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RETHINKING THE ROLE OF ENTERPRISE ARCHITECTURE DURING TIMES OF ECONOMIC DOWNTURN: A DYNAMIC CAPABILITIES APPROACH

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ABSTRACT

The role of Enterprise Architecture (EA) has recently evolved from merely outlining IT architecture and facilitating regulatory IT compliance towards an invaluable source of business agility, alignment and business innovation. There has been so much talk about the benefits of EA, but often these claims did not provide theoretical underpinnings or explanations on how to achieve these benefits. In this paper, we revisit the role of EA in the midst of the current economic downturn. In particular, we focus on the question: How can EA help enterprises cope with the prevailing economic conundrum? To do so, this research views the role of EA through a Dynamic Capabilities (DC) lens. Based on this DC perspective, we synthesize earlier research contributions and present the EA Adaptation Framework (EAAF). The EAAF suggests that EA can enable organizations to be better positioned to cope with turbulent economic climates by enhancing their sensing, learning, integrative, innovative and alignment capabilities. The EAAF also articulates the mechanisms through which the business, application, data and technology domains of the EA can be orchestrated to support the adaptation process during times of economic recession. We discuss the implications of the proposed framework and provide suggestions for future studies.

Keywords: Enterprise architecture, technology management, IT planning, strategic planning

INTRODUCTION

The latest global financial and economic crisis which started in the US at the end of 2007 has created the worst business environment in decades for most executives. Although some signs of improvements have emerged lately, recovery still remains uncertain and sluggish [21]. The uncertainty about the depth and duration of this financial crisis has been the main driver for the prevailing economic downturn [54]. This disruptive economic crisis has forced business executives to rethink their operational goals, business models and strategies, and changed the way they operate. CIOs have also felt the rippling effect of the downturn, as they were called upon

to adjust to the new economic reality and to find ways to help their organizations make it through the downturn.

The current economic crisis differs from previous economic downturns in several aspects:

- It originated from the 2008 crisis in the financial markets which left banks with serious liquidity problems and amplified risk aversion for lending to organizations as well as to individuals. As a result of these liquidity problems and lack of capital finance, the prevailing economic downturn is subjecting organizations to unprecedented threats to their survival and to strong pressures to control cash flow and adopt aggressive retrenchment strategies to cut cost [47].

- It emphasized the need for stronger enterprise risk management to cope with various types of accentuated risks. These include stock price volatility, credit availability, liquidity, commodity and/or competitive pricing, delays in payment of accounts receivable, macroeconomic trends affecting consumer spending behavior, and issues with financially troubled customers, suppliers and distributors.
- It came after of a long period of business expansion, including investment in capital, workforce and technology infrastructure [29]. Some of this expansion was associated with bad management practices. Many organizations have also inherited a set of redundant, complex and costly IT resources from the pre-recessionary period. These liabilities cannot be endured during downturn periods.
- It came at a time when the world was shifting towards a digital economy that is increasingly knowledge-based and service-driven, with increased investment in enterprise systems and new technologies.
- It came at a time where globalization of the world economies had led to unprecedented interdependencies among countries, which echoed the impact of recession from one country to another [47].
- It is characterized by a sharp decline in consumer confidence, which translates into lower demand for goods and services. As a result, the strategic focus of many organizations becomes oriented towards seizing market share from competitors [47].

The prevailing economic conundrum has shifted the main focus of IT organizations from simply finding ways to cut their budgets towards exploring opportunities to leverage IT to reduce business operating costs and improve business return – a deep divergence from previous recessions [44-45]. This is clearly reflected in the surveys that have been conducted for the past 10 years by the Society for Information Management (SIM) on the key issues facing IT executives in the United States (see for example [42-46]). These surveys revealed that the prevailing economic downturn impacted the priorities of IT executives in at least three major aspects:

- IT and business alignment has returned to the top priority list in 2011. However the focus has shifted from alignment compliance

towards leveraging opportunities for enhancing the relationship between the IT and business organizations in order to demonstrate proven improvement in organizational performance.

- The focus on business agility and speed to market has been accentuated, with more stringent requirements for identifying responsive IT approaches, capable of delivering immediate business value.
- The economic downturn in the U.S has repositioned Business Process change and re-engineering back in the top 3 IT management concerns. It has also emphasized the need for strong collaboration among the IT department, business divisions and the business partners to find the best ways to leverage technology to re-engineer business processes.

The volatile nature of today's economic environment is compelling organizations to become more flexible and adapt to the changing business landscape, while at the same time imposing stringent pressures to maintain low cost structures in order to meet investors' demands. During times of economic downturns, controlling cost, lowering inventories, enhancing quality and adopting best industry practices are no longer sufficient to sustain competitive advantage, at least in the long run. Success resides in the firm's ability to revitalize its entrepreneurial fitness through new organizational forms and business models. Achieving these business goals requires entrepreneurial management skills to sense and capitalize on new business opportunities, and to find better ways to creatively coordinate and reconfigure organizational structures, resources and capabilities to generate economic surpluses over time [79]. Unfortunately, senior executives often find themselves powerless when it comes to getting timely, meaningful and accurate information that is needed to optimize decision making, assess risk and predict best course of actions. The need for creative platforms for timely information access and innovative transformation becomes even more vital during times of economic downturn. In fact, while bad decisions and missed opportunities can be veiled during good economic times, they become exceptionally costly during times of economic downturn [28]. Further, for many years, many enterprises have accumulated a set of costly, complex and redundant information environments that are hindering their capability to (1) dynamically anticipate and respond to the changes brought by today's volatile economy, and (2) gain access to meaningful, consistent, intelligent and integrated (intra and

inter-enterprise) information that is needed to sustain competitive advantage.

At times where information management and Business Intelligence (BI) are gaining in popularity in today's volatile economic environment, business executives and Chief Information Officers (CIOs) are confronted with many pressing challenges, including [28]:

- Difficulties in tracking numerous and scattered data repositories.
- Lack of systems governance across functions, business lines, or geography.
- Costly system integration projects.
- Absence of common applications capable of blending together transactional, analytical, and unstructured information.
- A portfolio of IT projects that lacks the adequate prioritization needed to swiftly address the new business imperatives dictated by today's unfavorable economic climate.
- Significant pressures on traditional BI and Data Warehouse (DW) systems to deliver dynamic and timely business insights in response to changing needs in the business ecosystem.

This paper argues that when properly governed, planned and executed, an Enterprise Architecture (EA) approach can provide the cure to many of the previously cited "pain-points", while help guide the strategic priorities of IT executives. This research also demonstrates how EA can provide a holistic and integrated strategic perspective by which IT can evolve to assist enterprises cope with turbulent economic times. To achieve this, the Enterprise Architecture must embrace a dynamic strategy that adapts to the prevailing economic downturn by re-examining and then redefining the IT strategy and objectives. Previous studies (see for example [25]) showed that a turbulent economic climate can provide the EA team with an excellent opportunity to become a source of business creation and innovation by preparing for change or architecting for divestiture. The EA can be redesigned around a defensive strategy aimed to address the immediate threats to the survival of the organization, and an offensive strategy that aims to make best use of business opportunities once the economy rebounds [84].

However, it is unfortunate to note that enterprise architects have been largely unsuccessful in articulating the business value of the Enterprise Architecture during volatile times. For instance, a 2011 Gartner report [26] showed that only 9% of enterprise architecture efforts involved business collaboration. This rate of collaboration between business and IT is expected to grow up to 30%

by 2016. This seems paradoxical, as a key value proposition of EA is to provide a technology roadmap for the enterprise to adapt to environmental changes.

This paper is organized as follows: First, the relevant literature review concerning the role of enterprise architecture is presented and the contribution of the paper is articulated. Next, we provide an overview of the dynamic capabilities paradigm and its core components. In section 4, we discuss the four pillars of EA. We then present the EA Adaptation Framework (EAAF) which can guide EA to better assist enterprises cope with the current unfavorable economic climate. Finally, in section 6, we discuss the implications of this contribution for both research and managerial practice and provide some suggestions for future research.

LITERATURE REVIEW AND RESEARCH CONTRIBUTION

There has been a noteworthy interest among practitioners, EA vendors and service providers, as well as consultants, in the many ways by which EA can add value to organizations. However, as recently highlighted by Tamm et.al [76], most of these early contributions originated from the practitioner community and claimed EA benefits that were rarely grounded in theory. There is also a lack of understanding about the true value-proposition of EA in general and its role in today's volatile economic climate in particular. Some of the recurring EA benefit claims that were backed by relevant theoretical explanation or empirical evidence in the academic literature are listed in Table 1. One should note that there is some overlap among these reported EA benefits.

Among the notable earlier contributions that aimed to enhance our understanding of how EA can add value to organizations is the study of Tamm et al [76]. Through a systematic review of existing literature on the topic, the authors tried to synthesize the fragmented body of knowledge on EA benefits by proposing the EA Benefits Model (EABM). This model stipulates that EA can add value to organizations through four benefit enablers. These are organizational alignment, information availability, resource portfolio optimization, and resource complementarity. The study also recognizes that the benefits of EA may include lowering cost, enhancing strategic agility, and improving the operating platform's reliability. This study however did not take into account the contextual factors that shape the way EA can add value to organizations. In fact, most of the earliest contributions presented a static picture of the role of EA and thus undermined the role of the macro-environment in reshaping this

role. In particular these earlier contributions did not capture the dynamic role of EA in response to the shakeout brought by the current economic recession. Accordingly, this contribution aims to fill this gap by showcasing the potent role EA can play in shaping the response of organizations to turbulent economic conditions. This is a central strategic issue, as “business as usual” can no longer be a sustainable response during a recessionary period. In fact, stringent economic conditions suggest new survival and retrenchment approaches, and this contribution aims to showcase how EA can guide organizations through a recessionary period. For this purpose, this research takes the theoretical model of Dynamic Capabilities (DCs) as a suitable framework and a starting point for capturing the enterprise capabilities to respond to the current economic conundrum. Thus this paper focuses on one contextual factor, which is the prevailing economic turmoil, and attempts to re-examine the role of EA through a DC lens. We also note that our research can help business executives make best use of enterprise architecture in contexts other than economic turmoil.

This work also differs from earlier contributions in that while Tamm et al [77] contribution and other earlier studies highlighted the various (and often generic) ways by which EA can add value to organizations, the question of how to realize these benefits has remained unexplored. The present paper, on the other hand, goes beyond uncovering “what” EA can do for organizations by articulating the mechanisms on “how” to achieve EA’s claimed benefits. In particular, this research demonstrates how the four architectural domains of EA (i.e. business, application, data and technology) can be orchestrated to support organizations during stringent economic conditions. Putting things together, the question this contribution tries to answer is: How can EA benefit organizations in the midst of the current economic downturn? To address this question, we propose a two-dimensional logical template to synthesize a framework that can guide EA to play a greater role in helping enterprises survive during recessionary periods. This research is a first step towards enhancing our understanding of the greater role EA can play during times of economic recession.

Table 1: EA Organizational Benefits as Reported in the Academic Literature

Claimed EA Benefit	References
Reduced cost	Bernard [7]; Richardson et al [63]; Ross and Westerman [65]; Spewak and Hill [74]; Tamm et al [76]
Better decision making	Bernard [7]; Spewak and Hill [74]; Johnson et al [37]
Improved organizational performance	Bernard [7]; Ross et al [66]
Reduced cycle time	Bernard [7]
Better Information sharing and collaboration	Richardson et al [63]; Pereira and Sousa [58]; Boh and Yellin [9]; Spewak and Hill [74]
Improved software portability	Richardson et al [63]
Better strategic agility and change capability	Ross et al [66]; Spewak and Hill [74]; Tamm et al [76]
Improved customer responsiveness and intimacy	Ross et al [66]; Spewak and Hill [74]; Venkatesh [82]
Enhanced productivity	[Spewak and Hill [74]
Business reengineering	Segars and Grover [70]
Economies of scale	Venkatesh [82]
Improved business-IT alignment	Salmans and Kappelman [68]; Gregor et al [30]; Aziz and Obitz [6]; Tamm et al [76]
Improved ROI from IT	Ross et al [66]; Salmans and Kappelman [68]
Better situational awareness	Salmans and Kappelman [68]
Higher level of standardization and integration	Bernard [7]; Boh and Yelli [9]; Ross and Westerman [65]; Hjort-Madsen [33].
Improved data accuracy and reliability	Venkatesh [82]; Ross et al [66]
Resource overlap minimization	Bernard, [7]; Pereira and Sousa [58]; Boh and Yellin [9]
Better legislative and regulatory compliance	Ross et al [66]; Winter and Fisher [88]
More reliable operating platform	Tamm et al [76]; Ross et al [66]; Spewak and Hill [74]; Pereira and Sousa [58]; Richardson et al [63]; Boh and Yellin [9]
Intelligent profitable growth	Godinez et al [28]
Proactive risk management	Godinez et al [28]

DYNAMIC CAPABILITIES DURING VOLATILE ECONOMIC CLIMATES

Theoretical Background

The concept of dynamic capabilities was introduced by Teece and Pisano [77] and Teece et al [78] to reflect the fact that, in a dynamic environment, a firm's competitive advantage lies in its capability to exploit its resources, internal processes and routines in order to revamp its organizational competencies, given the potential constraints dictated by path dependencies and market positions. In strategic management, the dynamic capabilities approach is considered a potentially integrative approach to a better understanding of how firms create and sustain competitive advantage and avoid the zero-profit trap. It complements earlier strategic management paradigms, such as the competitive forces model [61], the strategic conflict approach (see for example [71]), and the Resource-Based View (RBV) paradigm ([57, 67, 85]). The DC approach differs from the organizational capability

paradigm in the sense that while the latter endeavors to provide innovative goods and services to customers, the former acts as a catalyst to enable and facilitate the manipulation and renewal of organizational resources and capabilities. This is achieved through organizational routines that focus on reconfiguring and renewing the endogenous and exogenous resource bases of the firm ([78, 19, 86, 22], cited in [34]). As a result, dynamic capabilities extends the resource-based view by emphasizing the fact that a firm's competitive advantage lies not only in its possession of strong resources, organizational capabilities and endowments, but also in its capability to timely and flexibly adapt, integrate, reconfigure, and renew these resources and competencies to address and capitalize on changing business environments. This capability is particularly needed during turbulent economic climates.

Based on Hou and Chang's [34] classification, the core components of dynamic capabilities are sensing capability, absorptive capability, integrative capability and innovative capability. To these, we add alignment capability ([80]). These are summarized in table 2.

Table 2: The Core Components of Dynamic Capability

DC Component	Definition	References
Sensing Capability	Ability to sense the internal and external environments and understand market dynamics and changing customer needs better than competitors.	Amit and Schoemaker [2]; Galunic and Rodan [24]
Absorptive/learning Capability	Ability to recognize and assimilate the value of new external information, and transform it into embedded knowledge for internal use.	Cohen and Levinthal [14]; Verona and Ravasi [83]; Woiceshyn and Daellenbach [89]
Integrative/reconfiguring Capability	Ability to integrate disparate patterns of interactions through heedful contribution, representation and interrelation.	Okhuysen and Eisenhardt [55]; Grant [30]
Innovative Capability	Ability to develop new products, services, ways to organize business, and markets through innovative behaviors and processes.	Deeds, et al [15]; Lazonick and Prencipe [41]; Petroni [59]; Hekkert et. al [32]
Alignment Capability	Ability to align internal resources and capabilities with changing external environmental conditions. Mostly enabled through strategic flexibility.	[Thornhill and Amit [80]

Dynamic Capabilities in the Midst of an Economic Downturn: Doing More with Less

During turbulent economic climates, firms undergo tough financial times, struggling to maintain earnings in light of declining or static revenues. As a result, organizations look for ways to deliver more value to the business at the least cost, while being vigilant in leaving little room for big mistakes. To do so, firms engage in many managerial tactics such as revisiting or cancelling costly projects with unpromising ROI, across-the-board budget cuts, outsourcing and offshoring of operations, shifts towards more centralized control, and streamlining business processes to cut waste and reduce inefficiencies [12]. Tough financial times may also push firms to confront a type of Schumpeterian shock that would challenge the relevance of the firm's resources and capabilities and, in some cases, necessitates the revision of the firm's business model. Investment decisions are often biased and constrained by cash flow and budget limitations. These decisions also require several tedious steps of justifications and approvals. Further, innovation becomes ill-served during economic turmoil as tight financial resources exacerbate problems of excessive risk aversion.

Based on the above, the prevailing economic downturn is subjecting firms to extensive strategic and operational constraints. Further, in an increasingly globalized economy, the contest for market share is mainly fueled by the ability of the organization to efficiently sense, assimilate and analyze information and then quickly respond to changing market conditions [53]. As a result, firms need to develop agile dynamic capabilities to survive, adapt to the unfavorable environmental conditions, and ensure readiness to capitalize on market opportunities once the economic conditions rebound back to normal [78]. Recall from previous discussions that dynamic capabilities enable organizations to build, integrate and reconfigure internal/external competencies to respond to changing and disruptive environmental conditions. In fact, in a turbulent economic environment, firms need to effectively mobilize organizational routines and capabilities to (1) sense the new internal and external environments and business landscape, (2) extract new information in light of the current economic conditions and transform this information into actionable embedded knowledge, (3) integrate, reconfigure and unleash resources to do more with less, (4) seize new opportunities to remove waste and add value with least cost, (5) make the right investment decisions, and (6) perform the needed organizational transformations to sustain competitive advantage. These objectives are core elements of the dynamic capabilities para-

digm and require new managerial learning systems and mental models to adapt to the new economic climate [5]. Therefore, the possession of dynamic capabilities is especially relevant to enterprises that are affected by the ongoing financial turmoil.

Therefore, we argue that a dynamic capability approach provides a suitable theoretical framework for capturing the enterprise capabilities to respond to economic downturn. It should be noted, however, that rough financial times introduce new constraints on a firm's ability to exercise dynamic capabilities because of the pressures to keep costs at a minimum level.

THE ENTERPRISE ARCHITECTURE

EA can be defined as the blueprint or the organizing logic that binds together aspects of (1) business planning, (2) business operations, (3) process rationalization, and (4) enabling IT infrastructure. Enterprise architecture views the organization as a complex system that cannot be tackled as a whole, but that rather needs to be decomposed into manageable entities. In essence, EA assists in understanding this complexity by binding and aligning the various elements of the enterprise systems, subsystems and applications to the organizational goals and strategies. This binding provides EA with the broader strategic context of optimizing business processes and performance by guiding technology, business and people to better understand and manage complexity and to swiftly manage the changing needs of the business environment. Typically, EA consists of baseline architecture, a target architecture (describing the current and future state of the enterprise, respectively) and a sequencing plan (roadmap for desired changes). The main goals of EA are to (1) create a unified and standardized IT environment across the whole enterprise, (2) maintain a strong symbiotic relationship between IT and organizational strategy, and (3) promote the reuse and sharing of IT assets and common methods across the enterprise. Once achieved, these goals enable the enterprise to benefit from a cheaper, more aligned, more strategic and more responsive IT [Minoli, 2008]. One should also note that EA has been around since the mid-1980s, but it is just recently that it gained unprecedented popularity. This is due to the fact that EA has shifted its mandate from a mere IT-centric function of standardizing, controlling and consolidating IT assets into a more strategic role that aims to align IT with the business to better position the enterprise to adapt to changing environments [51]. To this effect, Spewak and Hill [74]

argue that the higher the rate of organizational change, the greater the benefits from EA.

As illustrated in figure 1, EA is typically based on four pillars or architectural domains that need to be

cohesively integrated. These are business, systems/applications, data/information, and technical/technology architectures.

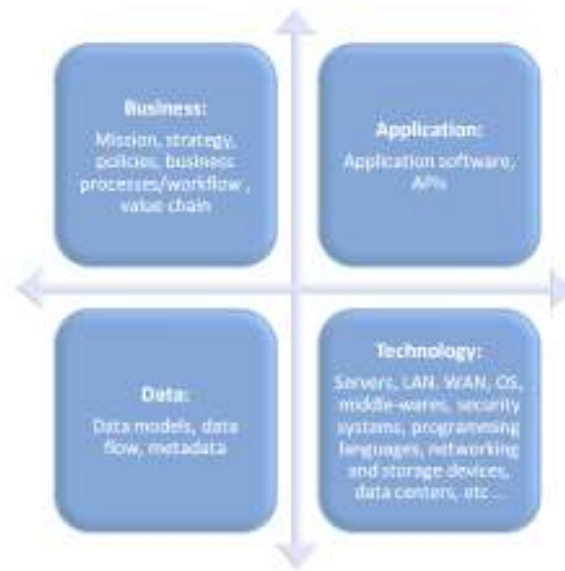


Figure 1: The Four Pillars of Enterprise Architecture

The *business* architecture describes the organizational structure, the business strategy, its governance, and the underlying core business functions and processes. The *systems/applications* architecture acts as the blueprint for the various application systems, showing how these systems interact with each other and how, together, they deliver computerized IT systems to support key business functions and processes. Often, within the framework of Service Oriented Architecture (SOA), business processes are implemented as business services that are exposed to and shared by different applications. The *data/information* architecture handles the various data management resources and the underlying logical and physical assets. This architecture defines the data models and data flows, and identifies the data interrelation needed to support the business functions. The *technical/technology* architecture describes the hardware, software, operating systems, and networking assets that are needed to support the enterprise applications [74]. Thus it is important to realize the much broader scope of EA, which goes beyond the business processes, IT infrastructure, or the services that run on this infrastructure. In fact, EA should be viewed from a global enterprise-wide perspective as a business-oriented management practice that intertwines business, technology and

people across the four domains of enterprise business (mission, strategies, governance, organizational structure, and processes), applications, data management resources and IT infrastructures.

Various EA frameworks, conceptual development tools, reference models, industry standards, and analytical techniques are available to enable enterprise architects capture and document the structure and dynamics of an enterprise. The most common EA frameworks are The Open Group Architecture Framework (TOGAF), the Zachman framework, the commercial-level Department of Defense Technical Reference Model (DoD TRM), the Enterprise Architecture Planning (EAP), and the Extended Enterprise Architecture Framework (E2AF) [51]. These frameworks comprehensively guide EA architects towards the governance, planning, design and implementation of enterprise information architecture. In addition, architectural efforts are driven by architecture principles that aim to provide guidelines on how to align the usage of IT resources and assets with the business strategic initiatives and priorities, taking into consideration existing resources, external constraints, and IT industry trends [81]. The present economic downturn is creating new business impera-

tives that are challenging the existing architectural principles in many ways:

First, EA strategy should direct the focus of the enterprise not only towards addressing short-term pressing challenges, but also towards putting the organization back on a sustained growth strategy for an anticipated subsequent recovery. In fact, by adopting a “don’t waste a crisis” attitude, EA can help enterprises use the urgency of the current economic crisis to introduce long overdue changes and drive innovative approaches that can result in better streamlined and integrated systems and processes.

Second, the lack of trust and the persisting uncertainty among stakeholders are accentuating the pressures on EA for stronger enterprise risk management and governance.

Third, the EA team needs to cope with limited funding to maintain or replace existing IT assets. Even if capital funds are available, new investments in IT would require a strong business case that demonstrates short-term financial returns. Further, the EA team is expected to play a leading role in helping the enterprise identify and dispose of redundant IT assets.

Fourth, as the economic stake of decision making is amplified during recessionary periods, there is an increased pressure on EA to deliver business intelligence and analytics for enhanced decision making.

Fifth, there is an increasing expectation from EA to convert the IT organization into a service-driven organization and to drive innovation and ingenuity, which are much needed during turbulent economic conditions [64].

THE PROPOSED CONCEPTUAL FRAMEWORK

Earlier empirical findings (see for example [72]) suggested that Information Technology can play an important role in enhancing the value of managing endogenous and exogenous knowledge, which in turn significantly enhances dynamic capabilities during turbulent environments. Teece [79] noted that “Dynamic capabilities reside in large measure with the enterprise’s top management team, but are impacted by the organizational processes, systems, and structures that the enterprise has created to manage its business in the past”. Enterprise architecture is a core building block for these systems and processes. Put differently, in order to appreciate the role of EA in enabling dynamic capabilities during challenging economic times, it is important to recall the strong dependence of firm-specific organizational and dynamic capabilities on business process management functions and on past records of “learning histories” that capture

previous positions and paths [72]. These capabilities are often embedded in various EA functions. For instance, Brits et al [11] proposed a conceptual framework for modeling business capabilities of agile organizations. The framework recognizes EA as a main practice that contributes towards the development of the business capabilities framework. EA has also been viewed as business capability architecture [10].

In what follows, we use the DC approach as a basis upon which we build a conceptual framework that can enable firms to make best use of EA in order to achieve better congruence with the prevailing economic conundrum.

As depicted in table 3, the proposed EAAF consists of the four EA domains of figure 1 as rows, and the core components of dynamic capabilities in table 2 as columns. In essence, the proposed framework provides a logical grid structure for organizing those core components of the EA that are relevant to dynamic capabilities of the enterprise during times of economic turmoil. Rows provide multiples perspectives on EA, while columns capture the various artifacts of the enterprise’s DC. The content of each cell reflects the different ways in which EA can better position enterprises during recession. These aspects have been synthesized through a combination of a top-down and a bottom-up approach. In the top-down approach, we start with the main benefits of EA, as reflected in each of its four domains, depicted in figure 1.

Table 3: The Proposed EAAF

DC component / EA domain	Sensing capability	Absorptive capability	Integrative capability	Innovative capability	Alignment capability
Business	<ul style="list-style-type: none"> ✚ Enterprise Information Architecture (EIA) ✚ Enterprise Risk Management (ERM) ✚ Enhanced process knowledge management ✚ Critical assessment of AS-IS business processes 	<ul style="list-style-type: none"> ✚ Common Requirement Vision (CRV) 	<ul style="list-style-type: none"> ✚ Business Process (BP) redesign and optimization ✚ Information governance ✚ Enterprise Information Management (EIM) strategy ✚ Cohesive business rules ✚ Alternate sourcing options 	<ul style="list-style-type: none"> ✚ EA governance ✚ Business Model (BM) revision ✚ Environmental scan ✚ New business opportunities, services, and value-chain capabilities 	<ul style="list-style-type: none"> ✚ Business-aligned Enterprise Information Architecture (EIA) ✚ EA governance ✚ EA policies and guidelines ✚ Common Requirement Vision (CRV) ✚ EA benefit logic ✚ EA sequencing and monitoring plans ✚ IT projects' revision and prioritization ✚ Better understanding of interdependent BPs ✚ Alternate sourcing options ✚ Facilitated collaborations among stakeholders ✚ Business Performance Management (BPM) ✚ Process optimization
Application	<ul style="list-style-type: none"> ✚ Business Intelligence and analytics ✚ Detection of duplicate enterprise applications 	<ul style="list-style-type: none"> ✚ Dynamic Warehousing (DYW) ✚ Business Intelligence and analytics 	<ul style="list-style-type: none"> ✚ Business Intelligence, advanced analytics and modeling ✚ Standardized interfaces across the enterprise ✚ Enterprise Content Management ✚ Enterprise Information Integration 	<ul style="list-style-type: none"> ✚ Business Intelligence tools 	<ul style="list-style-type: none"> ✚ Standardized applications ✚ Enterprise-wide unified applications ✚ Advanced business analytics and business optimization applications ✚ BP analysis and modeling tools ✚ Leveraging and reuse of existing applications ✚ Enterprise mashups
Data	<ul style="list-style-type: none"> ✚ BP Repositories ✚ Dynamic data streaming ✚ Real-time data collection ✚ Standardized methods for data definition, creation, and access ✚ Faster extraction of consolidated data ✚ Data marts and data warehouses ✚ Data virtualization 	<ul style="list-style-type: none"> ✚ Metadata, master data ✚ Structured, semi-structured and unstructured data. ✚ Data marts and data warehouses 	<ul style="list-style-type: none"> ✚ Master data ✚ Integrated and shared data ✚ Standardized information flows across the enterprise ✚ Standardized data definitions and structures across databases 	<ul style="list-style-type: none"> ✚ Information repositories 	<ul style="list-style-type: none"> ✚ Timely and accurate data about ecosystem ✚ Integrated and shared data ✚ Data marts and data warehouses
Technology	<ul style="list-style-type: none"> ✚ Information as a Service (IAAS) 		<ul style="list-style-type: none"> ✚ Asset reconfiguration, consolidation and integration 	<ul style="list-style-type: none"> ✚ Innovative IT services (mobile services, trusted cloud services, etc.). ✚ Information sharing and collaboration platforms 	<ul style="list-style-type: none"> ✚ Consolidated IT infrastructure ✚ Virtualized and shared assets ✚ Optimal usage of IT assets across the enterprise ✚ Cloud/Grid computing ✚ Open-source software alternatives

We then explore how these benefits can enable organizations to dynamically respond to the current economic crisis. In the bottom-up approach, we start by identifying potential “pain-points” within the core components of a firm’s dynamic capability. Within the context of the prevailing unfavorable economic climate, we then explore ways by which EA can address some of these hurdles.

The validity of the proposed framework is mainly reflected in its logical coherence, and its practical and theoretical relevance, as well as in its relative explanatory power [27]. In fact, the EAAF integrates proven strategic management concepts, such as the resource-based view, Schumpeterian theory, and dynamic capability approaches, with the four entrenched EA architectural domains. This integration enables us to discover ways by which EA can help organizations successfully navigate their way out of the economic recession. The proposed EAAF is also guided by the following principles:

- The four row-perspectives holistically capture all aspects of enterprise architecture.
- The five column-perspectives capture the critical aspects of the enterprise adaptation to the new business environment.
- Each row perspective is unique, but a perspective of a higher row provides service to the perspective underneath it. Further some EA domains may set requirements for other EA domains.
- The top rows are typically used in the earlier phases of the adaptation cycle, whereas the bottom rows become more important later. Further, top rows are more business-oriented, whereas bottom rows are more technically-oriented.
- Not all the column perspectives are necessarily ordered. However the first three columns can be considered ordered to reflect a sequential process of adaptation that starts with sensing followed by absorption and then integration.
- The framework is not meant to fill each cell from left to right and from top to bottom in a self-contained process.
- The cell-perspectives related to any particular EA domain should be read concurrently across all column-perspectives to affirm the contribution of a given EA domain.

One should note that the EA-enabled dynamic capabilities captured in the proposed framework are potential capabilities that cannot be unleashed successfully without the presence of other contextual factors, including

top management support and involvement, organizational agility, proper governance, a skilled EA team, a strong organizational culture, access to external expertise if necessary, sufficient funding and change management capabilities [13,76]. In particular, besides the requirement to align the EA strategy with the business strategy, some equally important governance considerations must be taken into account, including:

- Securing cross-functional commitment and advocacy from senior executives at all levels of the organization in order to initiate and maintain the enterprise architectural efforts.
- The presence of well-established executive sponsorship, mandates, and directives in support of the architectural efforts.
- Clear lines of responsibility, accountability and authority across all levels of the organization.
- Assigning information stewards to manage and maintain information as a strategic asset to be shared and easily accessed across the whole enterprise. This includes the implementation of policies governing the proper use of information.
- Focus on accountability, organizational policies and performance/risk management to monitor compliance and improve business performance.
- An enterprise-wide mindset that recognizes EA as a strategic change agent.
- Successful alignment of business processes, people and technology for business agility.
- Compliance to relevant legislative and regulatory directives, as well as to information security and privacy requirements.

The above governance considerations are different during the current economic downturn in the following ways:

- Increased scrutiny from investors, shareholders, and stakeholders towards corporate transparency, accountability, numeration process, reporting, and corporate governance (financial and non-financial) disclosures [38].
- Greater focus on risk governance and resiliency, including the adoption of proactive Enterprise Risk Management (ERM) strategies in light of the global economic downturn [38]. For example, Standard & Poor (S&P) has recently refined its rating process

by incorporating ERM as an integral part of corporate credit rating [20].

- Accentuated focus on data governance due to staff layoffs and the rationalization of IT assets [15].
- Stiffer constraints in securing sponsorship and funding for the desired changes in processes and IT resources due to budget constraints, over-centralization of decision making, and greater emphasis on meeting short-term business priorities.

We next look at the ways in which the enterprise architect can use the proposed EAAF, in order to facilitate the enterprise adaptation to the current economic downturn. At this stage, it is important to recognize that, for a given DC component, some overlap among the contribution(s) of each of the four EA domains is sometimes inevitable, as some EA domains may set requirements for or may provide services to other EA domains, as highlighted in the third EAAF principle.

Enterprise Architecture and Organizational Sensing Capability

In this section, we show how EA can help organizations sense for information about the ecosystem, better understand market dynamics, and better identify opportunities and threats posed by the current turbulent economic environment.

Business Domain

The EA can play a leading role in enhancing the organizational capability to sense the threats and risks that are dictated by volatile economic conditions. Enterprise Risk Management (ERM) becomes even more crucial during tough economic times and requires good sensing of the various existing and potential risk areas (e.g. market risk, liquidity risk, credit risk, and trading risk) that the enterprise might be exposed to. To address this challenge, the Enterprise Information Architecture (EIA), which represents the information viewpoint of the EA, can act as a valuable responsive asset that enhances the organizational risk-related information management capabilities through the following means [28]:

- Support for a large number of risk metrics
- Sensing and integration of enterprise risk information, including the relationships among different types of risk exposures across LOBs
- Support of a real-time enterprise-wide view of risk exposures to accommodate changing risk factors and predict potential threats via

advanced risk modeling engines and scenario analysis tools in order to meet the need for an integrated ERM, the following EA components are invoked [28]:

- Data related to enterprise risk comes from the operational systems to the analytical application component. The EII (Enterprise Information Integration) layer uses various integration mechanisms and the Master Data Management (MDM) component uses quality mechanisms to produce a consolidated view of trusted risk information.
- The analytical application component uses specialized risk engines to run risk analysis, prediction and reporting, while business rule engines can be used to recommend corrective actions, based on Key Risk Indicators (KRI). These tasks are enabled by networked BI capabilities, including BI reporting, multi-dimensional analysis, data mining, predictive models, and time series analysis.

Recognizing that organizational capabilities are often embedded into processes, Business Process (BP) repositories embed valuable knowledge, business intelligence and records of past paths. EA can unleash knowledge creation and management to facilitate the diffusion of endogenous skills and shorten time to market [72]. For instance, the business and system analysis activities performed during the EA planning phase enable organizations to tap into previously undocumented information related to the business processes. New interdependencies, inefficiencies and synergetic opportunities can thus be revealed, which further enhances organizational knowledge about its processes [76].

Applications Domain

In a turbulent economic environment, personal experience and insights as well as “gut responses” are no longer adequate to sense the environment; which leads to an increasing need for advanced dynamic data streaming, warehousing, Business Intelligence (BI), and analytic capabilities [28]. The BI and predictive capabilities embedded in the EA enable organizations to sense and quickly respond to changing conditions, especially during times of economic recession [73]. EA can also enhance the enterprise’s ability to sense duplicative capabilities that consume unnecessary additional resources and that can turn into a financial burden for the enterprise. For instance, the capability of the EA to detect unnecessary applications that are owned by a particular organization can reduce duplication in some individual organizational capabilities [51]. Further, the anticipated economic recovery will

bring new business opportunities that require firms to be agile and make best usage of business analytics to better understand the anticipated changes in customer buying habits, value chain arrangements, and the competitive landscape.

Data Domain

When properly planned and executed, EA can speedup data collection, creation and transfer across the organization. This will enhance the quality and efficiency of the sensing capability process. In fact, the enterprise architecture environment enables the extraction of consolidated, more accurate/accessible and timely data [51]. In particular, event-based information, based on data-driven facts, is collected and tracked in real-time and not after the facts. This data is pulled from internal (e.g. transactional, planning, CRM) as well as from external data providers [28]. Further, data virtualization can be implemented to use techniques such as federation to tap into heterogeneous data sources, which ultimately enhances the sensing capability of the firm. For instance, within the context of SOA, Information as a Service (IaaS) enables business processes to get timely information, following open industry standards. A federated server can poll and access data anywhere in the enterprise.

Enterprise Architecture and Organizational Absorptive Capability

The business and application domains of EA can congruently assist organizations in recognizing and assimilating the value of new external information, trends and requirements and transform it into valuable business insights for enhanced decision making.

Business Domain

During times of economic recession, enterprises need to recognize and assimilate emerging environmental trends, business strategies, business change requirements, and IT requirements to establish business solution requirements. EA can play an important role in fulfilling this need through the Common Requirement Vision (CRV). The CRV is a major element of the EA process that articulates the key information requirements needed to meet the strategic business objectives. For instance, during unfavorable economic climates, business leaders often opt for a series of common restructuring options, such as organizational layoffs, debt restructuring, LOB consolidations, and deleveraging of capital and financial structures. Business leaders need to accurately assess the impact of each of these options on future-state business objectives. The CRV can pull resources from the EA to envisage various courses of action, conduct what-if sce-

narios, and assist business managers assess the likely impact of each restructuring option [73].

Applications Domain

Enterprise Information Architecture (EIA) components are redefining the role of the traditional Data Warehouse (DW) in enhancing the organizational capability to quickly identify and assimilate the value of new internal and external information and transfer it into embedded knowledge for internal use. In essence, EIA components work closely with the evolutionary Dynamic Warehousing (DYW) approach to enable organizations to better respond to the changing business environment. DYW is the next step in the evolution of traditional DW, and its infrastructure leverages the EIA components, including Enterprise Information Integration (EII), metadata, master data, Enterprise Content Management (ECM) and analytical services. DYW uses the core components of EIA to facilitate the following capabilities [28]:

- Discover, extract, integrate, and mine knowledge coming from internal and external, structured as well as unstructured and semi-structured data (XML documents, documents, blogs, customer e-mails, video, etc..) to further strengthen the analytical and predictive power of BI tools. The DYW approach uses the Unstructured Information Management Applications (UIMA) standard for text analytics.
- Provide timely analytics and business insights which enable right-time operational Business Intelligence and thus better decision making.

Enterprise Architecture and Integrative/Reconfiguring Capability

The business and application domains of EA can play an important role in enhancing an enterprise's ability to integrate scattered patterns of data interactions; thus enhancing organizational responsiveness to weaknesses and threats, and improving decision making.

Business Domain

As many organizations continue today to find their way out of the prevailing economic predicament, cost reduction initiatives alone become insufficient for their long-term survival. There is also a need for organizations to have an integrated view into operations, LOBs, and processes, across the whole enterprise, so that degraded performance, quality issues, and operational inefficiencies are promptly and proactively spotted, and the right actions are taken. Furthermore, there is abundant real-time

data that is often scattered inside and outside the enterprise and which captures the various aspects of the business environment. Senior business executives are often concerned about the lack of critical integrated information that they need to make timely important decisions and respond to the prevailing economic downturn. EA can unbolt information and make it accessible to any person, entity, or process that needs it in a concise, timely, and actionable manner. For example, by implementing an Enterprise Information Management (EIM) strategy, the enterprise becomes empowered to effectively integrate and manage disparate enterprise-wide data. The EIM strategy is supported by the EIA and its underlying components (such as Master Data Management (MDM), Enterprise Content Management (ECM), and Enterprise Information Integration (EII)), as well as by the information governance [28].

EA can be empowered by advanced analytics and modeling capabilities to help enterprises evaluate a set of reconfiguration alternatives, taking into account the various dynamic constraints and risk factors that are dictated by today's somber economic climate [28]. For example, EA can help organizations reconfigure and recombine assets and organizational structures and try to escape shirking, free riding, and past unfavorable path dependencies. Redeployment and reconfiguration may also involve business model redesign and asset re-alignment activities. It may or may not involve mergers, acquisitions, and divestments [79].

Applications Domain

EA can facilitate the integration and sharing of enterprise-wide information by advocating common data definitions and structures across the enterprise databases, as well as by standardizing the interfaces and messaging among different enterprise applications [9]. In fact, by standardizing the methods of defining, creating, maintaining and accessing data, EA enables all organizations within the enterprise to make best use of shared and integrated data thus enhancing decision making [51]. For instance, EA artifacts can force business rules to be consistent across the organization and ensure that interfaces and information flows are standardized for maximum integration and interworking across the whole enterprise [28].

Various BI artifacts are involved in the integration and analysis of enterprise-wide performance data. These include enterprise reporting and ad hoc query tools, data integration and data quality functionality, dashboards, scorecards, packaged analytic applications, and enterprise reporting functionality. Advanced BI analytics techniques enable decision makers to slice-and-dice the data and get new insights that would not be possible with simple data

analysis tools [69]. To this effect, Madan [49] argues that "as companies brace themselves for a recession, investing in business intelligence (BI) software might well be their best defense". Today, using BI tools, EA can enable organizations to convert data collected from many sources into real-time 360-degree view of the enterprise and provide valuable insights on questions like the following:

- Which ongoing projects are most likely to exceed their budgets or miss their deadlines
- Which product lines are losing money?
- What is happening to our market share?
- How adequate is our pricing strategy in the current circumstances
- Who are our most profitable customers?

EA enables organizations to integrate scattered pieces of information related to the various vendors that participate in the enterprise architecture and build a consolidated view of the role each vendor plays within this architecture. This capability enables the organization to (1) identify costly applications that are rarely used, (2) discover opportunities to consolidate some applications and reduce dependence on a particular vendor, (3) explore alternate sourcing opportunities such as outsourcing and cloud computing, and (4) develop strategies to better negotiate and manage licensing contracts [48].

Enterprise Architecture and Organizational Innovative Capability

Historically, EA has rarely been considered as a catalyst for innovation. Typical areas where EA has been used to drive innovation are in the adoption of innovative SOA architectures and trusted cloud and Web services. However, the fact that enterprises are going through stressful economic conditions should not preclude the EA team from exploring innovative technologies that can potentially reduce short-term cost or drive profit [48]. Indeed, recently, the role of EA started to evolve from just a facilitator of IT-business alignment and enabler of IT governance and compliance towards a catalyst for business innovation initiatives. Many EA teams have in fact turned their IT organizations into service-driven organizations where emerging technologies are scanned for potential future innovative opportunities. A 2008 survey performed by the Architecture & Governance Magazine revealed that 57% of the 289 surveyed enterprise architects stated that EA is being used as a driving force for growth and business innovation initiatives [1]. A more recent survey conducted by Harvey Nash revealed that 74% of CIOs believe that the adoption of new technologies and technology-driven innovations must be at the heart of the company's strategy and that failure to do so will result in loss of mar-

ket share. However, only 34% believe that they have achieved anything close to their innovation potential [53]. Here, innovation can take many forms, including identifying new business opportunities, new services, enhanced information delivery models, new business models, or new value chain capabilities. However, appropriate governance is needed to ensure that funds are available to promote innovation, despite shrinking IT budgets during challenging economic times.

Today, more and more organizations are adopting a top-down architectural driven approach to ensure that their IT strategies are orchestrated in such a way as to cross-leverage organizational assets towards creating new capabilities and driving incremental innovation. These capabilities can be unleashed through the usage of information repositories and business intelligence tools [8]. During the early stages of the EA lifecycle, enterprise architects can make best use of the environmental scan phase to find ways to drive business innovation by questioning existing business models, business processes, and the portfolio of products, services, and applications. Enterprise architects can also provide the needed IT platforms to facilitate the sharing of information and collaboration across the enterprise, which can drive incremental business innovation.

In “Surviving the Slump”, a special report on business in America, the Economist magazine credited the current recession for its power of “creative destruction” [21]. The report argued that the economic downturn will produce stronger firms that learned through painful adaptation how to unlearn bad management practices and become more efficient, innovative and competitive. On the other hand, firms that just navigated through turbulent times of economic turmoil, hoping to emerge the same way they entered it few years ago, will find it hard to hold out in the long run [21]. In fact one of the key challenges that face CIOs today is how to keep tight cost control during the recession, while ensuring adequate technology capacity, innovation, and flexibility to enable the organization to renew its pursuit for market share growth, profit and new product development after the recession [53]. This is one area where the CRV of the EA can play an important role by scanning potential innovations and assessing the likely impact of each option, taking into account the short and long-term business goals. Enterprise Information Architecture will be a valuable resource to assess the risk exposures of various potential innovations.

Enterprise Architecture and Organizational Alignment Capability

Under the current recessionary conditions, the EA team must shift its focus from exploring long-term investment opportunities to finding new ways to reduce near-term costs [48]. In fact, among the important survival practices that EA can enable during challenging economic times are finding ways to reduce cost or reduce time to market without compromising customer service and quality, or finding ways to enhance organizational performance (e.g. via business process optimization) [40].

Business Domain

By nature, EA planning activities are cross-organizational and tend to facilitate dialogue, collaboration and objectivity in collective decision making among various stakeholders [63]. This inherent characteristic contributes towards better alignment of IT and business investment decisions by enhancing our understanding of the interdependent business processes that IT systems need to support.

During challenging economic times, the priority of the EA team should shift from the traditional tasks of guiding towards technology selection and defining technology standards towards more compelling business survival practices, such as swiftly aligning information assets with the strategic priorities with least risk and lowest cost [40, 51]. In fact, in light of the current economic conundrum, EA governance should articulate policies that describe the relationship of EA to the enterprise strategic plan, as well as a translation of business strategies into EA goals, objectives and strategies [51]. For this purpose, the EA team needs to work closely with business analysts to outline the architectural principles that align with the strategic priorities in response to the prevailing economic downturn. These principles capture the key requirements and best practices needed to meet the business requirements and are subsequently mapped into EA policies and guidelines [40].

The alignment of the EA with the business goals of the organization is best reflected in the benefit logic, which aims to map the strategic goals of the organization into architectural practices. EA teams need to work closely with the business groups to test the viability of the ongoing and future projects against the strategic priorities outlined in the Common Requirement Vision (CRV) of the EA [28]. This enables the enterprise to make judicious investment decisions and to categorically exclude doomed projects. Many models, views, and automated tools (including dashboards) can be created and integrated to represent the various aspects of the enterprise, including [40, 51]:

- *Baseline “As-IS” Architecture*: captures the current status of the IT infrastructure and current business processes. The analysis of the baseline architecture can reveal opportunities for identifying redundant resources, consolidating network services, or realizing economies of scale. In addition, EA can help enterprises identify and control the “bottleneck assets” or “choke points” in the value chain and can recommend outsourcing those assets and services that are in competitive supply.
- *Target “To-Be” Architecture*: captures the end-state enterprise status, as reflected in the business vision, mission, planned strategies, and business tactics.
- *Sequencing Plan*: captures the planned activities and the needed resources to address the prevailing priorities of the enterprise. The plan documents the strategies needed to migrate from the current baseline towards the target architecture. It outlines a portfolio of potential projects that will help the enterprise meet its goals and objectives. Process model analysis and business architecture analysis can be used to identify the needed changes in existing business processes, and recommend the IT infrastructures that are needed to support the target architecture. By using the visualization, time-lapsed and impact-analysis tools of EA, enterprises can identify gaps and take corrective actions. During this phase, EA teams need to revisit the ongoing and planned projects in light of the prevailing economic conditions. More precisely, EA teams should take a leading role in revising and, if necessarily, modifying the IT roadmap for better alignment with the business priorities. Such revision should be unbiased and should not exclude the delaying or cancelation (at least for the short-term) of some valued IT projects. In addition, enterprise architects can identify suitable opportunities for outsourcing some of the IT functions and suggest an unbiased roadmap for implementation.
- *Monitoring Plan*: ensures that the enterprise architecture realigns itself and evolves with changing business requirements.

In the midst of an economic downturn and increased global competition, enterprises need to carefully

re-examine the appropriateness of their sourcing alternatives. In particular, CIOs need to examine a multitude of IT sourcing options including in-sourcing, outsourcing, back-sourcing, multi-sourcing, offshoring, shared services models, and third-party cloud computing services. A sound sourcing strategy starts from the CRV of the EA by performing a strategic and economic assessment of the “as-is” sourcing arrangement, as well as other potential “to-be” sourcing alternatives. This analysis should be complemented by assessing the strategic fit, risks and organizational impact of each sourcing option.

Enterprise Information Architecture (EIA) uses business analytics and business optimization techniques to help enterprises get smarter and take right-timed actions. Performance managers, executives and business analysts have traditionally used a variety of business metrics or KPIs to conduct Business Performance Management (BPM). For instance, once each KPI is defined and associated with a specific business goal, BI and analytics techniques can be used to track in real-time the KPIs and present key decision makers with invaluable insights regarding the current and forecasted state of the business [28]. Scorecards and other PM tools enable the organization to monitor in real-time the extent to which the business metrics and KPIs of individual teams are being met and to proactively identify exceptional conditions and early signs of degraded performance. This takes BPM to a higher level by enabling the right actions to be taken in order to optimize business performance and close the gap between business needs and IT support [69]. In addition, EIA enables internal, external, structured, and unstructured data to be gathered, integrated, categorized, analyzed and processed to enable new business insights that go beyond business performance management to include the capability to predict future outcomes and optimize enterprise-wide business processes [28].

Applications Domain

One way that the enterprise application architecture can help enterprises reduce costs is by suggesting where to retain, retire, or rebuild applications [51]. For instance, enterprises can use EA to identify duplicated services and enable the migration towards a “shared service” model, or alternatively identify those services that are good candidates for temporal or permanent outsourcing [56]. To put it differently, EA can help identify overlapped, duplicate and non-value-adding resources, and can guide towards finding new opportunities for economies of scale and scope through reusing, streamlining and leveraging existing applications.

By driving standardization, EA enables enterprises to benefit from lower run-the-engine (RTE) costs,

and quicker rollout of functions and applications [51]. A more standardized IT platform also leads to reduced complexity, better interworking, and lower operating cost [9, 82]. For example, EA can push towards the development of unified applications across the enterprise. The rationale is that enterprise-wide capabilities are preferred over individual organizational capabilities which usually do not serve the entire enterprise and often duplicate existing enterprise capabilities. Ultimately, EA enables the organization to leverage, rather than replace, existing applications, thus minimizing unnecessary technology spending through the re-use of existing applications and infrastructure [18].

Given the tight financial constraints during times of economic downturn, it becomes necessary to ensure that technology investments are vectored towards those applications and resources that capture the highest potential value for the enterprise. During the business analysis phase, EA facilitates the understanding and the documentation of the purpose, lifecycle stage, and business impact of the various individual applications and system components [76]. Therefore, EA is well positioned to enhance resource portfolio optimization across the enterprise. Business Analytics and Business Optimization applications can play an important role in taking the right actions at all levels of the enterprise, including policy, processes, organizations, and applications. At the same time, IT organizations need to live with a shrinking budget that must to be wisely spent to optimally support the business strategy. For instance, given the tight budget constraints, any investment in a BI solution must be meticulously justified to show how the investment will result in increased revenues, reduced cost, or both. In fact, investing in BI for the sake of achieving its claimed benefits can actually wipe out business value unless these benefits can be translated and quantified in operational terms and realized through business processes that affect revenues or costs [87].

Enterprise architects can promote the adoption of *enterprise mashups* to bring down cost. Recall that mashups are lightweight web applications, developed by end users, that combine information and capabilities from more than one data source (e.g. news feeds, ERP applications, Google maps) to deliver new insights [28]. Enterprise mashups can contribute towards enhancing operational efficiency and reducing cost in at least two ways. First, enterprise mashups can relieve skilled IT staff from developing enterprise applications and have them focused instead on more important mission-critical tasks that can affect the business bottom line. Second, IT departments are nowadays pressured to quickly develop enterprise applications at minimum cost due to budget constraints. They can develop mashups for non-mission-critical appli-

cations, as mashups do not require highly skilled IT staff and can be developed more quickly. For example, mashups can enable business units to access supply chain information for a retailer, or share information with customers. However, to reap the benefits of enterprise mashups, the EA team needs to ensure that business users are properly trained. The EA team also needs to resolve issues related to information governance (i.e. the governance of the data accessed by the mashups), and should typically keep critical mashup applications under the jurisdiction and control of the IT department [28].

Technology Domain

EA can play an important role in leveraging the existing IT platform by suggesting ways to reuse, share, consolidate, or retire IT assets. In addition, EA can strategically adopt emerging technologies such as virtualization, grid computing, cloud computing, and open-source software to further drive down costs.

Virtualization enables the efficient pooling of networking resources, including servers and storage devices. Virtualization was ranked second in the 2010 SIM CIO survey regarding the most important applications and technologies [45]. Considering the EA infrastructure layer, enterprises can explore ways to migrate operating systems and applications from under-utilized physical devices to virtual servers and storage devices. Server virtualization can significantly reduce the cost associated with future hardware purchases, real estate (via footprint reduction), systems management, and power and cooling expenditures in the data centers [23]. These enhanced efficiency and cost reduction opportunities cannot go unnoticed during turbulent economic times. For example the Dell IT group recognized that nearly 75% of its 20,000 plus servers are running under 20% of processor utilization. By virtualizing more than 50,000 servers, the group estimated that it saved the company over US\$29 million, while reducing application deployment time from 45 days to just 4 - a critical factor to support potential growth in future business needs [17].

Grid computing is a technology that enables the enterprise to virtually and dynamically integrate, streamline and share distributed computing and storage resources into a cohesive and synergistic system in order to deliver services to everyone connected to the grid. This consolidation, distribution and integration of computing resources results in a lower cost, as resources are now consolidated, shared and synergistically better utilized, and as power and cooling costs are greatly reduced. It is expected that grid computing will yield a reduction in the TCO of IT assets by as much as 30% by 2010 to 2012 [51]. Since getting the most out of existing network capacity becomes

very relevant during an economic downturn, grid computing has been moving from the academic and scientific realms towards the mainstream of enterprise IT. In addition, by loosely coupling a number of distributed computing resources, grid computing enables organizations to run and process computing-intensive analytics in less time, thus facilitating a quicker response to changing environmental conditions.

Cloud computing, often referred to as the fifth utility, enables the outsourcing of computing capacity and enterprise software applications to third party services in order to reduce investment in hardware, applications, licenses, real estate, personnel, maintenance, power and related costs. Cloud computing also has the potential to free up the IT staff from performing daily maintenance tasks and have them focused instead on more strategic priorities that can improve bottom line results [23]. Since cloud computing embraces the “doing more with less” value proposition through lower TCO and higher ROI, it becomes even more appealing during this economic downturn.

Cloud computing refers to both applications delivered as services over the Internet (commonly referred to as Software as a Service (SaaS)) and the hardware and system software in the data centers that provide these services [4]. Cloud computing services can be classified into three major categories with overlapping provisioning capabilities, namely Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Other specialized cloud services are also available, including Database-as-a-Service, Security-as-a-Service, Management-as-a-Service, and Business Process-as-a-Service [50].

Software-as-a-Service (SaaS) is the application component of cloud computing that enterprise architects can recommend lowering the cost of software acquisition, development and maintenance. It refers to hosted web-based services for end-user applications, such as web-based email, HR management, payroll processing, inventory control, e-procurement, SCM, CRM, database processing and other application processes that are delivered as services over the Internet [50]. In many cases, SaaS has the potential to deliver software solutions to enterprises at a lower TCO [48].

Platform-as-Service (PaaS) is the development component of cloud computing where infrastructure software and operating systems are located. It provides the software environment, interfaces and associated services that developers can use to design build and test applications on the cloud infrastructure before delivering these applications to end-users from the cloud provider’s servers [75].

Infrastructure-as-Service (IaaS) is the IT infrastructure component of cloud computing. It refers to the virtual hardware devices and related services such as network devices, general processing, storage devices, database management, and virtualized servers that are offered as a service to enterprises through the network cloud.

The economic appeal of cloud computing is attributed to two main economic factors, namely elasticity and transference of risk. Elasticity of resources refers to the ability to adjust the needed resources with fine granularity (example, processors by hours and storage by days) to match workload with a lead time of minutes rather than weeks. Transference of risk refers to the fact that the risk of misestimating workload is shifted from the organization to the cloud provider. More precisely, organizations need no longer worry about the risks of over-provisioning (underutilization) or under-provisioning (saturation) services to accommodate periodic, seasonal, or unexpected computing demand fluctuations. These two factors provide enterprises with the opportunity to migrate from a Capital Expense (CAPEX) cost model towards an Operational Expense (OPEX) model, taking advantage of a pay-per-use business model to minimize start-up costs [4].

During times of economic downturn, start-up companies that depend heavily on Internet services no longer need to invest upfront in IT infrastructure and the associated maintenance cost. Instead, the pay-for-use business model of cloud computing enables these start-ups to pay for the use of the computing resources on a short-term basis as needed. This “pay as you go” model enables start-ups to redirect up-front capital expenditure in IT infrastructure towards supporting core business activities. The model also lowers the barriers of new entrants and facilitates experimentation. Therefore start-ups will have the flexibility to start small and scale their networking needs without building or maintaining a datacenter [4,39].

Cloud computing has also enabled established organizations (such as the Washington Post, Pixar and UCB) to take advantage of the elasticity of cloud computing and migrate their existing datacenter-hosted services to the cloud. This migration aims to reduce the Total Cost of Ownership (TCO) of delivering IT services, while enabling the enterprise to focus more on production, added-value services, and innovation [50]. In addition, organizations that have their own data center can procure cloud services for experimentation in order to expand their internal computing resources with additional “leased” computing facility. This enables enterprises to undertake heavy business analytics and simulations (such as real-time analysis of consumer behavior and spending patterns, and predictive simulations for financial modeling and marketing strategies) that require large-scale computing

resources that are not available in-house [39,62]. At the same time, enterprises will be able to enhance their sense-and-respond capability and proactively infer deeper insights to both the causes and their effects, thus exiting the economic downturn with a momentum rather than inertia [62]. Alternatively, for many SMEs, investing in traditional BI solutions might not be feasible under the current economic conundrum. However, cloud computing can provide an opportunity for these organizations to use cloud BI solutions or SaaS BI to improve business agility, while reducing IT expenditure [52].

Today, enterprises which are adopting a mature EA approach, e.g. an approach based on Zachman or TOGAF, are well positioned to benefit from pay-as-you-use cloud computing services. More precisely, enterprise can successfully map each of the four domains of EA to the corresponding cloud service category without additional capital investment as follows [50]:

- Use cloud IaaS and PaaS offerings as a basis for the EA infrastructure layer.
- Use cloud SaaS offerings as a basis for the EA application layer.
- Use cloud PaaS and IaaS offerings, or access other specialized cloud services such as Database-as-a-Service to organize the EA data layer.
- Explore the usage of other specialized cloud provision, such as Management-as-a-Service, to support the business layer while ensuring that the controls related to business strategy, governance and security remain in-house.

Therefore, the convergence of EA and cloud computing has a strong potential to make small, medium and large-scale enterprises more flexible, agile, efficient and productive [50,61]. To achieve this potential, the EA team should evaluate different cloud computing approaches and solutions and develop a business case on how cloud computing services can create value and enable cost savings. The Enterprise Information Architecture (EIA) and the CRV should articulate a roadmap and develop a framework to seamlessly orchestrate and integrate cloud services with the existing technical architecture. At the same time, the EA team will need to play an important role in overseeing and managing the cloud service outsourcing contracts. The EA team will also need to identify, assess and deal with the potential constraints, challenges, and risks emanating from a cloud computing approach. For a summary of these challenges, the reader is referred to the work of Mahmood [50] and the references cited therein. In particular, enterprises need to implement

a cloud computing governance program to effectively manage increasing risk and ensure continuity of critical business processes in the cloud [35].

Finally, the adoption of proven and reliable *Open Source Software* (OSS) for enterprise-class use is another alternative that the EA team can envisage to reduce costs. This is particularly important in the midst of the economic downturn, as the license and support costs associated with highly-priced proprietary packaged software, applications, operating systems, and middleware can become a real saddle on the business [48]. A 2009 survey conducted by IDC found that the open source software market has witnessed a strong boost from the prevailing economic downturn, with worldwide revenues expected to grow at a 22.4% compound annual growth rate to reach \$8.1 billion by 2013 [36]. This expected growth is also attributed to the increased quality, reliability and support services provided by OSS providers. In a declining economy, most IT departments are under increased scrutiny and increased pressure to reduce costs. As a result, many are turning to open source enterprise application-providers as viable sourcing alternatives to procure databases and enterprise-grade software applications (such as ERP) to reduce costs and increase competitive advantage.

Enterprise architects can play an important role in formulating a comprehensive enterprise open-source strategy that will provide guidance on how to effectively take advantage of those OSS solutions that have greatest potential for cost savings, while fulfilling the quality, reliability, security, support, and end-user requirements.

CONCLUSION AND FUTURE STUDY

This paper recognizes that the development of dynamic capabilities is crucial for the survival of many firms in the midst of the prevailing unfavorable economic climate. Accordingly, we have proposed a conceptual framework based on a dynamic capabilities approach to emphasize the greater role enterprise architecture can play to assist firms coping with challenging economic times. We demonstrated how EA can go beyond specifying IT architecture and how it can be used as a catalyst for business innovation and as an alignment force to unleash the power of enterprise information and assist enterprises cope with tough economic conditions. In particular, we showed how a properly planned and executed EA can help organizations embrace a dynamic strategy to counter the threats posed by the economic turmoil and capitalize on future opportunities. In addition, this research can help business executives make best use of enterprise architect-

ture to address and adapt to turbulent change contexts other than economic turmoil. We hope that this research will serve as a solid base for future studies on the greater role EA can play during turbulent economic climates.

One limitation of this research is that it does not offer an empirical validation for the proposed framework; however it does provide a sound theoretical framework for further empirical studies. A natural extension of this contribution can focus on conducting qualitative and quantitative studies to test the practical and theoretical relevance of the proposed framework. Another potential area for future study would be to explore if we have missed any relevant factor in the proposed EAAF. Thus, future research can focus on refining the proposed framework to further enhance our understanding of the greater role EA can play during challenging economic times.

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