

Design of an Integrated Model for Development of Business and Enterprise Systems

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Abstract: *Developing complex enterprise systems for various organisations in this world of business transformation is a challenging issue for system developers as most business needs to adapt to these changes dynamically and align their business processes, information system and technologies to the new requirements. This transformation and alignment requires a robust architecture. Unfortunately, business and information technology architectures that are supposed to support this transformation and reduce information system complexity are often disconnected, thus causing a severe constraint on enterprise agility. The Structured System Analysis and Design Methodology (SSADM) was used to analyze our findings. An archetype – architecture for enterprise and information system integration was developed based on enterprise architecture. The architecture is comprised of sub-architectures of Business and Environment, Information and Knowledge, Information System and Services, Infrastructure and Resources and Governance and Security, providing a holistic and systemic vision of the enterprise architecture framework. Prototyping was used for the progressive building of the architecture. The developed architecture was applied in an enterprise in Nigeria to authenticate its applicability and the result shows that the new architecture can successfully be used for enterprise and information system integration, business-IT alignment and information system complexity management. The architecture facilitates traceability from business strategy to business operations as well as the underlying technical design and platform deployment of information system for effective business transformation which will align IT resources with the business strategy.*

Keywords: *Enterprise, System, Enterprise Architecture, Information System, Business systems, business-IT alignment.*

1. INTRODUCTION

Enterprises globally are undergoing business transformation in reaction to worldwide economic factors such as market globalization, advancement in information technology, increase in customer requirements and the use of Information Technology. Intensive use of advanced information and communication technology (ICT) is nowadays considered as an essential part of modern enterprises' business strategy, significantly impacting the way they perform business services and compete on the market. The main challenge enterprises face today is how to manage the complexity inherent in the systems they are deploying, while at the same time to be able to rapidly adapt to changes in technology and business environments. Enterprises all over the globe have been reinventing their business patterns to benefit from these developments and gain competitive advantage. Changes in the business affect various aspects of operations which include operational environment, business processes, policies and important business metrics. All these changes, in turn, have an impact on the systems that are used to automate business operations. Often changes in the enterprise's technology infrastructure that supports its business systems are needed to achieve the desired shifts in business model and operations. To facilitate this transformation, this paper employed an integrated architecture. The key idea is to relate business architecture with information system and technical infrastructure architecture in a single framework: an Integrated Model for business and Enterprise Systems. In this way, the impact of new business processes and models on information systems can be evaluated quickly, and the other way around, the consequences of technology innovations can be assessed at the business level. The integrated model dynamically aligns business and technology components and processes within the organization and across its value chain, and also supports the organization for long term, cost-effective growth; manage IT system complexity and scale of change

in the business. With the Model, operational requirements are mapped to systems and systems are mapped to technologies that power them.

1.1. Need for Integrated Model for Building Business and Enterprise Systems

Information technology has the potential to transform entire enterprise (Merrifield et al., 2008). In some instances it offers short term opportunities for forward looking companies to gain an edge over their competition whilst in others it plays the role of a great equalizing force in eroding competitive advantage (Carr, 2004). In practice however there is widespread disappointment with the quality and usefulness of IT systems. There has been much debate over the strategic value of IT systems (Carr, 2003) but the effectiveness of an IT architecture in delivering business value, its flexibility in adapting to business change and the costs of implementing and maintaining the systems are all factors influenced by how well IT investments have been aligned with business strategies (Ross et al., 2006). From our study, four operations problems have been detected as affecting most enterprises. These problems are;

- IT systems have become unmanageably complex and increasingly costly to maintain.
- IT systems are hindering the organization's ability to respond to current, and future, market conditions in a timely and cost-effective manner.
- Mission-critical information is consistently out-of-date and/or just plain wrong.
- A culture of distrust between the business and technology sides of the organization
- In summary, many enterprises' use of information and communication technology is often unplanned, uncoordinated, inconsistently applied throughout the enterprise, reactive rather than proactive and always driven by individual requirements.
- This encourages poor utilization of resources and results in undue complexity of information system (Diversity and Scope).
- Explosive growth of information resulting to Island of automation.
- Vendors' products and technology becomes drivers of business capabilities and limitations.
- Lack of Information Technology(IT) Alignment with Business Objective
- High Cost of Development of Enterprise Information System

IT enabled enterprises must be designed from different architectural perspectives to relate the business with the technology that enables the business.

2. LITERATURE REVIEW

2.1. Current Approaches in Business and Enterprise System Architecture

Several architectures and models have been proposed and developed by different researchers and development groups. Enterprise architecture is a widely adopted means for coping with organizations' ever-increasing complexity and for ensuring that organizations appropriately use and optimize their technical resources. Enterprise architecture is an integrated and holistic vision of a system's fundamental organization, embodied in its elements (people, processes, applications, and so on), their relationships to each other and to the environment, and the principles guiding its design and evolution (IEEE, 2006). As the organizing logic for business processes and IT infrastructure, enterprise architecture reflects the integration and standardization requirements of the company's operating model to achieve business agility and profitable growth (Ross et al 2006). Enterprise architecture frameworks identify the architecture's scope and decompose its elements into structured layers and architectural dimensions. Many private and governmental organizations have adopted such frameworks for operational use.

Enterprise architecture first emerged as an idea in 1980 and was embodied in John Zachman's early enterprise architecture framework (Zachman, 1987). Its reemergence as a way to cope with organizations' ever-increasing complexity relates to evolving new business trends and IT. Business trends comprise globalization, mergers and acquisitions, e-commerce, and customer-relationship and supply-chain management. IT trends comprise advances in Internet technologies, hardware platforms,

and application and workflow servers. With the increasing importance of enterprise architecture, companies such as the Open Group and IBM are offering certification opportunities in an effort to standardize an open method for IT architecture.

An enterprise architecture approach can help align business and IT resources and conform them to fundamental principles and common methodologies governing the entire information systems development process. In that sense, architectural frameworks are a convenient way to support such methodologies and separate roles that facilitate and implement these methodologies as needed. Still, many organizational and technical enterprise architecture challenges remain.

2.2. Enterprise Architecture Frameworks

Enterprise architecture frameworks describe a method for designing information systems in terms of a set of building blocks and how these blocks fit together. Many organizations have adopted enterprise architecture frameworks for operational use—such as the Architecture for Integrated Information Systems (Scheer, 1999) and the Department of Defense architecture framework. In addition, the US government has adopted the federal enterprise architecture as a business-driven framework to optimize key strategic areas, such as budget allocation, information sharing, performance measurement, and component based architecture.

More specifically, enterprise architecture frameworks contain a list of recommended standards and compliant products for implementing an information system. These frameworks simplify the architecture's development and ensure complete coverage of the architectural dimensions of the designed solutions through a common terminology.

Enterprise architecture frameworks are language independent in that they provide generic concepts and common terminology, letting stakeholders communicate without making any assumptions about each others' language. Pragmatically, enterprise architecture frameworks play dual roles.

By representing an information system as a set of building blocks, enterprise architecture frameworks relate the required information system dimensions—such as business processes, data, and organization units—to different perspectives at certain levels of abstraction. These perspectives rely mainly on differences in stakeholders' views of the architecture at different levels of detail. As component-specification tools; enterprise architecture frameworks document the architectural layers, domains, models, and artifacts. Enterprise architecture frameworks are typically decomposed into five architectural views (Okonkwo & Mgbeafulike, 2013)

- The **Business view** aligns an organization's operating model, strategies, and objectives with IT; it also creates a business case for IT transformations and provides a business-centric view of the enterprise from a functional perspective. This part of the framework provides the following three key areas of information about the business: Business strategy, Business function and business organisation.
- **Information and Knowledge View:** The Information view describes all of the moving pieces and parts for managing information across the enterprise, and the sharing of that information to the right people at the right time to realize the business objectives stated in the business architecture.
- **Information System and Service View:** The information system view provides an application- and services-centric view of an organization that ties business functions and services to application processes and services to application components in alignment with the application strategy. The information system's scope, strategy, standards are a consequence of the Business Architecture.
- The **Infrastructure and Resource** view comprises the hardware platforms and communication infrastructure that supports the applications. These may be hardware or network related. They may include fundamental services such as databases, etc. and key security and other commodity shared services.
- The information system view determines the data elements and software applications that support the business layer.
- The resource and technology infrastructure view comprises the hardware platforms and communication infrastructure that supports the applications.

- **The governance and security view:** This view focuses on the manageability and quality of the architecture implementation (both business and IT) that is required to satisfy the services levels required by the business for its processes and systems.

3. SYSTEM ANALYSIS AND DESIGN METHOD

3.1. Systems Analysis

From review made on different existing architectures, three types of architectures have been identified with different objectives. There are the ones directed towards the development of integrated information system, the ones which cover the whole enterprise integration project and the ones that are only for methodology for architecture development.

- **Integrated Information Architecture:** the architectures for the integration of information have the objective of developing an integrated information platform that coordinates and communicates the different technological devices that generates, processes, distributes and supplies information. Among the well known are ARIS architecture and RM-ODP.
- **Total Enterprise integration:** the architectures for total enterprise integration are oriented towards the integration of the whole enterprise considering not only the technological aspects of the system but also the economic, social and human in terms of the business itself, the information and capabilities to support the business, the information system and infrastructure needed to automate the processes and information and the governance that manages change, risk and procedure. Among the most well known are; CIMOSA, PERA, FEAF etc.
- **Architecture methodology:** The architectures towards the methodology for developing architecture frameworks are oriented towards a step by step guide that enables architects to develop an enterprise architecture. Among this group are TOGAF etc.

3.2. Research Method

The major objective of this research was to develop an architectural framework to;

- Support building of business and enterprise systems through the use of enterprise architecture
- Help the alignment of business and IT related concerns and requirements in an enterprise, and
- Support the evaluation of ICT as a strategic means for business innovation.

In the development of the model, the following research phases were carried out:

- Gathering information about the business models and products to be enabled by IT Systems.
- Design of the Integrated Model for business and enterprise systems
- Case study.

3.2.1. Gathering Information about the Business Models and Products to be Enabled by IT Systems

The companies and interviewees are described in the table 1

Enterprise	No of Employees (Year 2014)	Number of Interviewees	Viewpoints of interviewees
Manufacturing Company	1500	2	Enterprise architecture, system architecture
Banking, finance and insurance company	5500	2	Enterprise architecture
Telecom Company	1,980	1	Enterprise architecture
Business and IT consulting and development organisation	1,200	1	Enterprise architecture, system architecture

Interviewees in the focus group were practitioners from four different sectors. They were managers and specialists of the management of enterprise and software architectures in their organizations. The participants were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others. The use of group interview did have an impact, bringing out new aspects. However, it is possible that the interviewees did not discuss some aspects due to

confidentiality reasons. Based on the data gathered, the integrated model framework was improved. This framework is designed and presented below.

3.2.2. Design of the Integrated Model for Development of Business and Enterprise Systems

In an effort to provide an efficient, business-driven framework to help enterprises align their IT and business strategies, we created a hybrid enterprise architecture framework, influenced by some existing enterprise architecture frameworks like Oracle Enterprise Architecture Framework (OEA), Gartner Integrated Architecture Framework (IAF), FEA and TOGAF. This simple yet realistic and flexible framework is called An Integrated Model for Design of Business and Enterprise System. It contains five (5) architectural components referred to in this paper as 'Views' and two (2) aspect areas.

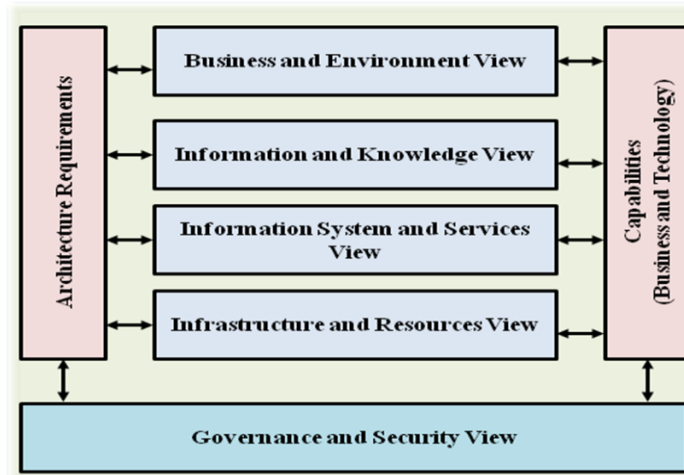


Fig1. Integrated Model for Development of Business and Enterprise Systems

Business and Environment View: The Business and Environment (BE) view consists of communicating and co-operating people in the role of employee, and of organisational units such as teams and departments. The view is organized as one or more supply chains of individuals, organisational units and companies working together in delivering products or services to the customers. The environment of a company is seen as system connecting the company with customers, suppliers and other third parties.

Information and Knowledge View: Information and knowledge (IK) is an important enabler of the business. The Business and Environment view is supported by an Information and Knowledge (IK) view formed by people and organisational units in specific IK supportive roles. These may be the same people and units that already have a role in the BE view. The IK view enables the business by supporting the creation, exchange, storage and use of information and knowledge. The IK view in fact acts as the collective memory of the organisation.

Information System and Services View: The information system(s) and services (ISS) encompass a network of communicating and co-operating applications. The applications work together in delivering communication and information services to the people in the ICT enabled Enterprise. These automated services enable the data processing, communication and control in the BE network, and the creation, exchange, storage and use of data in the IK network.

Infrastructure and Resource View: The technology infrastructure is seen as a network of communicating and co-operating hardware devices and system software and middleware.

The Technology Infrastructure (TI) delivers processing, communication and storage capabilities to the information systems.

Governance and Security View: The *Governance* view answers the question 'What standards and procedures will guide the implementation of the architecture?' This view focuses on the manageability and quality of the architecture implementation (both business and IT) that is required to satisfy the services levels required by the business for its processes and systems. The artifacts for this area are all fundamentally defined within the core views (Business, Information, Information Systems and Technology Infrastructure and Resource), although the outcome from this view will be new

specialized Services and Components to deliver the governance. The **Security** view focuses on the mitigation of known risks to the architecture implementation (both business and IT). The artifacts for this area are also all fundamentally defined within the core aspect areas (Business, Information, Information Systems and Technology Infrastructure and Resource). The outcome from this view will be new specialized Services and Components to deliver the required security.

The two (2) **aspect areas** are; Architecture Requirements and Business capabilities

Architecture and Information System Requirements: This aspect keeps track of the entire baseline of functional and nonfunctional (i.e., performance) system requirements. As the architecture evolves in function and shape, all artifacts in the logical and physical design, including business processes, business activities, business rules, and test cases must be traced back to this set of system requirements.

Business and Technological Capabilities: The business capability defines “what” a business does at its core. This differs from “how” things are done or where they are done. Business capabilities are the core of the business architecture. Technological capabilities define the technology (infrastructure) need to support the business. This defines the operational requirements needed by the business.

Characteristics of the Model

Among the main characteristics of the AIMES architecture, it can be shown that:

- It proposes an enterprise vision oriented architecture toward **Business processes**.
- It establishes the life cycle of the enterprise system based on a **continuous improvement process**.
- It uses modeling and simulation as a tool to analyze the decision impact
- It describes enterprise system as the instantiation of enterprise architecture in terms of a set of software modules, computer platforms, network components, and databases assembled in such a way as to be able to process business transactions and thus meet all the system requirements specified in that Enterprise Architecture and provide a methodology for continuous evolution based on Continuous improvement process.

Interrelation of the model Views

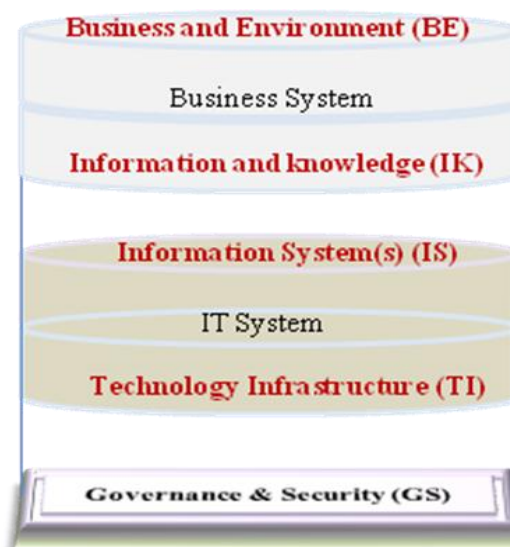


Fig2. The views on the IT enabled enterprise.

The five main architecture views of AIMES are based on a “holistic” view on business and IT system of the IT enabled enterprise. In this view, the business is seen as two interrelated networks (Figure 3.7). The Business and Environment (BE) network consists of communicating and co-operating people in the role of employee, and of organizational units such as teams and departments. The network is organized as one or more supply chains of individuals, organizational units and companies working together in delivering products or services to the customers. The environment of a company is seen as network connecting the company with customers, suppliers and other third parties.

Information and knowledge is an important enabler of the business. The BE network is supported by an Information and Knowledge (IK) network formed by people and organizational units in specific IK supportive roles. These may be the same people and units that already have a role in the BE network.

The IK network enables the business by supporting the creation, exchange, storage and use of information and knowledge. The IK network in fact acts as the collective memory of the organisation.

The IT system that supports the business is also seen as a network system in two main layers: the information system(s) and the technology infrastructure. The information system(s) encompass a network of communicating and co-operating applications. The applications work together in delivering communication and information services to the people in the IT enabled Enterprise. These automated services enable the data processing, communication and control in the BE network, and the creation, exchange, storage and use of data in the IK network. The technology infrastructure is seen as a network of communicating and co-operating hardware devices and system software and middleware.

The Technology Infrastructure (TI) delivers processing, communication and storage capabilities to the information systems.

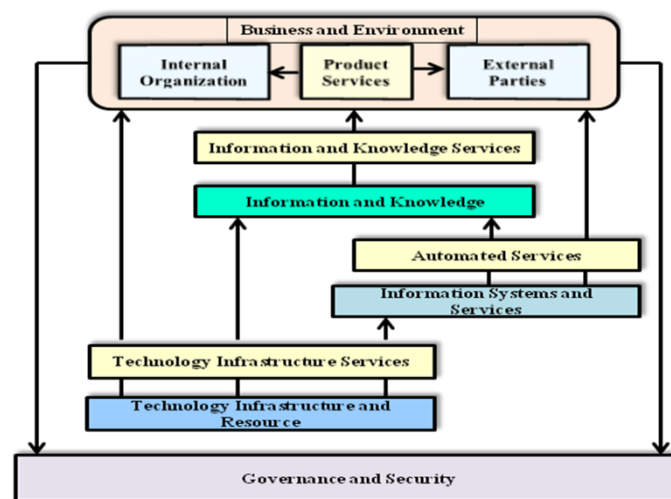


Fig3. The enabling relations between the architectural views.

The main objective of AIMES is to support an architectural design of an IT enabled enterprise as one coherent co-operation of people, information, knowledge, applications and technology. The specific added value and benefits of AIMES are in the design and assessment of the enabling relationships (Figure 3.8), interactions, and dependencies among these architecture areas and not as much in the architectural design of the individual areas.

4. CASE STUDY

4.1. Using the Integrated Model to Manage Information System Complexity

A leading corporation in Nigeria needed to ensure that it's recently outsourced IT activities continued to provide best possible service to the business. By expanding its EA capability, which had traditionally resided within the IT function, the enterprise successfully integrated those outsourced services. And by reusing applications and processes across its previously siloed business lines, it also reduced complexity and costs. The success of the program was driven by:

- Formalizing EA's strategic role in the governance of the new outsourcing arrangements to ensure that services provided by the extended organisation were aligned with the needs of the business.
- Building comprehensive organisational knowledge of the EA capability by locating architects within each business line.
- Maintaining EA's technology roots through close engagement between internal solution and infrastructure architects internally and the new outsourcing partners.

The enterprise has begun to reap the rewards of EA's growing profile and influence, in part because it is now the only function able to provide an integrated view across the extended enterprise. One of the key benefits the enterprise realized was the framework's ability to align their strategies with their

current state of redundant and missing processes. With this information as a foundation both business and IT were able to understand the IT impacts of business requirements and vice versa. As a result, the enterprise was able to create a prioritized business process roadmap with aligned IT budget and resource implications. An important benefit of the process was that the alignment increased the trust between the business units and IT.

5. CONCLUSION

In conclusion, the integrated model for business and enterprise system successfully integrates strategic planning, business planning, and technology planning making the enterprise more focused. It serves as an authoritative source for reference documentation and standards, making governance more effective.

The model is a repeatable, scalable methodology, making the enterprise more agile and helps to manage and drive change, in alignment with strategic and business goals, making the enterprise more successful. The architecture facilitates traceability from business strategy to business operations as well as the underlying technical design and platform deployment of information system for effective business transformation which will align IT resources with the business strategy.

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