Zachman Framework: Evolution, Comparison, and Implementation in SEA

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Abstract— **This article provides a full analysis of the Zachman framework for Enterprise Architecture (EA), it gives a brief history of the Zachman framework and focuses on its fundamental principles, practical implications, and comparative insights with another enterprise architecture framework, TOGAF. Depth analysis carried on Zachman framework, revealing its structure, perspective and interrogative, which serves as a foundation of enterprise architecture planning and management.**

Keywords— **Zachman, TOGAF, Columns, Rows, Architecture**

I. PURPOSE

The main goal of this study is to evaluate the Zachman Framework, for Enterprise Architecture in comparison to established frameworks like The Open Group Architecture Framework (TOGAF). The article aims to explore the principles of the Zachman Framework within the context of enterprise architecture as a concept and practice. We also want to highlight the differences, advantages, and unique features of both the Zachman Framework and TOGAF. Apart from that, we also evaluate the strengths and weaknesses of the Zachman Framework when compared to frameworks focusing on its recognition in industry, practicality, comprehensiveness, and complexity. We also interested to investigate the origins and evolution of the Zachman Framework tracing its development over time. Lastly, we would like to examine how businesses around South East Asia region currently implement and adopt the Zachman Framework showcasing examples of implementation success stories challenges encountered and lessons learned.

II. INTRODUCTION

Enterprise architecture (EA) plays an important role in modern organizations. It helps organizations to determine effectively how they can achieve their current and future objectives. Enterprise architecture is a practice of analysing, planning, designing and implementation. According to Gillis [1], example of frameworks include: (1) The Zachman Framework for Enterprise Architecture, (2) Unified Architecture Framework (UAF), (3) Agile enterprise architecture, (4) Federal Enterprise Architecture Framework (FEAF), while other are The Open Group Architecture Framework (TOGAF), the European Space Agency Architectural Framework, the SAP Enterprise Architecture Framework or the Ministry of Defence Architecture Framework. Each framework has different purposes thus the organization needs to choose the best framework that fits the architecture and their target.

This article focuses on one of the foundational frameworks in enterprise architecture: the Zachman Framework. Developed by John Zachman in the 1980s, Zachman Framework provides a structured approach to understanding and managing enterprise architecture. According to Hay [2], "Zachman's framework, structured as a matrix, six rows representing these perspectives, each corresponding to essential elements such as the data handled by the organization (what), its operational functions (how), business locations (where), triggering events (when), involved entities (who), and underlying motivations and constraints (why) while focusing on the perspectives of stakeholders involved in business processes." The elements of the matrix are complete where all 6 questioner words are used in the matrix framework hence this will collect all the important information needed to implement effective solutions for the business needs. The structure of the framework also helps organizations to organize and manage their architectural artifacts systematically.

The aim of this paper is to provide a comprehensive overview of the Zachman Framework and to compare it to other frameworks thus elucidating their respective advantages and disadvantages. It first represents a brief history of Zachman framework, then a discussion on Zachman framework architecture, then comparative analysis of Zachman and TOGAF, followed by advantages and disadvantages of Zachman framework and implementation of the Zachman Framework in South East Asia before concluding.

III. HISTORY OF ZACHMAN FRAMEWORK

John A. Zachman was born in America and is one of the founding developers of IBM's Business System Planning (BSP). Based on 'The Zachman Framework Evolution' by J. P. Zachman [3], the original Zachman framework, titled 'Information Systems Architecture - A Framework, by John A. Zachman was created in June 1984. As we know, the framework consists of 6 columns, but we noticed only 3 columns exist in the first design of Zachman Framework. During this time, Enterprise Architecture (EA) had not been born yet and originally this first framework was created as a framework for Information Systems Architecture. Later, John improved the graphics of Zachman Framework representation original drawings using IBM graphics support and he used this graphic until his retirement in 1990. The framework was not published until now. The first image of the framework was published in 1987 IBM Systems Journal as 'Framework for Information Systems Architecture'. IBM Systems Journal published "A Framework for Information Systems Architecture" in 1992, but Enterprise Architecture began to recognize John's ideas that strategy and information systems should be "engineered" for the entire enterprise, not just "manufactured" by the Information System department. In 1993, John renamed the framework Enterprise

Architecture-A Framework. Two years prior, he launched "Enterprise Architecture" consulting and education firm. He thought people would prefer his "Enterprise" Architecture over "Information Systems" Architecture.

About 2001, John's concepts for Enterprise Architecture became well-known. We referred to it as The Zachman Framework. It encompassed ten years of research achievements and was widely dispersed. This version focused column changes and used color-coded models to illustrate various viewpoints. Using the hues of the spectrum—Red, Orange, Yellow, Green, Blue, and Orange—he attempted to alter the concept. In 2002, Intervista-Institute in Canada produced a new Zachman Framework graphic with aesthetics and graphic design, following copyright clearance from John and his development help. Adjectives, deemphasized Row 6, IDEF0 notation in Column 2, Row 2, and IMS Root-Segment notation in Column 1, Row 4 are all included in this version of the text related to information systems. A significant enhancement was the black-to-white gradient that dropped vertically through the columns in this edition.

One year later, thanks to ZIFA, the Zachman Framework was widely recognized. Some ZIFA partners were let down by the graphic version of Intervista. The version they requested only indicated ZIFA and went back to previous notation difficulties. This edition, however, was rife with errors. The phrase used is Information Systems (I/S) rather than Enterprise, there are unclear adjectives, and Row 6 is minimized even more than previously. In 2002, Intervista Institute produced a slightly altered version of the same edition. Despite being comparable to the previous version, this one was better thanks to the gradient color banding across the Rows and Columns. This gradient color banding illustrates Integration (across Rows) and Transformations (down Columns) more clearly than it did previously. The Zachman Framework was renamed as The Zachman Framework2TM in 2004. John thought this edition's significant changes were good. This version's usage of white lines on a vivid blue background to construct the matrix made it difficult to explain Integration and Transformation.

A few years passed, and John developed a new version of the framework in 2011 after internal restructuring within Zachman International where he took complete control over its design. Seeking input from the representative in the Enterprise Architecture (EA) space, including academia, consulting, data and process modeling communities and tool vendors, John made several adjustments to create the most inclusive representation of The Zachman Framework. The 2011 version resembled the original 2001 framework image, but it was labeled as "Version 3.0". The subtitle "The Enterprise Ontology" is to clarify The Framework's nature as an ontology rather than a methodology. So far, the 2011 Zachman Framework Version 3.0 was the most descriptive Framework graphic produced. It clarified The Zachman Framework as an enterprise ontology, emphasizing its scientific nature and classification theory about any enterprise.

IV. ABOUT THE ZACHMAN FRAMEWORK

The Zachman Framework can easily be explained as a bounded 6 x 6 matrix with the Communication Interrogatives as Columns and the Reification Transformation as Rows. The Columns represent the communications perspective (What, How, Where, Who, When, and Why) while the Rows represent stakeholder viewpoints (Planner, Owner, Designer, Builder, Subcontractor, and Implementer). Based on the information provided by Visual Paradigm, sometimes the Rows also can be represented as viewpoints (Scope Concepts, System Logic, Technology, Physics, Component Assembles and Operations Classes) [3]. The six rows and six columns create a two-dimensional matrix with 36 categories set inside. The Zachman Framework is an ontology and not a methodology. According to "A DEFINITIVE GUIDE TO Zachman Framework", ontology serves as a process to define a set of concepts and categories to represent the subject. Ontology is a structure while methodology is a process [4]. A structure establishes definitions while a process provides transformation. As the Zachman Framework serves as ontology, the framework is unpredictable and changing to produce unrepeatable various outcomes. On the other hand, a methodology represents a process of transformation from one state to another state. Apart from the Columns and Rows, John Zachman also introduced seven rules for his framework that will assist architects and IT managers use the tool efficiently and effectively.

A. Components of The Zachman Framework

Communication perspective describes enterprise data, procedures, and networks. Functional and system architectures are examined under the How perspective to understand how processes and technologies benefit the business. The Where perspective emphasizes architecture's infrastructure, networks, and places. Who examines architects' organizational structure, functions, and responsibilities. The When perspective examines the architecture's process and event sequence. Why symbolizes architecture's goals, strategies, and techniques [5]. While in stakeholder perspective: Planners focus on strategic planning, company goals, and long-term goals. The Owner ensures the architecture satisfies business goals from a management standpoint. The Designer must create exact specs and designs that meet business management criteria. The Builder executes and builds architecture, making it functional. Third-party solutions and components are acquired and integrated by the Subcontractor. The Implementer deploys, runs, and maintains the architecture [5].

B. Rules of The Zachman Frameworks

There are several basic rules that must be applied in the Zachman Framework. The rules will help architects and IT managers effectively and efficiently use the tools as they use it in the right ways. First rule based on "A DEFINITIVE GUIDE TO Zachman Framework" [4], avoid adding more rows or columns to the framework. Additional rows or columns will disrupt the classification system. This will help to maintain the framework's integrity. As John introduced this framework with 6 columns and 6 rows, adding more columns or rows will affect the originality of the framework and its fundamental structure. The second rule is each column has a simple generic model and they can have their own meta-model within that column [4]. The third rule is that the particular model for any cell needs to be customized to fit the constraints, semantics, vocabulary, terms, and facts of the perspective represented by the row. Each cell specializes according to the generic model of its respective column [4]. Customization will help in producing accurate representation of the enterprise architecture within the cell as it will align with the constraints and semantic of the respective perspective. Rule number four is the basic model must avoid overlap or replicate data in other columns in order to be unique [4]. The uniqueness of each column's basic model will prevent any confusion and make sure that each part of the architecture is defined clearly and distinctly. Fifth rule is no diagonal relationship between cells. Although columns can be arranged in any order, it should follow a top-down sequence starting from the most significant category [4]. This arrangement will help in analysing complex architectural questions thus help in effective decision making and problem solving. The next rule is to refrain from changing the names of rows and columns as this will lead to confusion and miscommunication among stakeholders [4]. The last rule is the logic is both generic and recursive where it allows to classify or analyse anything related to enterprise architecture [4]. Generic means the framework is applicable widely in any situations or

aspects regarding enterprise architecture. Recursion is when the same logic or structure can be applied at different levels of enterprise architecture. Simply put, this rule ensures the framework is capable of handling various complexities in the organization's architecture while remaining versatile and scalable. Lastly, these seven rules are the guidelines to keep the Zachman Framework values as the tool for organization. The integrity, flexibility, clarity, and utility that prove through these rules are to ensure its effectiveness in handling the complexities of enterprise architecture.

V. COMPARATIVE ANALYSIS BETWEEN ZACHMAN AND TOGAF

TOGAF and Zachman are two primary Enterprise Architecture (EA) frameworks that have sparked debate due to their variances and suitability for enterprises. Although there are some distinctions, both frameworks offer fundamental support for managing a company's architecture.

According to Tochukwu Okonkworu [6], the Zachman Framework is **an ontology for organizing architectural artifacts that is not limited to a single discipline, including security. It categorizes numerous aspects of an enterprise architecture, offering a matrix for organizing and classifying diverse pieces**. It is more of a classification scheme than a procedure or methodology. For example, in an aircraft industry, the Zachman Framework might be used to organize views such as business processes, data models, and security issues, resulting in a more comprehensive view and better decision-making.

TOGAF is a process-driven technique that walks practitioners through the step-by-step process of creating an enterprise architecture [7]. It is prescriptive, with explicit guidelines. In contrast, Zachman is a classification framework that organizes and categorizes architectural artifacts from several perspectives without prescribing a specific process. For example, while constructing a new cybersecurity solution, TOGAF may provide a clear roadmap for creating security architecture, whereas Zachman may assist in categorizing artifacts such as security policies, processes, and technological components inside the framework [6]. The Open Group's research confirms the widespread adoption of TOGAF, with over 120,000 certified personnel and its use in various organizations [7].

Comparing Enterprise Architecture Frameworks (EAFs) presents various challenges. Some frameworks have a very specific scope and are applicable only to certain applications. In order to overcome above challenges, we decided to compare the frameworks based upon **architecture development process, views, abstractions, and systems development life cycle** [5] [8].

A. Comparisons in the architecture development process between TOGAF and Zachman

The Zachman Framework is a fundamental structure for Enterprise Architecture that provides a formal and structured classification schema reflecting the intersection between primitive interrogatives and reification transformations. This framework is essential for understanding and organizing the components of an enterprise architecture [5] [9].

Table 1- Comparisons in the architecture development process

Aspect	TOGAF	Zachman Framework
Scope	Covers architectural description, implementation, and management	Focuses primarily on architectural description and taxonomy
Level of Detail	More detailed approach with specific methodologies and tools	Less prescriptive, allowing organizations to choose methodologies and tools
Structure	Four-layer architecture: business, data, application, and technology	Nine domains or categories of information based on different perspectives
Approach	Bottom-up, starting with processes and structures	Top-down, starting with a high-level view
Change Management	Emphasizes documenting and tracking changes	Allows for change without reworking existing structures
Usage	Typically used for smaller organizations or projects	Typically used for larger organizations with diverse departments
Framework Composition	12 principles, 4 phases, 10 roles	Nine domains or categories of information

In our opinion, TOGAF is similar to a precise, step-by-step method for baking a cake, as it provides a clear process to follow, much like recipe instructions. It thoroughly covers all areas, including the ingredients (business, data, applications, technology) and the mixing and baking procedures. TOGAF is more prescriptive and extensive, providing precise guidelines throughout the process. In contrast, the Zachman Framework resembles a basic sketch or blueprint for how a cake should appear, providing a structural overview comparable to a cake's layers and components. However, it does not provide a detailed procedure to follow. Instead, the Zachman Framework allows for greater flexibility in the actual cake-baking process. If a company wants a more structured and precise approach with specific advice, TOGAF is the superior option, similar to following a proven recipe step by step. In contrast, if a business values flexibility and broad guidelines, the Zachman Framework may be favored because it gives a blueprint but allows the organization to choose how to implement it. To put it simply, TOGAF is similar to a chef's complete cookbook, but the Zachman Framework is more like an architect's high-level plan.

B. Comparison by views

Table 2- Comparison by views 1

Framework	Planner	Owner	Designer	Builder
Zachman	Scope	Business Model	System Model	Technology Model
TOGAF		Business Architecture View	Technical Architecture Views	

Table 3 - Comparisons by views 2

Framework	Subcontractor	User
Zachman	Detailed Representations	Functioning System
TOGAF		

Table 2 and Table 3 are compare various corporate architecture frameworks, such as Zachman and TOGAF, from different views [8].

In my opinion, the Zachman Framework offers a systematic method for defining and describing an organization's architecture from various viewpoints or levels of abstraction. The table consists of rows representing various roles or players (Planner, Owner, Designer, Builder, Subcontractor, User) and columns representing different elements or domains (Scope, Business Model, System Model, Technology Model, Detailed Representations, Functioning System). While TOGAF, short for The Open Group Architecture Framework, is an iterative framework designed for the development of corporate architecture. The resource offers a comprehensive approach and a range of tools to facilitate the implementation of enterprise architecture [8]. Zachman offers a detailed classification system for describing all parts of a business from different angles, while TOGAF concentrates on the methodology and procedures for creating and executing the architecture, especially in terms of commercial and technological issues.

Both frameworks are designed to be flexible and adaptive to an organization's specific demands and requirements. The roles or viewpoints aim to offer a systematic method for comprehending and creating enterprise structures from many perspectives.

C. Comparison by Abstractions

Table 4 - Comparison by Abstractions

Framework	What	How	Where	Who	When	Why
Zachman	Data	Function	Network	People	Time	Motivation
TOGAF		Decision Making guidance		IT resource guidance		

Table 4 compares different enterprise architecture frameworks based on various abstractions or perspectives, such as What, How, Where, Who, When, and Why [8].

For example, in the DoDAF (Department of Defense Architecture Framework) which aligns with Zachman, the "What" perspective is the Data (mission), Logical Data Model, while the "How" is Function/Traceability, Functional effectiveness. On the other hand, TOGAF (The Open Group Architecture Framework) does not map directly to these abstractions in the same structured way. Instead, it provides guidance on decision-making and IT resource allocation, rather than a comprehensive taxonomy like Zachman. In simpler terms, Zachman gives a comprehensive, multi-dimensional way to describe and analyse the architecture from various angles. While TOGAF provides more practical guidance and processes for developing, implementing, and managing the architecture especially from an IT and decision-making standpoint.

Through the analysis of these frameworks by their abstraction level, we can determine their ways of handling complexity, stakeholder views, and architectural components. It is through this comparison that organizations are able to make the most suitable framework choice that corresponds to their particular needs and objectives in enterprise architecture development and management [8].

D. Comparisons by SDLC Phases

When evaluating frameworks in relation to the Systems Development Life Cycle (SDLC), it is crucial to determine whether they encompass all eight phases of the SDLC: Planning, Analysis, Design, Implementation, and Maintenance [8].

Table 5 - Comparison by SDLC phases

SDLC Phases/Framework	Planning	Analysis	Design	Implementation	Maintenance
Zachman	Yes	Yes	Yes	Yes	No
TOGAF		principles that support decision making across enterprise; provide guidance of IT resources; support architecture principles for design and implementation			

Table 5 compares different enterprise architecture frameworks across the phases of the Systems Development Life Cycle (SDLC) - Planning, Analysis, Design, Implementation, and Maintenance [8]. The Zachman Framework provides a comprehensive structure that covers all phases from Planning through Implementation, but it does not explicitly address the Maintenance phase. Zachman backs the Planning, Analysis, Design, and Implementation stages, for example, as shown by the "Yes" entry in the table. The Open Group Architecture Framework (TOGAF), on the other hand, doesn't exactly map to the SDLC phases in the same table-based way. Instead, it gives broad rules and suggestions for making choices across the whole company, handling IT resources, and following principles for designing and putting architecture into action.

The table indicates that TOGAF is centered around "principles that support architecture principles for design and implementation; provide guidance of IT resources; and support decision making across enterprise" [8]. Thus, TOGAF focuses more on the wider guidelines, governance, and best practices for developing and managing the architecture from an enterprise-wide, IT-centric perspective across all phases, whereas Zachman provides an extensive, phase-based taxonomy for characterizing the entire systems architecture.

VI. ADVANTAGES AND DISADVANTAGES OF ZACHMAN

The Zachman Framework has a few advantages that contribute to its effectiveness in enterprise architecture management. Firstly, it simplifies and prioritizes the organization process by focusing on key perspectives such as data, function, location, people, time and motivation. This framework enhances stakeholder understanding and decision making by organizing, managing and analyzing large and complex information architecture [10]. Next is integration with other tools where the Zachman Framework can integrate with other enterprise architecture methodologies such as TOGAF [10]. This integration allows organizations to use several frameworks together in order to create a more holistic approach to enterprise architecture management, accommodating various business requirements and technological landscape. Moreover, the Zachman Framework facilitates efficient documentation by offering standardized approaches to both individual projects and company's IT architecture. Structured documentation enables understanding, planning and decision making for future enhancement [10]. Standardizing documentation helps to foster shared understanding among stakeholders including IT professionals, business leaders and external partners. Additionally, the framework helps to improve communication where it provides common language and structure to improve communication between information systems

professionals. Share understanding effectively helps foster collaboration, alignment, and consensus among stakeholders [10]. Finally, the continuous improvement of the Zachman Framework shows that it continues to be developed to a better version that suits modern architecture [10]. Embracing innovation and evolution proved that the Zachman Framework will continue to serve as a valuable tool for organizations seeking to effectively manage and optimize their architectural assets in today's dynamic business environment.

Despite its strengths, the Zachman Framework also presents several disadvantages. Firstly, it has no clear development methodology. This framework focuses on various viewpoints and perspectives without providing structured guidance on architecture development. No step-by-step methods for designing enterprise architecture provided [10]. Furthermore, the Zachman Framework provided limited guidance on artifacts where it does not provide clear instructions on the content and development [10]. Organizations will face confusion because of the lack of guidance to help them in implementing the framework. Moreover, this framework has minimal emphasis on business value where it does not explicitly address the aspect of aligning business and IT strategies and delivering business value through IT. It can limit its effectiveness in business outcomes as it does not provide a framework for investment and initiative based on business goals [10]. Organizations need to use other business tools to get better business outcomes, and this will increase the cost for the organization. Lastly, scalability and complexity challenges arise due to the focus on various perspectives and viewpoints that lead to many artifacts and a complex architecture. Organizations with limited resources will face difficulties in maintaining and scaling [10].

VII. ZACHMAN IMPLEMENTATION IN MALAYSIA AND SEA REGION

The research of Enterprise Information Architecture (EIA) implementation in Malaysia has included assessing the existence and effective use of enterprise architecture in public and private companies. The Zachman Framework was used to evaluate the application of EIA in these businesses, uncovering deficiencies in present EIA procedures and pinpointing factors that affect EIA execution. Enterprises are advised to deliberately embrace the EIA paradigm to achieve their aims. This study highlights the importance of organized frameworks such as the Zachman Framework in improving enterprise architectural practices in Malaysia. [10] [11].

Indonesian research has focused on business architecture design using the Zachman Framework to automate citizen management in Bogor Regency [12]. This study automates citizen administration in Bogor Regency using enterprise architecture design and the Zachman Framework. This technique comprises creating voter lists using general election commission data with the Citizen Administration Bureau in Karadenan Sub District as an experimental project. Enterprise architecture design for citizen administration at the General Election Commission is examined in this study. It focuses on citizen data gathering, updating, and alteration in Karadenan Sub District, Bogor Regency. This study examined data from 122 neighbourhoods~~neighbourhood~~ unit leaders and 19 residential unit leaders in Karadenan Subdistrict, Bogor Regency. The Zachman Framework was used for qualitative research [12].

Furthermore, studies have examined the utilization of Enterprise Architecture (EA) in public sector entities, including the Ministry of Health in Malaysia, with the goal of investigating the EA implementation process and pinpointing key success elements. The studies examine how the Zachman Framework was used and its effects on the Malaysian public sector during a specific time frame [13].
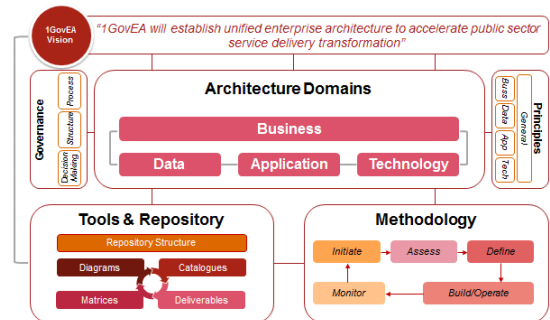

Figure 1 - MyGoveEA framework

In addition, Malaysia has made significant progress through projects such as the 1 Government Enterprise Architecture (1GovEA) spearheaded by the Malaysian Administrative Modernisation and Management Planning Unit (MAMPU) [14]. Based on *Figure 1*, this methodical approach is designed to assist public sector organizations in creating their enterprise architectures, focusing on merging business and technical elements to improve operational efficiency and service provision [15] [16]. EA implementation relies on the established EA framework to identify fundamental architecture aspects for constructing and executing EA practices. The key elements of the EA framework include of methodology, governance, domain architecture, and tools and repositories. Globally used EA framework options include The Open Group Architecture Framework (TOGAF), Federal Enterprise Architecture Framework (FEAF), and Zachman Framework. The MyGovEA Framework, derived from TOGAF, serves as the basis for implementing EA in public sector entities [14].

VIII. CONCLUSIONS

The article discusses the Zachman Framework for Enterprise Architecture's history, components, rules, benefits, and downsides. It contrasts the Zachman Framework with TOGAF, showing significant differences. In the 1980s, John Zachman devised the Zachman Framework, a matrix arrangement with six rows reflecting multiple perspectives and six columns signifying communication interrogatives, to understand and regulate business architecture. The framework identifies and defines business information assets using Communication, How, Where, Who, When, and Why aspects. Planners, owners, designers, constructors, subcontractors, and implementers are also considered. The framework makes information architecture management more flexible by integrating with existing corporate architectural methods.

The Zachman Framework streamlines organizational processes, connects with TOGAF, assists with documentation, enhances stakeholder communication, and promotes continuous development. No development methodology, no artifact guidance, low business value alignment, and scalability and complexity issues. Despite these drawbacks, the Zachman Framework helps business designers communicate, cooperate, and make choices by providing a common language, structure, and basis for information systems experts. EIA deployment in public and commercial companies has been studied in Malaysia and Southeast Asia. The framework's systematic approach is noted, although its architecture's extensive documentation and disdain for information system state are downsides.

To conclude, the Zachman Framework's structured enterprise architecture provides a complete and scalable solution for managing information structures. Its ability to improve understanding, planning, and decision-making, promote stakeholder participation and alignment, and adapt to new architectural practises makes it important. TOGAF, FEAF, and Zachman are popular EA framework alternatives. Implementing the Zachman framework can improve enterprise architecture practices and help firms achieve their goals.

IX.   ACKNOWLEDGEMENT

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