Towards the Development of an Adaptive Enterprise Service System Model

Completed Research Paper

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ABSTRACT

The continuous adaptation of modern enterprises is largely dependent on their underlying adaptive enterprise architecture capability. However, the establishment of an adaptive enterprise architecture capability requires defining the enterprise context before actually commissioning any enterprise architecture or adaptation work. This paper presents the adaptive enterprise service system (AESS) model based on the "Design Science" research method and "Theory Triangulation" approach. The AESS integrates the enterprise context perspectives from three well-known theories of agility, (agent) system, and service science. The AESS model, as a part of the large adaptive enterprise architecture toolkit, defines a modern enterprise as an adaptive enterprise service system. The adaptive enterprise service system is a multi-agent system of service systems that exhibits agility and focuses on the emerging service-centric view as opposed to a traditional product-centric view. The service-centric view of an enterprise is critical for establishing the adaptive enterprise architecture capability for handling complex enterprise transformations.

Keywords

Agility, Agent, Enterprise Architecture, Enterprise Transformation, Service System, Modelling

INTRODUCTION

Enterprise is defined as ". . an entity, regardless of its legal form . . including partnerships or associations regularly engaged in economic activities" (European Commission 2003). Enterprises need to identify appropriate capabilities for the consistent and smooth enterprise operations and adaptation (Espinal et al. 2012). The continuous enterprise adaptation is significantly dependent on the enterprise architecture capability. Architecture is defined as the "fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution" (ISO/IEC 42010 2007). Enterprise architecture is a strategic discipline, which is critical for developing and realising enterprise strategy and roadmap (Ross et al. 2006). Enterprise architecture is a blueprint that describes the overall structural, behavioral, social, technological, and facility elements of an enterprise's operating environment that share common goals and principles.

An agile or adaptive enterprise architecture capability is the ability of an entity or enterprise that applies different methods, practices, models and tools to support enterprise adaptation (Gill 2012). It requires the engagement of multiple enterprise capabilities and stakeholder groups who may have different perspectives, objectives and conflicting priorties. Adaptive enterprise architecture can be used to deal with the modern complex enterprise adaptation (Doucet et al. 2008). The challenge is how best to establish, integrate and continually improve the adaptive enterprise architecture capability in order to support the systematic and less risky enterprise adaptation.

The emerging trends of global supply chain, outsourcing and collaborations suggest that "there is an increasing need for a holistic enterprise perspective in the current environment" (Purchase et al. 2012). The modern enterprises operate beyond their physical boundary and are a part of the overall enterprise eco-system, which includes customers, partners, collaborators and community etc. Modern enterprises are essentially "extended enterprises". Architecting and managing complex extended enterprise are not easy tasks. There are a number of architecture frameworks such as Zachman (1987), Federal Enterprise Architecture (CIO Council 2001), and The Open Group Architecture Framework (TOGAF) (Harrison 2011) that can be used to facilitate the enterprise adaptation. These frameworks suggest the need for first defining the holistic enterprise context before actually commencing any enterprise architecture or adaptation work. However, the challenge is how best to define the complex enterprise context?

This paper presents the adaptive enterprise service system (AESS) model that adopts the "Theory Triangulation" approach (Thurmond, 2001). The AESS model can be used for defining the enterprise context from the perspectives of three well-known theories: agility (e.g. Dove 2005; Qumer and Henderson-Sellers 2008), complex adaptive agent system (e.g. Miller 95; Jennings et al. 1998; XX and YY 2006, Kramer and Magee 2007), and service science (e.g. Spohrer and Kwan 2009). The AESS model is a part of The Gill Framework (Gill 2012 - see Figure 1), which provides an adaptive enterprise architecture toolkit.
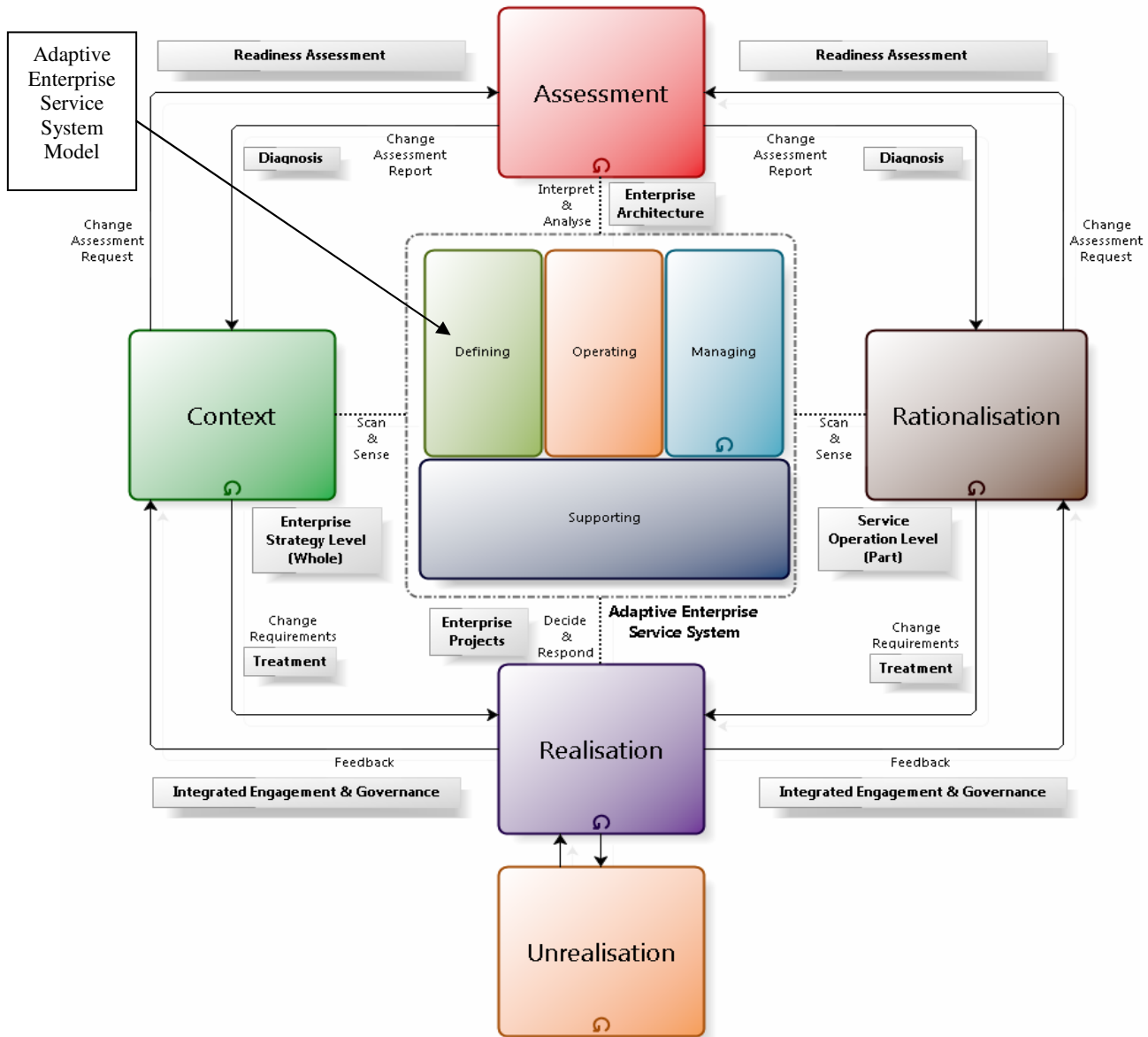

Figure 1: The Gill Framework - Adaptive Enterprise Architecture Toolkit (Gill 2012)

The architecture toolkit has two main layers: inner layer and outer layer (see Figure 1). The inner layer contains capabilities for defining, operating, managing and supporting situation specific adaptive enterprise architecture capability. The outer layer contains the enterprise architecture adaptation capability, which includes enterprise context (awareness), assessment, and rationalisation, realisation, and un-realisation stages for continually adapting the enterprise architecture for enabling the contineous enteprrise adaptation. The detailed discussion of the adaptive enterprise architecture toolkit is beyond the scope of this paper. The focus and scope of this paper is to present the novel AESS model, which is embedded in the "Defining" capability of the toolkit (see Figure 1). The AESS model is intended to be used by enterprises as a guideline for defining the

complex enterprise as an adaptive enterprise service system before commissioning enterprise architecture work. The adaptive enterprise service system is viewed as a complex adaptive multi-agent system of service systems that exhibits agility and focuses on the emerging service-centric value-proposition as opposed to a traditional product-centric value-delivery view.

The paper is organised as follows. Firstly, it discusses the research method. Secondly, it discusses the theoretical background and AESS model development. Thirdly it presents the construct of the AESS model. Finally, it presents the future directions and concludes with a short discussion about the future research.

RESEARCH METHOD

The scope of this paper is to present the novel AESS model. The AESS model has been developed by using a design science (DS) research method (Hevner et al. 2004; Peffers et al. 2006) and the "Theory Triangulation" approach (Thurmond, 2001). DS, as a constructive research method, permits the development of a novel artifact or model. In the development phase of the DS research method, the Theory Triangulation approach has been used to analyse the agility, complex adaptive multi-agent systems, and service science theories for developing the AESS model. Theory Triangulation is an approach to look at the same phenomena from different theoretical perspectives. It is useful for establishing and increasing research validity by analysing the research question and proposed solution or artifact from multiple theoretical perspectives. The purpose of the Theoretical Triangulation was to include different perspectives for coverage- and-consistency when addressing the research question. Theoretical Triangulation (Patton 2002) approach has been used in developing the AESS model construct because it provides an opportunity to uncover hidden denotations and include different perspectives from different theoretical viewpoints. The key research process steps are summarized here:

1. Identified the problem and motivation for the development of the AESS model
2. Identified the objective of the proposed model development
3. Applied Theory Triangulation approach in reviewing and analysing the relevant theories
4. Identified and integrated theoretical elements to develop the AESS model

THEORETICAL BACKGORUND AND AESS MODEL DEVELOPMENT

The "Defining Capability" (Gill 2012) is required for defining the complex enterprise as an adaptive enterprise service system. The adaptive enterprise architecture toolkit (as discussed earlier) includes the AESS conceptual model to define the enterprise context. This section discusses the agility, and system (e.g. agent systems) and service science theories underpinning the AESS model, which is called Theory Triangulation.

Agility

Enterprises are constantly challenged by organically changing complex environments in which they operate. They need to adopt a contemporary agile way of dealing with 21sth century challenges pivot around emergence and complexity (Dove 2005). Enterprises should have the ability to scan sense and adjust in response to emerging complex surrounding environments. Use of an agile approach, under optimum conditions, can indeed create a high performance enterprise (Sherehiy et al. 2007). However, before jumping on the bandwagon of agile or agility, it is important to understand the concept of agility and its application in the context of an enterprise – enterprise agility. Based on recent literature review and ongoing research in agility (e.g. Dove 1997, 2005; Wong and Whitman 1999; Christopher 2000; Conboy and Fitzgerald 2004; Boehm and Turner 2004; Henderson-Sellers and Serour 2005; Sherehiy et al. 2007), Qumer and Henderson-Sellers (2008) offered the following definition for the agility.

''Agility is a persistent behaviour or ability of a sensitive entity that exhibits flexibility to accommodate expected or unexpected changes rapidly, follows the shortest time span, uses economical, simple and quality instruments in a dynamic environment and applies updated prior knowledge and experience to learn from the internal and external environment.'' (Qumer and Henderson-Sellers 2008)

Consequently, by applying the above definition of agility to the notion of an enterprise, we derive the definition of an ''agile enterprise'' as:

''An entity is said to be an agile enterprise when an enterprise is responsive (scans, senses and reacts appropriately to expected and unexpected changes), flexible (adapts to expected or unexpected change at any time), speedy (accommodates expected or unexpected changes rapidly), lean (focuses on reducing waste and cost without compromising on quality), and learning (focuses on enterprise fitness, improvement and innovation).''

Enterprise agility refers to the ability of an enterprise to handle changes. It can be expressed in terms of five attributes or principles of agility: responsiveness, flexibility, speed, leanness and learning. These five agility principles can be used to measure the degree of agility of an enterprise, which can help us to differentiate between a non-agile and agile enterprise. All five identified attributes of agility may not be equally important to an enterprise. However, one can add the relevant importance (e.g. High, Medium, and Low) and weights (e.g. 100%, 75%) to show the priority among the agility attributes according to the specific enterprise context. These five identified attributes or principles of agility have been discussed in detail in the following sections.

Responsiveness

The focus is on harvesting adaptation recognition capabilities in an enterprise in response to external and internal oppurtunities. It is the ability of an enterprise to scan and sense the situation (e.g. expected or unexpected changes in the business or technology or regulatory environment) and form an appropriate response. A responsive enterprise does not remain silent when a response is required in different situations.

Flexibility

The focus is on harvesting flexible response capabilities in an enterprise. An enterprise may demonstrate flexibility by accommodating expected or unexpected changes. It is the ability of an enterprise that allows adapting to changing complex business demands.

Speed

The focus is on harvesting quick flexible response capabilities in an enterprise. The response or flexible behavior of an enterprise may be slow or fast. It is the ability of an enterprise that demonstrates a rapidness and quickness in its response. A fast enterprise delivers the results quickly (e.g. quick time to market).

Leanness

The focus is on harvesting quick flexible lean response capabilities in an enterprise. A lean enterprise operates with optimal or minimal resources without compromising the quality of its outputs or offerings. It refers to compactness and tidiness. A lean enterprise offers the desired quality output in an optimal manner (e.g. reduced cost and waste, improved quality).

Learning

The focus is on harvesting learning capabilities in an enterprise. It is an indispensable ability of an enterprise that uses up-to-date knowledge and experience. A learning enterprise demonstrates continuous growth and adaptation over a period of time (e.g. knowledge and experience base).

Agility lens only discusses the ability of an enterprise and in order to further understand the underpinning architecture of an enterprise, we need to seek help from the system and system of systems theories. The next section discusses the system and system of systems theories under the overarching theoretical lens of "System".

System

Adaptation may require fundamental changes in the existing state of an enterprise. Traditional static view of the enterprise architecture, as a fragmented structure of business units or functions, is not appropriate for successful 21st century adaptations. Enterprise adaptation or transformation requires a holistic system thinking approach in order to deal with the rapidly emerging complex business environment (Pourdehnad and Bharathy 2004). System thinking emphasizes that an enterprise is a living system that has the ability to quickly adapt in response to internal and external changes (e.g. agility of an enterprise). The concept of agile or adaptive enterprise has already been discussed in the previous section. This section discusses the concept of system thinking in the context of agile or adaptive enterprise architecture.

An enterprise system is composed of different connected parts or sub-systems (e.g. a system of systems), which are managed as a whole. These parts operate as a whole to achieve their system goals. Any changes in one part of a system are not dealt in isolation of other parts of the system. This means a change in one part can impact other parts. A system has a number of different components such as inputs, processes, outputs, constraints, culture and feedback. System receives inputs. It processes the inputs within its constraints for producing outputs. Systems performance is impacted by its culture and feedback received. Shifting from traditional to system thinking would require focusing on the iterative and participatory design processes for redesigning the whole instead of a part for effective enterprise adaptations.

Miller (1995) introduced a theory of living systems that integrates structural and behaviour aspects from different disciplines (e.g. biology, social science) in order to study or describe living systems. The notion of living system conceptualises system as living organism, which is continually evolving and self-adapting. Living systems are created, used, maintained, transformed and retired or expired. Similar to the system concept, living system organisms are composed of nested parts or cells. According to living systems metaphor, each living system at the higher level is made of other low level systems. The real world living systems or enterprises can be seen as multi-agent systems (an agency of agents). A multi-agent system is an environment where several agents interact with each other for the provision of continuous and dynamic services to achieve their objectives. An agent is an autonomous, interactive and flexible complex entity in a multi-agent system that communicates with other agents to solve a complex problem (Jennings et al. 1998; Knublauch 2002; Luck et al 2004; Qumer and Henderson-Sellers 2006; Kramer and Magee 2007).

Now, by applying the above notion of living agent systems to the notion of an agile or adaptive enterprise, an enterprise is a living agent system or living organism (e.g. like human), which is:

- made of other low level agent systems

- an open and dynamic agent system forming a whole that consumes energy or resources and respond to their environment

- composed of nested parts or cells (a basic unit of function) or organs

- continually strive to reduce stress and maintain a steady internal state regardless of their external environment

- continually evolving and self-adapting toward higher levels of order for differentiation and organisation through communication and feedback

- architected and managed as a whole of connected parts or cells instead of a collection of separately architected and managed business units or functions

- integrated and aligned to survive and achieve desired business goals via different pathways

- created, used, maintained, transformed and retired or expired.

Enterprise as an agile or adaptive living multi-agent system can be described in terms of their origin, goal, role, hierarchy or level, openness, purpose, location, dynamism, awareness, energy, structure, function, fitness, responsiveness, improvement, growth and transformation. The enterprise system inherits or exhibits the adaptive multi-agent system properties in the context of enterprise adaptation or transformation. Adaptation must take into the consideration of inter-dependency and interactions of enterprise system parts or cells because changes in one part or cell of a system can impact other parts or cells of that system and other systems. Traditionally we used to manage enterprise adaptation at the individual or part level (e.g. sales, purchase, and human resource unit level) for achieving sub-optimized improvements. However, viewing enterprise as an adaptive system would require looking at the change impact on the whole system i.e. holistic approach. This is critical because changes made in one part while ignoring the whole may direct the system energy in the wrong direction and could be a recipe for system malfunction or failure.

Agility and system (including system of systems) lenses describe the ability and architecture of an agile or adaptive enterprise. Further, we need to understand the capabilities of the agile enterprise. The next section discusses the "Service Science" lens for describing the agile enterprise capabilities.

Service Science

Service science is an emerging area of research. It views enterprise as a "service system". The focus is not that the one service system is providing a service and another one is using it, rather the focus is on that the service systems interact with each other, and offer or consume services (e.g. service experience) for mutual benefiters or value co-creation. Value co-creation and service system is an emerging area of interest in the service science body of knowledge. Service science body of knowledge (e.g. Spohrer et al. 2008; Spohrer and Kwan 2009) defines the service thinking. Now, by applying the notion of service to the notion of adaptive system, an adaptive service system is:

- a collection or inventory of services that are offered based on agreed contract and service billing approach (e.g. pay-per-use, fixed subscription model)

- focused on mutual use and adaptation through proposal, contract, access and feedback mechanisms

- an abstraction mechanism that represents different types of both human and non-human entities (e.g. people, business units) who apply physical (e.g. material, tools) and non-physical resources (skills, knowledge) for value co-creation or mutual benefits or mutual satisfaction

- focused on value-proposition interactions via value co-creation interaction channels for mutual value-creation

- an access rights based system which constraint their interaction with other systems

- dependent on governance interaction mechanism for any dispute resolutions or service conflicts that lead may to dissatisfaction

- an ecology of different types of stakeholders such as service creator, provider, consumer, carrier, partner, auditor, observer, competitor, regulator and broker

- viewed with its concerns (e.g. performance, security, quality, compliance).

Enterprise as an adaptive service system focuses on the collaborative value-proposition or value co-creation. Adaptive service system encompasses the notions of agility, service and system. An adaptive service system represents an individual, enterprise capability or function or a group of related services.

THE AESS MODEL: ADAPTIVE ENTERPRISE SERVICE SYSTEM

Adaptation of an enterprise operating in the realm of bewildering uncertainty and complexity is an arduous task. Different systems interact with each other for value co-creation. Adaptation of a one system in isolation of other systems would poses greater risks to the whole service interaction value co-creation mechanisms. Today's quick adaptation or transformation in isolation could become tomorrow's problem. The business and operating model of an enterprise need different approaches of thinking when looking at the enterprise adaptation opportunities. An adaptive system of service systems view presented in this paper combines the agent based system of systems approach to establishing the enterprise-as-a-whole view. The concept of enterprise as an adaptive service system has already been discussed in the previous section. The concept of enterprise as an adaptive system of service systems is discussed here - adaptive enterprise service system.

A system of systems (Maier 1998) approach is different from a simple collection of large monolithic systems. A system of systems is composed of systems that are functional and independent. However, system of systems is essentially a linked-chain of different systems that operate independently but are linked to each other and interact to achieve the shared strategic goals. A collaborated and coordinated response of different public and agencies to disaster management forms a system of systems enterprise. For instance, agencies in the system of systems environment operate independently but they are linked to each other to serve the common customer i.e. citizens.

System of adaptive service systems is a chain of inter-linked adaptive service systems. This is aimed at relating different adaptive service systems in a specific context for value co-creation. In a system of adaptive service systems, desired behaviours emerge through the collaborative interactions of service systems.

Now, by applying the notion of system of systems to the notion of adaptive service system, an adaptive enterprise service system is:

- a set of independent adaptive service systems that are integrated in the adaptive enterprise service system environment. These adaptive service systems can be created, acquired, operate and managed independently

- a distributed and collaborative environment where several geographically dispersed adaptive service systems interact with each other for value co-creation

- evolved in response to meet the dynamic contextual demand; based on the contextual demand, adaptive service systems can be added, removed, and modified in the integrated adaptive enterprise service system environment

- designed to exhibit emergent behaviour through the interactions of adaptive service systems; although, each adaptive service system is independent but system of service systems behaviour cannot be achieved and localised to a specific single adaptive service system.

Adaptive enterprise service system emerges through the collaboration or volunteer interactions of different adaptive service systems. An adaptive enterprise service system can be "defined" as

"a complex distributed integrated supply chain network of entities or adaptive service systems that interact with each other for value co-creation."

This whole analysis and the notions of agility, system (including system of systems) and service science have been integrated and the "AESS" model is emerged (see Figure 2).
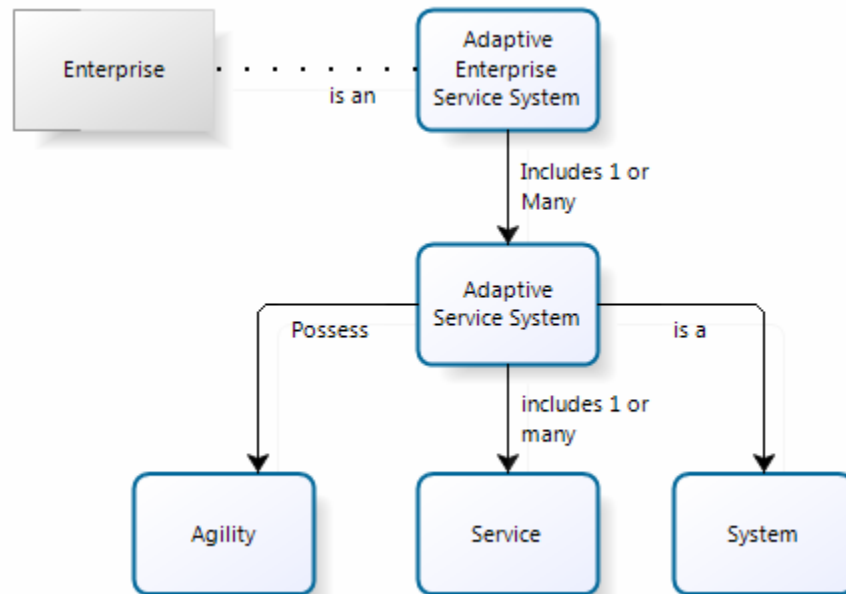
Figure 2: The AESS Model

The AESS (Figure 2), views the modern enterprise as an "Adaptive Enterprise Service System". The adaptive enterprise service system includes 1 or many "Adaptive Service Systems". The adaptive service system possesses "Agility". The adaptive service system includes 1 or many "Services" that are on offer. The adaptive service system is a multi-agent "System", where change in one part of the system may impact the other parts of the system.

DISCUSSION, CONTRIBUTION AND LIMITATIONS

The AESS model describes an agile or adaptive "enterprise" as an adaptive enterprise service system. An adaptive enterprise service system is architected as an agile service-centric, value-proposition, and value co-creation system of service systems as opposed to a traditional collection of product-centric, value-delivery and fragmented business units. The notions of agility, service and system of the AESS model are critical for understanding the characteristics and outlining the boundary of an enterprise pursuing to establish enterprise architecture capability for enabling enterprise transformation or adaptation. Agility lens describes the "agility" characteristics of an adaptive enterprise service system. It can be used to determine the current and desired agility of an adaptive enterprise service system. For instance, the "responsiveness" attribute of agility can be used to determine whether the current adaptive enterprise service system has the ability to scan, sense and respond to changes or not? The service lens describes the "services" (e.g. business services, information services) of an adaptive enterprise service system. The system lens describes the adaptive enterprise service system as a living "system" of multiple agents with connected independent and dependent agents or parts. The system view of an adaptive enterprise service system would ensure that any strategic or operational changes are not dealt in isolation and the impact is determined and assessed at the enterprise level.

There are a number of architecture frameworks such as Zachman (1987), Federal Enterprise Architecture (CIO Council 2001), and The Open Group Architecture Framework (Harrison 2011). These frameworks suggest the need for defining the enterprise context before actually commencing any enterprise architecture or adaptation work. These frameworks lack the support for concrete guidelines or model for developing such enterprise context. These enterprise architecture frameworks, originated in the context of industry best practices, also lack academic research. The AESS model is an attempt to fill this small gap. Since the AESS model construct is a novel contribution, it needs to be considered with a view of its limitations. The model is necessarily focused on the agility, system and service aspects of an enterprise. Since the literature and practice are dynamic, the AESS model should be considered as an evolving construct to be revised and extended by future research. Despite its limitations, this paper present previously unavailable novel AESS model. The identified aspects of the AESS model, if not all, could be considered a research theme.

CONCLUSION

Most enterprises attempt to adapt by simply focusing on the identification of the weakest link in their local operating environment. They tend to optimize the performance of that weakest link in isolation of other links in the whole systems of service systems supply chain. Such a local adaptation or transformation may not be helpful and may adversely impact the performance of other links in the chain. However, a less risky and most effective approach to adaptation would require looking at the optimization of the whole. This paper presented the AESS model that incorporates the concepts of agility, service and system that can be used to define the principles and boundary of the adaptive enterprise service system. The analysis and the resultant AESS suggest that an enterprise must be viewed as an adaptive system of service systems in order to deal with the complex adaptation of linked system of service systems. It requires thinking beyond one system for defining the scope of the enterprise architecture and adaptation initiatives. The research work presented in this paper concludes and suggests reviewing all the adaptive service systems in the adaptive enterprise service system upstream, midstream, and downstream zones of the supply chain network; identifying the adaptive service systems that would be impacted by the adaptive enterprise architecture capability related initiatives (e.g. establishment, integration, adaptation); and identifying the adaptive service systems that would be impacted by the enterprise adaptation initiatives. This paper necessarily focused on the agility, system and service aspects of an enterprise. In future, we will empirically validate the proposed conceptual model and may extend it to include other aspects, if necessary and required.

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