, these operational capabilities are necessary to attain and sustain a competitive advantage over competitors. This present study performs a set of post-hoc analyses looking at a presumed association between operational capabilities that a firm has developed, and competitive firm performance (as of now 'performance') to strengthen the interpretation of this study's results. This study perceives the performance of firms as a measure of how well they do better their competitors in the same industry (Rai and Tang 2010). Hence, performance is conceptualized using the reflective-formative type II model (and thus also as a HOC), as previously discussed, containing the first-order benefits constructs market-based performance (i.e., 1. growth in market share, and 2. growth in sales) (Chen et al. 2014; Rai and Tang 2010), financial performance (i.e., 3. profitability, and 4. return on investment, ROI) (Chen et al. 2014; Rai and Tang 2010) and customer satisfaction (i.e., 1. increasing customer satisfaction, customer loyalty and business brand and image) (Chen and Tsou 2012). All participants had to rate the performance of their firms by comparing it with the main competition during the last 2 or 3 years (in the same industry). By including all the first-order construct of performance into the measurement model analyses, all previously assessed measures and validity metrics (including CA, CR, AVE, Fornell-Larcker criterion) were once more confirmed. This study controlled for and simultaneously analyzed the role of dynamic enterprise architecture capabilities within this newly established nomological path. Performance is likely to be influenced by several other organizational aspects in addition to those the ones outlined above. So, to validate the research model, the present study controls for the effect of industry type. This study, once more followed the outlined mediation assessment guidelines, to address the imposed mediation effects within the post-hoc analyses. Firm's operational capabilities now show a positive association with performance (β = 0.470, t = 7.977, p < 0.0001), rendering support for this theorized relationship. Dynamic enterprise architecture capabilities once more positively influence operational capabilities (β = 0.277, t = 3.461, p = 0.001). The included direct path (dynamic enterprise architecture capabilities → performance), now shows a relationship that is not significant, as the p-value is above 0.05 (β = 0.088, t = 1.623, p = 0.105). After removing operational capabilities, the direct effect of dynamic enterprise architecture capabilities on performance changes from non-significant to statistically significant (β = 0.270, t = 4.715, p < 0.0001). Operational capabilities, act as a primary antecedent of performance, explaining much of its variance (R^2=.279), while the included control variable (i.e., industry) showed non-significant effects. These analyses are in line with those of (Protogerou et al. (2012) showing that the dynamic capabilities that firms develop are primary drivers for firms' operational capabilities.

Discussion, Contributions, and Concluding remarks

This final section briefly outlines this work's discussion. Hence, it puts the study's theoretical and practical contributions in context, outlines inherent limitations, and outlines avenues for future work. It ends with some concluding remarks.

This work adds value to the IS, and management literature, by, making four substantial theoretical contributions. First, this study tried to conceptualize and define EA-based capabilities, following DCV, and proposes a research model that tries to explain how dynamic enterprise architecture capabilities enables firms' operational functioning. This study's central argument was that when firms have developed higher levels of dynamic enterprise architecture capabilities, they are better equipped to enhance their operational capabilities. This argument was confirmed by the PLS analyses using a sample of 299 firms. Second, these outcomes extend current insights on which benefits can be achieved with EA practices and capabilities. Using these new insights, scholars can now conduct more foundational analyses on the use and deployment of EA in organizations. More specifically, they can now systematically link EA to firm's efforts to integrate knowledge processes, firm assets, and resources in the form of complementary technological and market-oriented competences and use them to efficiently exploit organizational resources (Danneels 2002; Wilden and Gudergan 2015). Third, with these outcomes, the present study also extends previous empirical studies that focus on project contributions from effective EA deployment, see for instance (Shanks et al. 2018). Finally, this work contributes to the EA and dynamic capability knowledge base and strengthens the theoretical ground on which future studies can base their work in explaining IS-related phenomena. As such, this study tried to coalesce important work on EA resources, EA-based capabilities, the DCV, operational capabilities, and organizational benefits, or performance. This work could guide new areas of IS and EA research that focuses on dynamic enterprise architecture capabilities and their contribution to organizational value and innovation.

The study also has practical implications for business and IT managers. While there has been substantial attention for EA artifacts and framework as sufficient conditions to enable business transformation and attain organizational benefits, this work emphasizes a broader dynamic capabilities perspectives when it comes to EA deployment in firms. Managers can now use a diagnostic, (self)assessment and benchmarking tool grounded in theory, that opens up the value-creating black box of EA and justify the investments made in the EA practice and '*EA as a strategy*' (Ross et al. 2006). Decision-makers should know that these particular investments cannot be cultivated instantly through direct performance impact. Instead, this research unfolds the different and related value paths through which operational benefits and competitive firm performance gains can be achieved. Using dynamic enterprise architecture capabilities business and IT managers can now leverage previously unavailable EA assets, resources, and sets of decision options. They can use them to enhance their firms' ability to change business processes beyond normal levels of activity with ease, speeds, and competence and to dominate in the marketplace with high levels of technological competences. The present study provides guidance as well as foundational knowledge and insight on how to achieve those benefits. The present study contains various limitations that future research should embrace as opportunities. First, this study only used self-reported measures and followed a similar approach to the ones used by, e.g., (Hazen et al. 2017; Mikalef et al. 2016; Schmidt and Buxmann 2011). It is, therefore, worth investigating how triangulation with available archival data from public sources matches the current outcomes. Incorporating these additional data (e.g., financial metrics) into the research approach could help further strengthen and once more validate the empirical outcomes as perceptual data are typically associated with objective measures (Wu et al. 2015). Second, this study unfolded a complementary partial mediating relationship between EA resources, dynamic enterprise architecture capabilities, and operational capabilities. This study did not hypothesize and focus on this particular relationship, although the nature of the mediating relationship requires further investigation and interpretation in the context of EA deployment. Third, all data were gathered from Dutch-speaking organizations. Possible directions to confirm this research's outcomes could be to do a replication study in different (non-Western) countries, and even continents.

In conclusion, this study examined the hypothesized relationships among EA resources, the critical capabilities in which EA should be infused, and the operational functioning of the firm. In the post-hoc analyses, this study demonstrated the importance of EA-driven operational capabilities in enhancing performance. Scholars and practitioners can now benefit from these outcomes as they unfold the mechanisms through which EA can be leveraged in practice.

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Appendix A: Constructs and measurement items

Construct		**Measurement item**	**λ**	**μ**	**Std.**
EADP	*To what extent do you agree with the following statements? (1. Strongly disagree–7. Strongly agree). * EAS, EAM, EAT use the same Likert scale.*				
	DP1	We use an EA Framework Approach or method for our EA development.	0.88	4.50	1.79
	DP2	We use EA principles for the deployment and use of all IT assets and resources and organizational capabilities across the enterprise.	0.90	4.50	1.67
	DP3	Our EA outlines all the enterprise architectural artifacts (e.g., models, business/IT mappings), across various architectural layers (e.g., business, information, and infrastructure layer).	0.83	4.17	1.77
	*Indicate the degree to which you agree or disagree with the following statements about whether the organization has: (1. Strongly disagree–7. Strongly agree). **TC uses same Likert.*				
	KC1	Knowledge of the complexity of the organization.	0.74	5.32	1.34

EAKC	KC2	A clear image of the desired future situation.	0.81	4.93	1.49
	KC3	Effective communication.	0.82	4.31	1.51
	KC4	Shared interpretation of the EA norms.	0.83	3.82	1.53
*EAS**	S1	We use our EA to identify new business opportunities or potential threats	0.77	3.83	1.61
	S2	We review our EA services regularly to ensure that they are in line with key stakeholders wishes	0.84	4.10	1.60
	S3	We adequately evaluate the effect of changes in the baseline and target EA on the organization	0.86	4.02	1.48
	S4	We devote sufficient time to enhance our EA to improve business processes	0.82	4.01	1.56
	S5	We develop greater reactive and proactive strength in the business domain using our EA	0.85	4.04	1.54
*EAM**	M1	We use our EA to draft potential solutions when we sense business opportunities or potential threats	0.85	4.39	1.51
	M2	We use our EA to evaluate, prioritize and select potential solutions when we sense business opportunities or potential threats	0.86	4.37	1.51
	M3	We use our EA to mobilize resources in line with a potential solution when we sense business opportunities or potential threats	0.88	4.19	1.45
	M4	We use our EA to draw up a detailed plan to carry out a potential solution when we sense business opportunities or potential threats	0.87	4.12	1.59
	M5	We use our EA to review and update our practices in line with renowned business and IT best practices when we sense business opportunities or potential threats	0.84	4.22	1.48
*EAT**	T1	Our EA enables us to successfully reconfigure business processes and the technology landscape to come up with new or more productive assets	0.85	4.40	1.45
	T2	We successfully use our EA to adjust our business processes and the technology landscape in response to competitive strategic moves or market opportunities	0.87	4.17	1.56
	T3	We successfully use our EA to engage in resource recombination to better match our product-market areas and our assets	0.83	3.95	1.47
	T4	Our EA enables flexible adaptation of human resources, processes, or the technology landscape that leads to competitive advantage	0.84	3.88	1.50
	T5	We successfully use our EA to create new or substantially changed ways of achieving our targets and objectives	0.87	4.06	1.51
	T6	Our EA facilitates us to adjust for and respond to unexpected changes	0.80	4.02	1.46
MA	*How would you rate your firm's market agility aspects in comparison to industry competitors? (1. Much weaker than the competition–7. Much stronger than the competition)?*				
	MA1	Expanding into new regional or international markets	0.71	4.35	1.33
	MA2	Responsiveness to customers	0.83	4.71	1.22
	MA3	Responsiveness to changes in market demand	0.87	4.55	1.17
	MA4	Customization of products or services to suit indiv. customers	0.74	4.87	1.28
*TC***	TC1	Competence to obtain information about the status and progress of science and relevant technologies	0.79	4.95	1.26
	TC2	Competence to generate advanced technological processes	0.89	4.65	1.42
	TC3	Competence to assimilate new technologies and useful innovations	0.83	4.80	1.30
	TC4	Competence to attract and retain qualified scientific-technical staff	0.77	4.30	1.54
	TC5	Competence to dominate, generate or absorb basic and key business technologies	0.83	4.68	1.27