IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, March 2024

Strategies for Effective E-Governance Enterprise Platform Solution Architecture

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Abstract: *Several challenges arise during the development of e-government systems, including interoperability issues, integration complexities, and the absence of standardized practices which stands for enterprise architecture, has emerged as a potentially useful way to address these problems. Nevertheless, it is of the utmost importance to choose the appropriate Enterprise Architecture Framework (EAF), as this framework determines the conceptual structure and methodology for the creation of EA. There are many EAFs, each with a unique content and audience that they are aimed at. In this research, an evaluation of four EAFs that are prevalent in use is carried out. We provide criteria for evaluating these frameworks from two different points of view: the first consideration is focused on non-functional needs that are crucial for the success of e-government systems and how EAFs satisfy these requirements, and the second consideration is centered on concerns that are relevant to international development. At the end of this discussion, we offer some observations and recommendations for further research in this field.*

Keywords: Enterprise Framework-Government, Enterprise Architecture organization structure.

I. INTRODUCTION

Governments often oversee multiple independent projects without cohesive coordination, leading [1] to fragmented business procedures and duplicative systems as well as technologies. This division hinders interoperability between agencies. A suggested approach to enhance the understanding of the relationships across various e-government initiatives is to implement an EA program. This program functions as a strategic management tool that brings together business process development, simplifies complexity, and encourages more alignment. EA is a strategic framework that defines an organization's objective and identifies the technology and information required to achieve that mission. Additionally, it provides suggestions on how the organization's architecture should be altered to accommodate shifts in the mission. EA refers to the underlying framework of a system, including its current structure, the intended future structure, and the strategy for introducing changes gradually. The enterprise architecture, as outlined in reference [3], serves as a thorough framework facilitating a profound understanding of an organization's fundamental business activities. It delineates the essential technologies required to enhance and support these operations. The specific reasons for incorporating Enterprise Architecture (EA) into the development of e-government can vary, shared justifications, as mentioned in [4], encompass:

- Facilitating compatibility and establishing guidelines for agencies in terms of technology and management.
- Facilitating resource sharing among agencies and decreasing both IT and operational expenses by pinpointing redundancies and possibilities for re-utilization.
- Facilitating the creation of collaborative procedures and the provision of uninterrupted services

In the context of EA, a framework can be defined as a conceptual structure outlining the essential components and methods for building enterprise architecture. These encompass several models, ideas, processes, and standards that offer direction for the creation of enterprise architectures. Presently, there is a wide array of frameworks accessible, each with distinct contents and aims. Several researchers have endeavored to assess these frameworks from various viewpoints. Nevertheless, although the significance of EA within the triumph of e-government initiatives is acknowledged, no research has been agree to to assess the current EA frameworks specifically designed for the e-government environment.

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This article intends to develop a common framework for comparing and assessing the many EAFs available for adoption in e-government. Architects can enhance their understanding of a selected framework's adaptability to changes and its ability to achieve business objectives through review. This paper proposes the assessment of EAFs utilizing two techniques that are derived from the current obstacles faced by e-government and its surrounding context. The introductory perspective examines the importance of non-functional needs in ensuring the success of e-government. It also evaluates how EAFs address these criteria. The second perspective focuses on specific developmental challenges that have been selected for analysis. The structure that follows describes the succeeding sections of this document. In Section 2, a comprehensive summary of the current body of research concerning the evaluation and comparison of frameworks is presented. In Section 3, a concise overview of the selected framework that will be estimate is presented. In contrast, Section 4 delineates the procedure for determining criteria from two distinct viewpoints and presents a comparative analysis. A comprehensive analysis and clarification of the findings is presented in Section 5. In Section 6, which concludes the study, future research directions are also discussed. The process of administering and supervising an organization is referred to as governance [1]. Governance encompasses the oversight, maintenance, regulation, and accountability pertaining to policies, benchmarks, and behaviors [2].In general, three categories of governance are distinguished by the characteristics of the organization, the intended outcomes, and the implementation strategies. [3-12].

Fig. 1 EA Solution Architecture

Enterprise Architecture Governance (EAG) entails the application of regulatory bodies with expertise in finance, administration, and governance to oversee the progression and execution of the EA Initiative. Organizational control over the information technology solutions it implements to ensure that said solutions adhere to the EA vision, principles, and standards is influenced by both the organizational structure and procedures of the organization. The figure that follows illustrates the connections that exist between the various concepts of governance that are utilized by different companies. In most cases, the business strategy serves as a source of inspiration for the development of both the corporate governance plan and the information technology strategy. Enterprise Information Technology Governance serves as the basis upon which Corporate Governance and IT Strategy are constructed. EA and its governance were managed either by the business strategy, the IT strategy, or both, depending on the circumstances. It is crucial to understand that each component in the hierarchy has the potential to influence how other concepts emerge and evolve in the future [22]. The many forms of governance and how they relate to the strategy are shown in the figure below.

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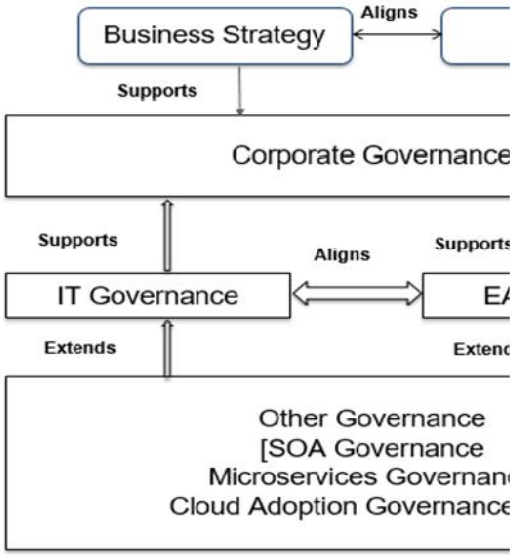

Figure 2: Overview of Governance and its Strategic Alignment

EA Governance involves the framework or arrangement and guiding principles necessary for organizations to effectively manage their implemented IT solutions, ensuring they conform to the vision, values, and standards of the enterprise architecture. Enterprise governance is a collaborative effort among a diverse group of executives tasked with overseeing information technology. This group comprises IT directors, the chief information officer, along with executives responsible for business operations, enterprise architects, subject matter experts, and additional support staff. The success of enterprise design extends beyond the IT department and necessitates the active participation of the entire organization. Insufficient or erroneous EA governance leads to ineffectual EA, consequently impeding the achievement of the advantages offered by EA. Inadequate EA Governance within an organization leads to a lack of synchronization between operations and information technology. This can further lead to the acquisition and adoption of non-standard products or technologies, resulting in architectural inconsistencies. Monolithic implementations, commonly referred to as "built-in silos," may result from these inconsistencies. Such systems are notoriously challenging to integrate with, both internally and externally. Without a clearly defined EA Governance model or process, the data used in EA becomes outdated and loses its significance, hindering the ability to make informed strategic decisions. This undermines the fundamental purpose of enterprise architecture. The objective of this article is to offer an in-depth examination of EA Governance, encompassing its motivating factors, core principles, definition, and recommended strategies for implementation.

EA Governance: Addressing the Necessity

EAis a continuous endeavor that involves the governance of processes to effectively manage and sustain the organizational structure. Business and IT alignment is not a separate discipline, but rather an essential component of an enterprise's operations.EA Governance is necessary to guarantee that an Enterprise maximizes the benefits of EA. It cannot be conducted autonomously as a vocation, but rather it is an essential component of a business. EA Governance ensures that all components of the enterprise—individuals, departments, new IT systems, and applications—adhere rigorously to the Enterprise Strategies, Objectives, and EA models prescribed by IT. Furthermore, a robust EA Governance model is crucial as EA is an ongoing process rather than a singular event. An Enterprise can only maintain up-to-date EA data for new business and IT initiatives, as well as modifications to existing environments, by implementing a suitable EA Governance model. This results in the successful synchronization and alignment of information technology activities and architectures with business efforts, the establishment of standards in information technology architectures, procurement, and the facilitation of data-driven strategic decision-making. EA will continue

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to be a conceptual idea and will not be able to realize the economic benefits that were intended for it if adequate governance is not implemented. Architecture governance requires the support of an Architecture Governance Framework. Its purpose is to help identify efficient processes and Enterprise structures, in order to clarify, communicate, and effectively manage the business responsibilities associated with architecture governance.The following advantages of effective governance are available at the enterprise level:

- Faster IT solution time to market
- A consistent increase in time to market
- Improved system integration
- A smoother integration with external systems
- Simplifying in order to reduce complexity
- Increasing the use of older systems
- Guidance and recommendations for forthcoming investments
- Launch of novel technology promoted by industry
- Improved IT integration with the business
- Increased vendor influence and improved interface efficiency
- A company that can adapt quickly and is prepared for unforeseen, abrupt changes

II. CONCEPTUAL STRUCTURE OF ARCHITECTURE GOVERNANCE FRAMEWORK

Key Concepts-Architecture Governance is an all-encompassing framework that includes a methodology, a sequence of procedures, a cultural mentality, and a set of obligations that are owned by the organization. Its objective is to ensure that the structures of an organization are both effective and consistent with their integrity. An illustration of the fundamental concepts can be found in Figure 3. For effective support in the Architecture Governance project, it's crucial to differentiate between process, content, and context. This divide makes it possible to include new governance material without having an overwhelming impact on the procedures that are already in place. The framework is guaranteed to be adaptable and versatile thanks to this technique, which does not rely on any particular content. The processes are frequently unaffected by the particular content, and they conform to a strategy to active governance that is well-established and efficient. The Enterprise Continuum is not complete without the Architecture Governance Framework, which is an essential component. It oversees all-important content related to both the architecture itself and the activities involved in Architecture Governance.

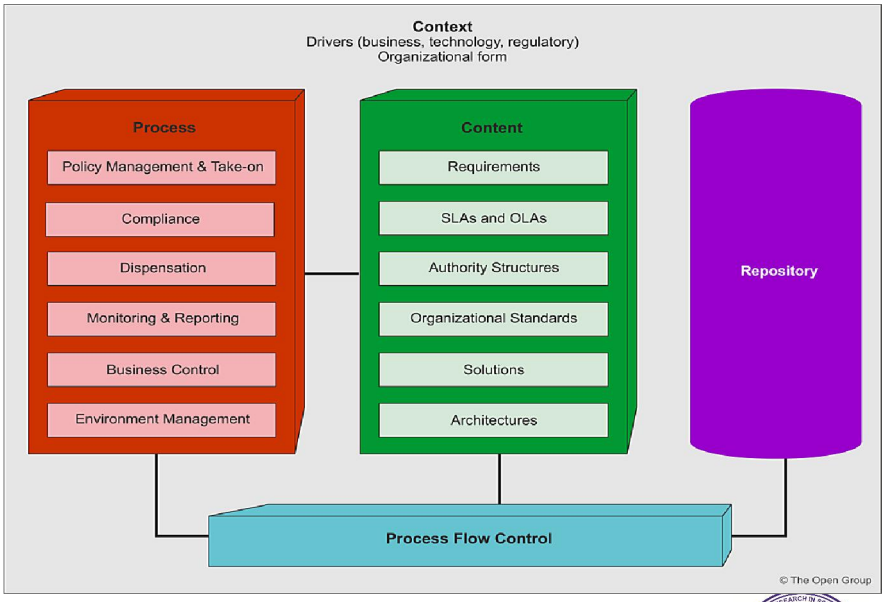

Figure 3: Conceptual Structure of the Architecture Governance Framework

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Key Architecture Governance Processes

Identifying, managing, auditing, and disseminating all of the information that is associated with architecture management, contracts, and implementation are all required to be done through governance processes. These governance tools will be utilized to maintain continuous monitoring of all architecture artifacts, contracts, principles, and Operational-Level Agreements, ensuring transparency and auditability of all decisions made.

Policy Management and Take-On

Registering, validating, ratifying, managing, and publishing new or updated material all require explicit governance over any architecture revisions, contracts, and supporting documentation. These protocols will ensure the orderly integration of governance materials and the comprehensive management and auditing of all relevant parties, contracts, documents, and supporting data.

Observance

Stability, conformity, and performance monitoring will be maintained by the implementation of compliance evaluations against standards, regulations, Service-Level Agreements (SLAs), and other relevant documents. Based on the criteria outlined in the governance framework, these evaluations will be either approved or refused.

Dispensation

Non-compliance in the focus area (be it design, operations, service level, or technology) may result within the rejection of a Compliance Assessment. When this occurs, the subject matter may:

Realign or adjust as necessary to satisfy the compliance obligations. Petition for a dispensation in situations where a Compliance Assessment is declined, dispensations are offered as an alternative means of achieving interim conformance. These are authorized for a specified duration and are subject to a predetermined set of operational and service standards that must be maintained throughout the dispensation's duration. Although not bestowed indefinitely, stipulations serve as a mechanism to guarantee adherence to service and operational standards while affording a degree of adaptability in their execution and scheduling. Because of their urgency, dispensations play a crucial role in driving the compliance cycle forward.

Observation and Documentation

Performance management is vital for maintaining effective oversight of operational and service components in alignment with established standards. This involves monitoring adherence to Service Level Agreements (SLAs) and Operational Level Agreements (OLAs), providing insights for required modifications, and generating reports. Internal management information, particularly concerning environmental management, will be considered.

Control over Business

Business Control refers to the procedures implemented to ensure adherence to the business policies of an organization.

Management of Environment

The effectiveness and efficiency of the governance framework's repository-based environment are guaranteed by all the services that are needed for this. All users' access, communication, training, and accreditation are part of this, as is the management of the logical and physical repositories. Official registration, validation, approval, oversight, and publication of new or updated content require that all architectural artifacts, service agreements, contracts, and supporting material be exposed to governance through a formal method. Through systematic integration with existing governance material, these approaches ensure efficient management and auditing of all relevant parties, contracts, and supporting information. A number of administrative procedures are outlined to set up a regulated service and process environment, which is part of the governance environment. Management information reporting, internal service level agreements (set up to control its own operations), and user management will all be part of the procedures.

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III. ARCHITECTURE GOVERNANCE FRAMEWORK - ORGANIZATIONAL STRUCTURE

The process and methodology used to manage and regulate enterprise architectures as well as other architectures is referred to as architectural governance. Building the right organizational structures to support all governance measures is essential to guarantee the efficacy of this control within the company. The following layers are often found in a well-organized Architecture Governance framework that is used to implement the strategy described in this section. These tiers can involve a blend of current organizational structures, competencies, and IT governance procedures. Usually included are the following components:

- Global Governance Board
- Local Governance Board
- Design Authorities
- Working Parties

Figure 4 depicts the key structural components necessary for an Architecture Governance project. Although the specific needs of each company may vary, it is anticipated that the fundamental structure depicted in Figure 4 will be relevant and feasible for a broad range of managerial models.

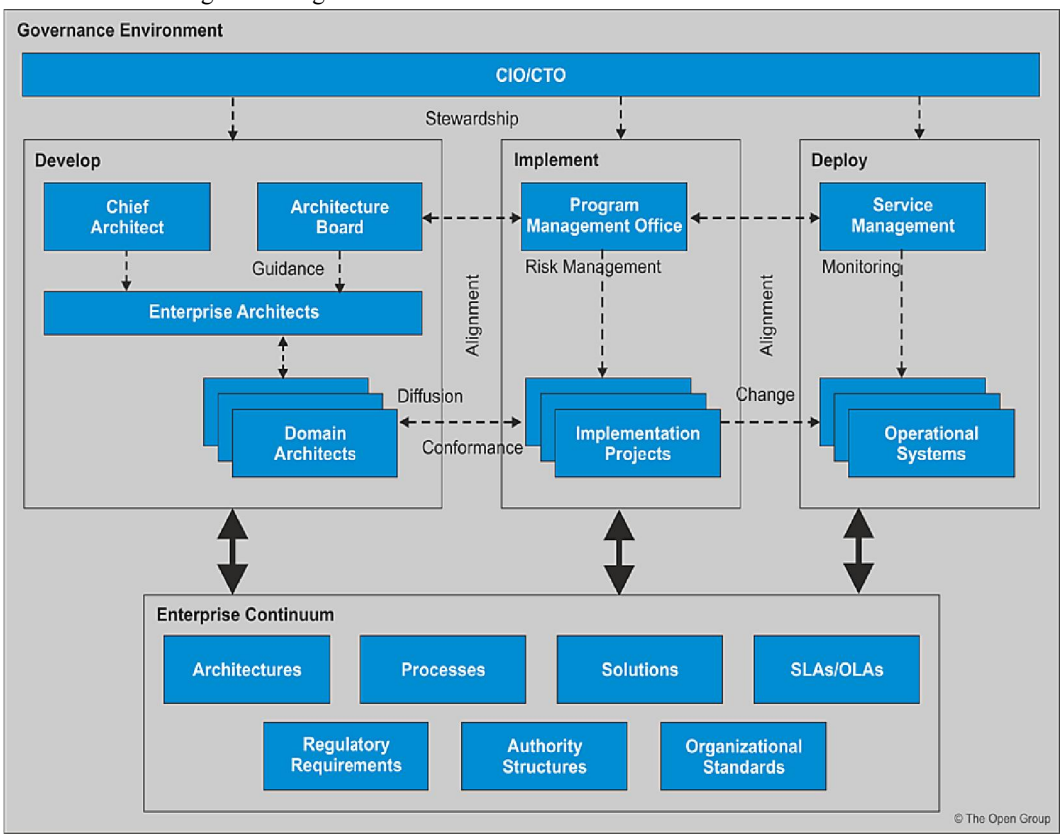

Figure 4: Organizational Structure of the Architecture Governance Framework

Key Areas

Develop, Implement, and Deploy are the three core domains of architectural management that are shown in Figure 4. While specific groups within the organization are assigned to perform individual responsibilities, the Enterprise Continuum is designed to facilitate all activities and resources related to managing architectures throughout their lifecycle.

Whereas the roles, procedures, and organizational frameworks linked to development are generally associated with Phase G, the roles, procedures, and organizational frameworks linked to implementation are normally associated with the TOGAF ADM and its application. A crucial component of the Enterprise Continuum is the Architecture

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Governance Framework. It is responsible for managing all pertinent content pertaining to Architecture Governance procedures as well as architectures.

Operational Benefits

The governance of the organization's architectures, depicted in Figure 44-2, not only oversees and directs their development and deployment but also extends to the management of the implemented architectures' operations. The ongoing governance of architectures has been found to yield the following benefits: Aligns IT procedures, resources, and information with company strategy and objectives.

Incorporates and establishes IT methodologies that are considered the most effective and efficient. Adheres to industry standards such as COBIT, which prescribe activities including IT performance monitoring, procurement and implementation, delivery and support, and planning and organization. Enables the organization to optimize the utilization of its hardware, software, and information infrastructure.

Safeguards the fundamental digital resources of the organization Adheres to regulatory and industry standards, ensuring traceability, protection, liability, and answerability. Facilitates the implementation of transparent risk management. The TOGAF Architecture Governance Framework offers several advantages, such as its capacity to operate as a methodology, a sequence of procedures, a cultural compass, and a collection of accountable responsibilities. These elements collaborate harmoniously to ensure the effectiveness and integrity of the architecture of the organization.

IV. EA ORGANIZATION STRUCTURE

The EA group supports the creation and deployment of capabilities for designing, reviewing, executing, and governing EA. These competencies consist of several essential components, which include:

- Enterprise Architecture Frameworks. Enterprise follows a set of guidelines, protocols, and procedures that govern the decision-making process for adopting, reusing, reporting, and retiring information technology. These encompass fundamental principles, techniques, protocols, measurements, optimal methods, and models for reference.
- Effective governance of Electronic Arts (EA). An Architecture Review Board (ARB) consisting of representatives from different organizations and disciplines, supported by top-level executives in Enterprise IT, is in charge of overseeing the application of the framework description and technology governance plan.
- Compliance with EA regulations. A specified plan and the implementation of a set of standardized and repeatable procedures are the components of an EA compliance strategy, which ensures adherence to the plan. Establishing appropriate organizational roles and structures to uphold architecture governance processes and meet reporting requirements.

The guidance and oversight provided by EAensures that the procedures for delivering IT solutions across the organization are focused on achieving specific features of those solutions. The following items are included:

Standardization refers to the process of creating and advocating for IT standards that are applicable throughout a whole organization.

- Consistency: Ensure the necessary degrees of integration and interoperability of information, processes, and applications.
- Reuse: Techniques and enabling abilities that make it easier to reuse and make use of IT assets when they're in the design, implementation, and portfolio management phases. This includes aspects related to asset repositories and process/governance.
- Quality: Providing solutions that meet both the functional and technical requirements of the business, while implementing a lifecycle management process to ensure the quality of these solutions.
- Cost-effectiveness and efficiency are achieved by implementing consistent standards, reusing resources, and ensuring quality through repeatable decision governance processes. This leads to decreased total solutions lifetime cost and higher returns on IT expenditures.

The EAgroup is in charge of planning and supervising the entire architecture. This entails examining technology strategies, setting up guidelines and policies, providing recommendations for the organization's overarching technology

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strategy, and evaluating technological acquisitions. The CIO is typically the person to whom the EA Chief Architect reports, and the IT Leadership receives guidance from the EA group.

The graphic below illustrates the overarching organizational structure necessary to attain business-IT alignment within a corporation.

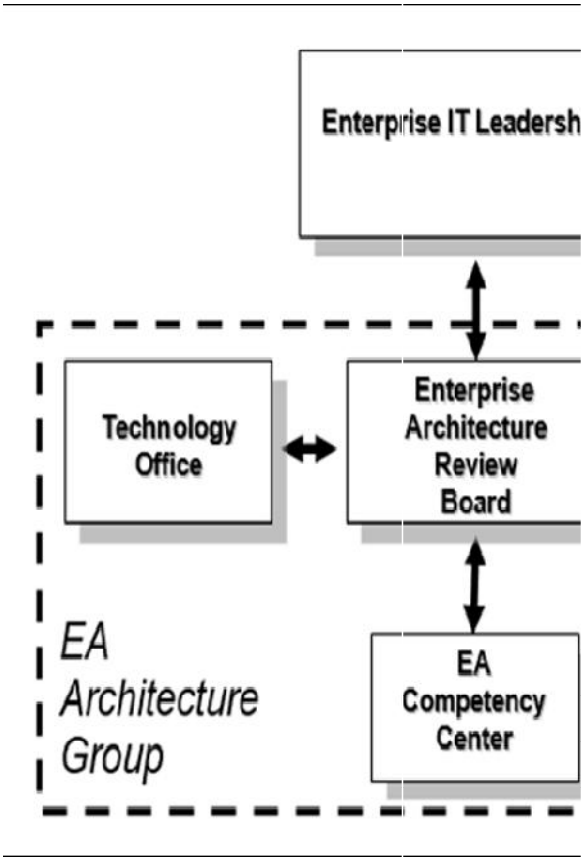

Figure 5: High-Level Enterprise Architecture Organization Model

Enterprise IT Leadership Council: The senior management team, including of business leaders and the Chief Information Officer (CIO), is accountable for delineating the strategic elements of the organization. They work closely with the program management office and the EAReview Board (EARB) to transform these elements into procedural elements. The Enterprise IT Leadership Council is responsible for the following:

- Overseeing the enterprise business portfolio in conjunction with the Chief Information Officer (CIO)
- Developing enterprise business strategies in conjunction with the CIO
- Establishing the strategic direction and priorities for the use of IT to support the business
- Collaborating with the EA workgroup to guarantee comprehensive analysis of the project portfolio.

Working alongside the EA Competency Center to develop cohesive technology visions and requirements across the entire organization.

- EA Workgroup: The process entails creating the dynamic elements of EA, including the infrastructure, application architecture, data architecture, and business model. Along with offering suggestions for a thorough governance process and EA lifecycle procedures, it also creates official engagement models with other organizations, including the technology office and EA competency center.
- EA Review Board: The primary EA Review Board comprises numerous architects. The main duty of this organization is to engage in important tasks such as conducting architectural assessments, prioritizing and approving projects, evaluating RFPs/vendors, and reviewing processes. This entity must also ensure

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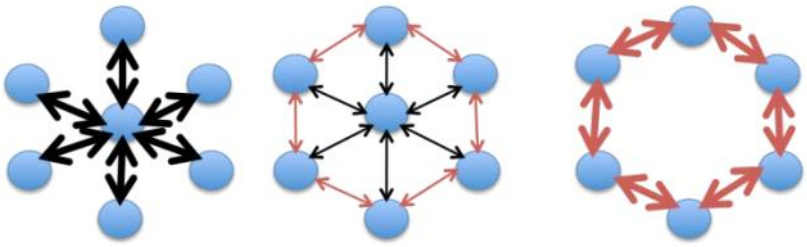
compliance with established standards and protocols. The following section delves into the complexities of the EA Review Board, outlining its roles and responsibilities.

- EA Competency Center: it will closely monitor the emerging technologies in the market and assess their business value for the firm. It aids in the creation of tools, procedures, and migration strategies that facilitate the transition of outdated systems to new technologies and platforms. The IT Leadership Council may be recommended by the Technology Office to create new competency centers that are based on the business benefits that particular technologies provide. Typically, a variety of governance structural models can be applied in an IT decision framework. These frameworks vary in their degree of centralization, ranging from very centralized to highly decentralize. Enterprises commonly utilize a range of them, employing diverse methodologies for these distinct decision frameworks. The subsequent section elucidates the principles underlying the paradigms of Centralized, decentralized, and federated architecture.

Concepts for Reasoning about Decentralization

Three generic sorts of organizational structures are considered: centralized, federated, and decentralized. Our attention is on the components of these structures that influence the definition (EA method) and subsequent implementation (EA engine) of the EA principles that guide the organization towards its desired architecture: the core and the driving forces. A Center is a component of an organization, such as an individual, a group, or a unit, that assumes the responsibilities of a leader, supervisor, or coordinator. It possesses authority to direct and guide the other components of the organization. The concept of center might be either implicit or explicit. Organizations that have centralized IT, as shown in Figure 6-a, have a clearly defined center, such as an EAdepartment or an EA steering committee. This center is responsible for initiating, overseeing, and verifying the changes in the organizational IT and in the EA itself. It guides and oversees all the departments inside the business by establishing regulations and ensuring adherence to them. It might be stated that there are steering forces between the central and non-central units. Figure 6 illustrates three different types of organizational structure, which are characterized by the concepts of center and guiding forces. Organizational units are represented by solid circles. A circle located at the center represents the concept of "Center". The arrows connecting the circles represent the forces that control the direction of movement. Steering forces refer to explicit and implicit protocols, policies, norms, and procedures that govern the communication and control between different units within an organization. These forces can be defined by their orientation (vertical, horizontal, lateral) and their magnitude. In businesses that have centralized IT, the center is connected to various units through strong steering forces, creating a hierarchical structure (radial forces). Figure 6-a depicts a basic model consisting of two hierarchical levels. The forces involved in this model can be categorized as either top-down, which include supervision, decision making, and task/resource planning, or bottom-up, which involve local efforts that are escalated to the center for approval. In federated organizations, the central authority is clearly defined, but the connections between the center and other units have limited influence due to the fact that local decision-making and priority in IT are also possible. Conversely, this model exhibits sideways steering pressures as a result of increasing interactions that arise locally between units, bypassing the central authority. In decentralized businesses, the central authority diminishes or becomes implicit, resulting in a lack of general commitment to a specific set of EAprinciples and a loss of centralized control over the evolution of IT. The sole driving force that propels the evolution of organizational IT is the presence of powerful lateral forces.



centralized federated decentralized

Figure 6 different types of organizational structure,

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Using the concepts of center and guiding forces, three different organizational structures are illustrated in Figure 6. Filling up the circles represents the various organizational units. As a symbol for the "Center," a central circle is used. Directional arrows show the forces acting on the circles.

V. RELATED WORK

A collaborative tool for gathering and storing common architecture information, the EAF facilitates teamwork. It bolsters standards and offers direction for building the desired EAand all of its parts. At this very moment, there are a great many Electric Arc Furnaces (EAFs) in operation, each one modified to fit the specific needs of a company. ZEAF is an early example of a framework that John Zachman created. The FEAF [6] was published by the United States CIO Council to offer direction for EA endeavors on the national level. Also, to help with their EA lifecycle efforts, the US Department of the Treasury put out the TEAF [7]. To further aid in the definition of IT architecture, the Open Group created TOGAF, which stands for The Open Architecture Group Framework [9].

A comprehensive assessment and comparison of the accessible alternatives is required for the difficult and time-consuming process of selecting an adoption framework. A number of studies have sought to offer assessments in this domain, each with its own unique goals and points of view. Here we give you a quick rundown of various studies that have been done in this area.

Using a paradigm that aids in comprehending the fundamental components of architecture, Tang et al. [10] compared six architectural frameworks. Based on their goals, inputs, and outputs, they evaluated and contrasted the frameworks. Disagreements between the frameworks are found through the architectural analysis [11].

Although the writers did touch on the interrelationships of the other frameworks with the Zachman framework, they failed to present the details in a manner that would have made a choice between them straightforward. On top of that, Sessions [12] compared a plethora of popular architectural frameworks. The case study centred on an imaginary pharmacy chain experiencing operational problems, and he set up certain criteria for comparison. None of the frameworks are sufficiently thorough, according to the author's study. Thoroughly assessing the unique needs of the business is essential when choosing a framework. Finding an appropriate solution could require integrating features from multiple frameworks.

In categorizing to create a common ground intended forevaluating architectural approaches, [13] used a meta-framework. This structure is based on an analysis of numerous well-known architectural methods. It is subjected to a series of analyses that identify, extract, and define entities in general terms. The last step in creating the meta-framework is to merge these things. In order to compare and integrate architectural alternatives, the authors have verified that this meta-framework is a feasible choice.

EAis crucial to the success of e-government programs around the world, but there hasn't been much study that specifically looks at how well existing EAFs operate in this setting. With a focus on the challenges currently encountered by e-government development, this study intends to offer an evaluation of e-government Electronic Application Forms (EAFs). We shall approach the evaluation from two distinct angles. Interoperability and agility are two examples of non-functional requirements that the first viewpoint identifies as critical to the success of e-government programs. In light of the complexity and specific requirements of e-government development, the second viewpoint discusses specific development issues.

VI. SUMMARY OF THE CHOSEN FRAMEWORKS

In this section, we will offer a concise summary of the four selected frameworks scheduled for assessment.

Zachman Enterprise Architecture Framework (ZEAF)

The ZEAF framework is regarded as the initial EAF to be implemented. It is based on the Information System Architecture framework initially introduced by John Zachman. [14]. ZEAF is presently incorporated into a number of architectural frameworks, owing to its considerable acclaim within the architectural community. The examination and formulation of enterprise architecture, with an emphasis on the development of information systems, are the primary objectives of ZEAF. A perspective is an individual data point presented in a tabular format, which represents the viewpoint of a project team stakeholder with respect to the system. A multitude of stakeholders are engaged in the undertaking, comprising the planner, proprietor, designer, builder, programmer, and user. Each stakeholder's unique

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viewpoint contributes to the creation of specific deliverables. The framework organizes information for each perspective into distinct categories, such as the scope document, enterprise or business model, system model, technology model, and components. (1) The term "what" pertains to the gathering of data and information. (2) How: Denotes the operations and procedures that are entailed. (3) The term "where" denotes the tangible location of software and hardware. (4) Who: Denotes individuals by their assigned responsibilities and level of authority. (5) When: Denotes the temporal requirements of operational procedures. (6) Why: Indicates the underlying motivation that drives a particular action or decision. The number 6 serves as a reference to the text.

Table 1 presents the Zachman framework in its entirety, consisting of 36 cells. Each cell represents a distinct creationotherwise artifact, which could include, among other things, a scope document, enterprise or business model, or system model.inside order to preserve simplicity, the model names contained within the compartments have been omitted.

Table1: Zachman Framework

	Data What	Function How	network Where	People Who	Time When	Motivation Why
Planner						
Owner						
Designer						
Builder						
Programmer						
User						

While the examination of the business is extremely beneficial, ZEAF does not offer a precise methodology for the building of systems. Nevertheless, a revised edition known as Zachman ontology [6] was published in October 2011. The upgraded iteration improves comprehension by incorporating enhanced graphics, meta-modeling, integration lines connecting cells, transformation notation within cells, and enriched perspectives.

Federal Enterprise Architecture Framework (FEAF)

The FEAF, established by the US CIO Council, aims to facilitate collaborative development for standardized US Federal processes and foster information exchange among federal agencies and other government entities. It comprises five reference models:

The Performance Reference Model (PRM) evaluates the effectiveness of major IT investments and their impact on program performance, aiming to enhance alignment and identify areas for improvement.

The Business Reference Model (BRM) provides a comprehensive framework delineating federal government business operations, irrespective of the implementing agencies, organized functionally to illustrate routine business operations systematically.

The Service Component Reference Model (SRM) simplifies the identification of business and application service components essential for government-wide IT investments. It is structured across horizontal and vertical service domains and supports the potential for business service, enterprise application, and component reuse.

The Data Reference Model (DRM) defines the data and information required to support business line operations, aiding agencies in defining interactions and transactions between the federal government and citizens, serving as the primary reference for data architects to establish modeling standards.

The Technical Reference Model (TRM) is a component-driven technical framework that classifies to aid in the provisioning of service components and capabilities efficiently.

The Open Group Architecture Framework

An all-inclusive method for enterprise information architecture design, planning, implementation, and governance is offered by the architectural framework Open Group Architecture Framework. The Open Group's well-known OGAF[9] and is as follows:

Business architecture: outlines the procedures that the company uses to achieve its objectives.

Application architecture: explains the structure and interactivity of applications.

Data architecture: explains the structure and accessibility of the enterprise data repositories.

Technical architecture: denotes the infrastructure of hardware and software supporting applications and their interplay.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, March 2024

The most recent iteration is Open Group Architecture Framework 9.1, which was released in February 2009. Open Group Architecture Framework 9 is an advancement of Open Group Architecture Framework 8, introducing numerous new features and improvements. An important inclusion is the ADM, a clearly defined procedure that is implemented during the development of a system. The ADM process is characterized by its iterative and cyclic nature, encompassing eight distinct phases: Change management for architecture, information systems architectures, technology architecture, potential solutions, migration strategies, and governance of implementation. [9]. One benefit of Open Group Architecture Framework is its close integration with ArchiMate, a robust and self-sufficient programming language utilized for the modeling of business processes. ArchiMate enables the visualization, analysis, and construction of EA. The ArchiMate programming language integrates contemporary service orientation paradigm principles and offers tools to assist enterprise architects (EAs) in accurately delineating, examining, and representing the interconnections among diverse business domains.

Treasury Enterprise Architecture Framework (TEAF)

The TEAF framework builds upon the Zachman Framework and enhances the operational processes of the Treasury related to products. In a rapidly changing technological landscape, this framework aids in the development and restructuring of business processes across various departments to adhere to recent legislative requirements.

TEAF proposes the partitioning of EA into more manageable components, which may be constructed incrementally across various projects or utilized autonomously, so as to streamline the construction and utilization processes. The allocation is ascertained based on distinct perspectives, viewpoints, and task deliverables [8]. Similar to the ZEAF, the TEAF establishes a cohesive and consistent framework for the complete business architecture by employing a matrix. The TEAF matrix consists of four architectural views—Functional, Informational, Organizational, and Infrastructure—and four perspectives—Planner, Owner, Designer, and Builder.

The ELC, which is introduced by the TEAF, serves to coordinate the business and IT operations of the entire organization by integrating its management and business activities. Enterprise Life Cycle (ELC) is an abbreviation for the all-encompassing strategy an organization implements to manage its operations, make decisions, and align its business and technical procedures with its intended goal. These responsibilities include asset management, project definition, configuration management, accountability, and guidance for systems development.

VII. ASSESSMENT AND COMPARISON

Here, we shall delineate the criteria employed to assess EA frameworks for e-government. We advocate for the selection of these criteria based on the particular challenges encountered in the advancement of e-government. Citing references [15-18], the progress of E-government encounters several obstacles that can be categorized from various viewpoints. However, for brevity, we will provide a concise overview of the challenges that we believe can be mitigated through the adoption of an architecture-focused approach to systems development.

Fragmentation and coordination challenges: The absence of integration among different applications across government departments results in the formation of isolated systems. This occurs because each agency operates with its own specific set of data, management protocols, and initiatives. Such projects frequently fail to adhere to standards, resulting in duplicated efforts among agencies, increased complexity, and reduced interoperability.

Agility challenges: Modern e-government must possess the capacity to adapt to environmental changes and effectively deliver services to citizens through alternative channels such as mobile and cloud. It is essential for e-government to be able to effectively manage the evolving needs of citizens and leverage the latest advancements leveraging cloud technologies and services to achieve optimal advantages.

Cost challenges: The absence of disseminating successful implementations frequently leads to avoidable replication of work and resources. Hence, it is imperative to establish a system that enables the recognition and specification of shared business procedures, promoting their reuse. This will facilitate the exchange of these procedures among various government departments, resulting in cost reduction and fostering integration.

Given the previously mentioned difficulties and the specific circumstances of e-government, we have put forward an evaluation method that takes into account two different viewpoints. The initial viewpoint places emphasis on quality or non-functional criteria, whereas the subsequent viewpoint addresses particular concerns related to development. The

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Impact Factor: 7.53
Volume 4, Issue 5, March 2024

elucidation of the two perspectives is presented in separate paragraphs A and B. Using these criteria, Tables 2 and 3 provide a comparative analysis of four EAFs. A total of four assessment frameworks were chosen on the basis of their extensive utilization and substantial citation count. Following an exhaustive examination of the existing frameworks, we have reached the determination to exclude the DODAF framework from our assessment.

The decision was prompted by the exclusion of the DODAF framework from e-government initiatives, as it was originally tailored solely for the US Department of Defense to support its military operations. Furthermore, the Gartner framework has been excluded from the analysis due to commercial restrictions that hinder its accessibility and its substantial reliance on consulting services. The frameworks selected include ZEAF, FEAF, OGAF, and TEAF.

Assessment from the Perspective of Non-functional Requirements

Non-functional needs are a reflection of the overall quality of a system. If these requirements are not given adequate consideration during development, the implications can be rather costly. In the event of the most severe scenario, it may be necessary to entirely overhaul systems [19]. Therefore, we propose conducting an evaluation with a specific emphasis on four non-functional prerequisites that directly tackle the obstacles associated with the establishment of e-government. Interoperability refers to the capacity of disparate software systems, applications, and services to exchange and communicate data with accuracy, consistency, and efficiency [5]. Enabling the delivery of services across agencies is an essential requirement in the realm of e-government, rendering interoperability an indispensable component. As a result, throughout the evaluation process, we conduct a thorough analysis of the various facets of interoperability and examine how enterprise architectural frameworks address these facets. Three dimensions comprise the UNDP e-government initiative [2] classification of e-government interoperability: Interoperability between organizations pertains to the coordination and harmonization of information architectures and business processes within and between entities. Collaboration involves the application of established methods, protocols, and community-based services to facilitate work flow, decision-making, and financial exchanges.

Semantic interoperability refers to the process of ensuring that any individual or computer receiving the data can accurately discern the intended meaning of the transmitted information. Semantic interoperability facilitates the integration of received data with other data for the purpose of conducting meaningful analyses [19]. Nonetheless, it is indisputable that further consideration is necessary for the current EAFs. Technical interoperability refers to the process of establishing seamless connections between computer systems in order to facilitate the sharing of information or the application of common functionalities. It refers to the protocols and standards that enable consistent information exchange among computer systems.

Agility: Enterprise change management is a crucial factor for the sustainability of businesses operating in dynamic contexts, like e-government, where change is continual. TEAF has effectively addressed the requirement for agility by adopting a flexible and iterative enterprise lifecycle approach. This allows for the evolution of the enterprise over time through the incorporation of new business processes, technology, and capabilities.

Integration: Integration is the systematic procedure by which distinct subsystems are merged to form a unified system, with the aim of guaranteeing their harmonious operation. Integration enables the validation of the consistency of business principles across the entire organization and guarantees the uniformity of system implementation within the enterprise's boundaries [5].

Reusability: Interoperability pertains to the capability of enterprise components, including the business reference model and services, to be employed across multiple systems. Reusable modules reduce expenses and accelerate the implementation process, increase the likelihood that problems have been resolved through prior usage and testing, and concentrate code updates in the event that an implementation change is required. An initial assessment, predicated on the aforementioned non-functional requirements, is displayed in Table 2. Based on our survey findings and practical understanding of these frameworks, subjective evaluations were collated to provide comprehensive insights.Table2: Evaluation according to non-functional requirements

Table 2: Assessment based on non-functional requirements

Criteria	ZEAF	OGAF	FEAF	TEAF
Organizational Compatibility	1	2	2	1
Semantic Compatibility	1	1	1	1
Technical Compatibility	0	1	2	1

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Volume 4, Issue 5, March 2024

Agility	0	2	1	2
Integration	1	1	2	1
Reusability	0	1	2	1
Score	3	8	10	7

Assessment from the

Development Viewpoint

We have taken on eight specific criteria for evaluation, carefully chosen to address the challenges and distinctive needs of e-government within its context.

Architecting Process: TOGAF encompasses the essential procedures necessary for developing a comprehensive architecture, along with a systematic approach for transitioning from the current architecture to the future one. The framework incorporates the Architectural Development Method (ADM), which is a highly structured and iterative process consisting of eight steps. In contrast, the Zachman framework does not offer a predefined method for developing enterprise building.

Service Orientation: Adopting the service-orientation paradigm entails breaking down software into operational capabilities that cater to specific needs. Service-Oriented Architecture (SOA) has garnered considerable interest from governments over the past decade due to its advantageous features, including enhanced return on investment, directorial adaptability, in addition to interoperability. Nevertheless, we have seen that the existing frameworks do not comprehensively address the concepts of service-orientation design.

Cloud Enablement: Because of its potential as a simple and inexpensive solution, cloud computing is attracting the attention of government organizations. This is especially true in these times of tight budgets and quick adjustments. Agencies can move funds from capital to operational expenditures via cloud computing. While current frameworks have come a long way, they still have a ways to go before they can fully support the cloud.

Architecture Modeling: When evaluating the modeling tools and techniques used by the framework, we take into account their scope and effectiveness. Various modeling approaches and languages are employed by different EAFs, but they vary in terms of their range and specific features. TOGAF benefits from the utilization of ArchiMate, an open and autonomous modeling language for business architecture. ArchiMate enables the representation, analysis, and visualization of architecture.

Evaluation and Governance: The framework assesses the effectiveness and maturity of various agencies in leveraging EA and ensures that the organization's IT investments align closely with business objectives. Additionally, it fosters agility by implementing ongoing enhancements. The primary objective of the FEAF is to evaluate the effectiveness of an organization's usage of EA by implementing evaluation methods to measure architectural completion and utilization.

Reference Models: The cornerstone of EA development can be considered to be the ability to communicate in a common language and facilitate reuse, sharing, and learning experiences. Moreover, it facilitates the implementation of Service Level Agreements (SLAs), which are essential for adopting cloud solutions. In this regard, we consider FEAF to be the preferred choice due to its comprehensive emphasis on reference models.

Table 3: Assessment in Relation to Development Challenges

Criteria	ZEAF	TOGAF	FEAF	TEAF
Process of Architecting	0	3	2	2
Service-Oriented Approach	0	2	2	1
Cloud Integration	0	1	1	0
Modeling Architectures	1	3	2	1
Assessment and Oversight	0	2	3	3
Model References	1	2	3	1
Management of Complexity	1	2	3	2
Documentation Practices	2	2	3	2
Rating	5	17	19	12

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Complexity Management: Managing complexity effectively is paramount in assisting the development of enterprise architecture, given that complexity is inherent in all enterprise-wide system, including e-government. Recognizing this, the FEAF addresses this issue by introducing the notion of segments in its perspective on enterprise architecture. TEAF also suggests simplifying enterprise architecture by breaking it down into smaller components using views, perspective, and work products.

Documentation: In the ever-evolving landscape of e-government, characterized by frequent changes in rules and stakeholders, prioritizing the documentation of EA development is essential. This facilitates the sharing of information and experiences. Table 3 provides a comparison of the four frameworks based on the eight selected growth criteria.

DISCUSSION

We evaluated each framework based on specific criterion, taking into account our survey and experience. The ratings are subjective. The final scores for each framework were calculated and presented in tables 2 and 3. FEAF received the highest score; making it the most suitable framework for e-government adoption It effectively meets our criteria from two distinct perspectives. However, it's important to note that FEAF and TOGAF deliver comparable results. The adoption of TOGAF by governments is extensive and it has numerous benefits that can improve FEAF. These include a well established process for creating architectural designs and its seamless connection with the robust ArchiMate language. Consequently, we assert that no EAframework is genuinely all-encompassing. Every framework possesses distinct advantages and disadvantages, which mutually enhance one another.

VIII. CONCLUSION

Integrating Enterprise Architecture into e-government development offers a comprehensive perspective on business processes, promotes the adoption of standardized procedures, and enhances collaboration among government organizations. However, the progression of EA necessitates the selection of a framework that clearly delineates essential elements and the process for its development. Currently, various Enterprise Architectural Frameworks (EAFs) are in use, each with distinct objectives and levels of advancement. This article explores the challenges associated with e-government systems development and the framework selection process. The proposal advocates for evaluating the framework from two perspectives: one emphasizing non-functional requirements crucial for e-government effectiveness, particularly interoperability, and the other addressing significant developmental concerns. The study revealed that while FEAF proved to be the most effective framework, no single EAF can fully satisfy all criteria and requirements. Each framework possesses unique strengths and weaknesses, complementing one another. Nonetheless, certain aspects such as semantic interoperability, adherence to service-oriented design principles, and facilitation of cloud computing, remain inadequately addressed or unresolved. These issues necessitate future advancements. Moreover, it is important to undertake further study on more precise criteria in order to offer precise advice for choosing an EAframework. It is imperative to take into account business concerns during this process. Currently, we are actively involved in a case study focused on tailoring an enterprise architectural framework for the Egyptian e-government.

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ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
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