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# Implementation of Enterprise Architecture in Cloud Computing Companies

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**Abstract:** In the current era of digitalization, the cloud computing industry market is increasingly shining along with the birth of a number of renewable technologies in this industry. A good and well-planned architectural design for the cloud industry is a major factor in the success of cloud computing companies in competing in a market that has a very broad market share. By conducting research on enterprise architecture, a cloud computing company is expected to provide a different approach to exploring and planning a cloud computing company according to market needs so that it can help or provide different methods and designs that allow us to enter the business world. and business. cloud industry competition. in this digital age. Architectural design planning for companies engaged in the cloud computing industry can use several approaches and tools available in the field so as to simplify, save time and encourage new ideas and initiatives. To be able to achieve the expected goals, it is necessary to conduct several studies and research that is quite intensive so that it can provide significant results and impacts. This research is expected to be one of the means to present a cloud computing architecture that is able to compete in the market and as a whole becomes the concern of all users or researchers. This study aims to discuss Enterprise Architecture related to Cloud Computing companies as providers of modern technology services. Provide information that the technology used is effective and cost-effective for industrial cloud service users. This study uses the TOGAF ADM method in conducting Enterprise Architecture.

**Keywords:** Enterprise Architecture; Cloud Computing; Design Planning; TOGAF ADM;

## INTRODUCTION

Cloud Computing is a type of Internet-based computing service that provides computing to process resources on demand. This service provides access to a configurable shared pool of computing resources such as networks, servers, and applications on-demand, and these resources can be provisioned and released with minimal effort.

Cloud computing provides services to users and organizations with the ability to store and process their data in central third-party data that may be located in remote geographic locations. Cloud Computing, or Cloud, is a metaphor for the supply and consumption of information technology resources. Information technology resources in the cloud are not directly visible to users; there's a layer of abstraction in between. The level of abstraction offered by the cloud varies, from offering virtual machines (VMs) to providing software as a service (SaaS) based on complex distributed systems.

Cloud computing has recently received great attention from academia and the information technology industry as a new infrastructure that requires less investment in hardware platforms, training staff, or licensing new software. Cloud Computing can be seen as a subscription-based or pay-per-use service that extends the existing capabilities of the Internet. It can be used as Software-as-service (SAAS), Platform as a Service (PaaS Cloud), and Infrastructure as a Service (IaaS). Data storage as a service (DaaS Cloud) has also emerged in recent years to provide users with storage capabilities.

Today the term Cloud Computing, may be one of the most popular vocabulary words for any Information Technology professional, but not many people understand the term in depth. A holistic approach based on strategic enterprise architecture is appropriate to guide the systematic adoption of cloud services. One might argue that the enterprise architecture is not necessary for certain cloud services such as public clouds. On-

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demand cloud services offer several benefits over traditional Information Technology services. There is a growing interest among companies to adopt cloud services such as: Software As A Service (SAAS), Platform As A Service (PAAS), Infrastructure As A Service (IAAS).

Architecture: the basic concept or nature of a system in its environment, embodied in its elements, their relationships, and in their principles of design and evolution. Enterprise architecture: the overall principles, methods, and models used in the design and realization of an enterprise organizational structure, business processes, information systems, and infrastructure. Enterprise architecture captures the essence of business, Information Technology and its evolution. Enterprise architecture (Anggraini et al., 2019) is a strategic capability that can be used to address the challenges of enterprise adaptation supported by modern cloud technologies. Architecture is defined as the basic concept or nature of a system in its environment embodied in its elements, their relationships, and in the principles of design and evolution. There are a number of well-known architectural frameworks, such as Zachman, Department of Defense Architecture Framework, Federal Enterprise Architecture Framework, and Open Group Architecture Framework. The following sections review this well-known framework in the context of building adaptive cloud enterprise architecture capabilities for cloud adoption.

The TOGAF standard is an architectural framework (Camatti et al., 2020). It provides methods and tools to assist in the acceptance, production, use, and maintenance of Enterprise Architecture. The TOGAF standards regard the company as a system and seek to strike a balance between promoting concepts and terminology drawn from the relevant standards, and generally accepted terminology familiar to most TOGAF readers.

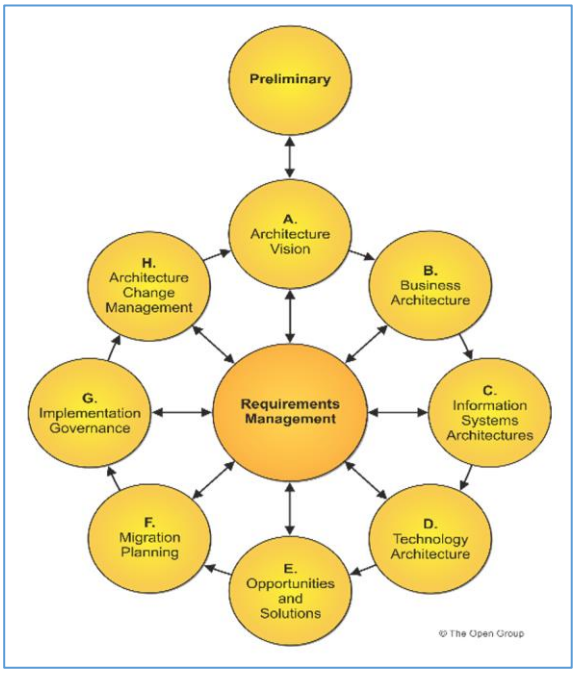


Figure. 1 TOGAF Framework
**Source : The Open Group**

In Figure 1, there are eight domains used in completing enterprise architecture planning. The eight domains are Architecture Vision, Business Architecture, Information Systems Architecture, Technology Architecture, Opportunities and solutions, Migration Planning, Implementation Governance, Architecture Change Management. The Open Group Architectural Framework (TOGAF) (de Oliveira et al., 2021): Strong on Business Architecture and Technical Architecture Aspects. It doesn't provide much detail from the planning and maintenance aspect. TOGAF is one of the most comprehensive with respect to the actual processes involved. This framework provides guidelines for principles for decision making, IT resource guidelines, and architectural principles. This framework is measured towards the development of open systems in (Urbaczewski & Mrdalj, 2012).

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## LITERATURE REVIEW

There have been many studies on Enterprise Architecture. This study discusses the Enterprise Architecture related to Cloud Computing service providers. Discussion about previous research does not mean looking for weaknesses from previous research, but this research is complementary to previous research.

Table. 1 Previous studies discuss Enterprise Architecture

| Author | Topic | Advantage | Disadvantage |
|---|---|---|---|
| (Wahidin, 2021) | ENTERPRISE ARCHITECTURE PLANNING BASED ON CLOUD COMPUTING USING TOGAF (Case Study: PT. XYZ) | The discussion on Enterprise Architecture focuses on the implementation stages in the company. Discussion of business architecture, technology architecture and actual versus target gap analysis. The discussion is complete with eight domains. Business View, Application Architecture, Technology Architecture, Data or Information Architecture, Solutions and Opportunities, Migration Planning, Implementation Management, Architectural Change Management. | The discussion about Enterprise Architecture discusses it in less detail, all of which are discussed with eight domains of Enterprise Architecture but do not focus on details on a particular domain. Like discussing the details of the technology architecture, it only discusses the actual and the target achievement. |
| (Muttaqin et al., 2017) | Enterprise Architecture Design Supporting the Implementation of Cloud Computing PT. Angkasa Pura 1 (Persero) Juanda Airport Using TOGAF ADM | The discussion on the enterprise architecture of PT Angkasa Pura 1 discusses eight domains. The discussion is complete with eight domains. Business View, Application Architecture, Technology Architecture, Data or Information Architecture, Solutions and Opportunities, Migration Planning, Implementation Management, Architectural Change Management. | This study of eight domains is not detailed. Four architectural domains such as business view, technology architecture, information architecture and opportunity are discussed in detail, but other domains are not detailed. |
| (Martadinata & Firdaus, 2020) | Adaptive Information Technology Enterprise Architecture Design With Togaf Framework At Bina Insan University | Discussion about Enterprise Architecture at University Human Development, Business view, application architecture, architectural information, architectural technology, Opportunities and Solutions | Weaknesses have not discussed Migration Planning, Implementation Governance, Architecture Change Management |

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| | | | |
|---|---|---|---|
| (Cahyana, 2019) | Manufacturing Information System Enterprise Architecture Planning Using Togaf (Case Study of Pt. Pindo Deli Pulp And Pepper Mills) | Discussion of Enterprise Architecture in the domain of Business Architecture, Technology Architecture, Information Architecture, Application Architecture, Opportunities and Solutions, Migration Planning | Weaknesses do not discuss Implementation governance, Architecture change management |
| (Edi, 2015) | Analysis and Design of Cloud Computing-Based Information Technology Architecture for Higher Education Institutions in South Sumatra | The discussion on Enterprise Architecture discusses the Application Architecture and Technology Architecture. | Weaknesses in this study have not discussed Information architecture, Opportunities and solutions, Migration, Architecture change management |

Many previous studies have discussed Enterprise Architecture with the TOGAF method, not yet complete with eight domains. The state-of-the-art of this research discusses in more detail the issues of implementation and Architectural Change Management. Where the contribution in this research discusses the implementation of the TOGAF Enterprise Architecture with more details on the implementation domain in cloud computing service providers.

## METHOD

The method proposed in this Enterprise Architecture research can be seen in figure 2 where there are six stages of implementing it. Study literature is used to make references from several articles as a guide in carrying out the implementation stages.

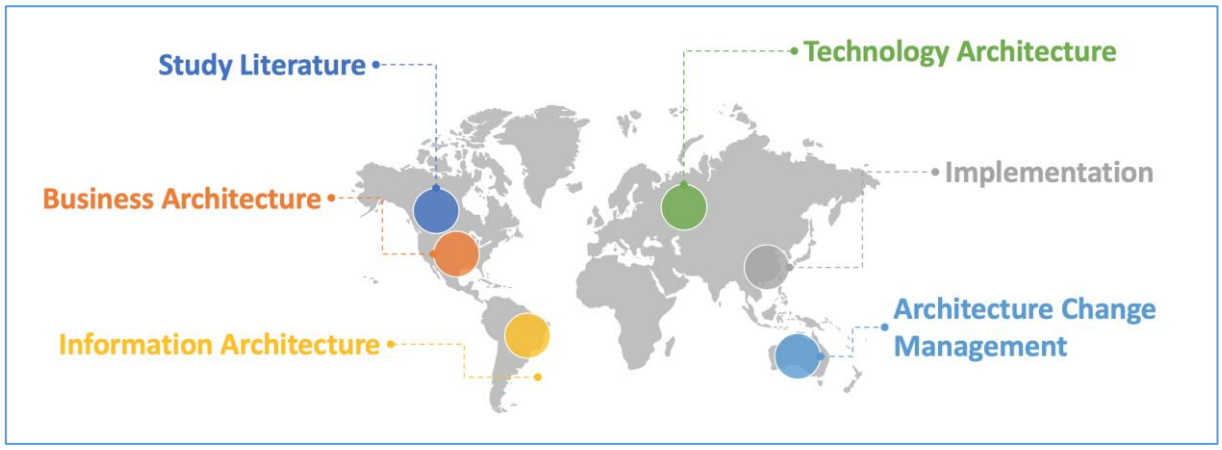


Figure. 2 The proposed method
**Source : researcher property**

The next application is Business Architecture (Tutaj et al., 2021), to be involved in cloud business which is currently a trend, and in the future, we need to understand the benefits and advantages of cloud computing better. In accordance with the TOGAF process framework, of course, everything starts from the company's vision because it is very important and becomes part of the foundation. Growth and scalability are critical, as is the ability to meet today's industry security compliance benchmarks. Business model canvas design related to cloud computing.

Table 2. Design Business Model Canvas

| No | Segment | No | Relationship |
|---|---|---|---|
| 1 | Individual / Corporate Buyer | 1 | 24/7 Interactive Customer Support |

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| | | | |
|---|---|---|---|
| 2 | Seller | 2 | 24/7 Automated Chatbot |
| 3 | Reseller | 3 | 24/7 Self services Knowledge Base support |
| 4 | Developer | 4 | Regular meet up and free training |
| 5 | Software House | | |
| 6 | Game Production | No | Channel |
| 7 | Entertainment & Media | 1 | Web Console |
| 8 | Youtuber | 2 | Mobile Apps |
| 9 | eCommerce | 3 | API |
| 10 | Startup | 4 | Partnership / affiliate |
| | | 5 | B2B |
| No | Revenue / Income | 6 | B2C |
| 1 | Pay per use | 7 | C2C |
| 2 | Pay per services | | |
| 3 | Services package | No | Key proposition |
| 4 | One time subscription | 1 | Low cost/price |
| 5 | Support subscription | 2 | Wide selection of products |
| 6 | Platform license commission | 3 | Convenience |
| 7 | Other commission | 4 | Auto Scaling |
| | | 5 | Ease to use |
| No | Main activities | 6 | Advanced Shield Security |
| 1 | Building multiple region infrastructure | 7 | Simple notification services |
| 2 | Building Partnership | 8 | Marketplace from millions partner and buyer |
| 3 | Logistics | 9 | Platform as a services |
| 4 | Platform development and maintenance | 10 | Software as a services |
| 5 | Services and Support modelling | 11 | Infrastructure as a services |
| 6 | Services Catalog preparation | 12 | Function as a services |
| 7 | Online learning tools | | |
| | | No | Key partner |
| No | Key Resources | 1 | Logistics Company |
| 1 | Technology infrastructure | 2 | Technology providers |
| 2 | Best Brand Supplier | 3 | Software partner licensing |
| 3 | Best Researcher and Architecture Designer | 4 | Hardware Supplier |
| 4 | Best UI and IX Consultant | 5 | 3rd party application |
| 5 | Advanced Engineering | 6 | Training material partner |
| 6 | Advanced Engineering | 7 | Security & Networking partner |
| 7 | Warehouse | 8 | 3rd party Security Drill application |
| 8 | Software and Licensing | | |
| 9 | Multiple Platform | No | Cost Structure |
| 10 | Support and Operational | 1 | Warehouse, People |
| 11 | Software and Technology expertise | 2 | Digital Infrastructure |
| 12 | 3rd party partner | 3 | Training, Free Tier |

Archi® is a free, open-source, cross-platform tool for creating ArchiMate models. Archi® modeling tools are targeted at all levels of Architects and Enterprise Modelers (Bhattacharya, 2017). The goal is to provide a low entry fee solution to users who may be making their first steps in the ArchiMate modeling language, or who are looking for a free cross-platform ArchiMate modeling (Pankowska, 2019) tool for their company or institution and want to engage with the language in TOGAF® or other Enterprise Architecture frameworks.

In SP 800-145, the cloud deployment model describes how the cloud is operated and who has access to cloud service resources. Private Cloud. The cloud infrastructure is provided for exclusive use by a single organization made up of multiple CSCs (for example, business units). It may be owned, managed, and operated by the organization, third parties, or a combination and may exist on or off-premises. Cloud Community. The cloud infrastructure is provided for exclusive use by certain CSC communities of organizations with shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations within the community, third parties, or a combination of and may exist or be inactive. Public Cloud. The cloud infrastructure is provided for open use by the general public. It may be owned, managed, and operated by a business, academic, government organization,

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or some combination. It's on the cloud provider's premises. Hybrid cloud. Cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by proprietary standards or technologies that enable data and application portability (e.g., cloud bursting for load balancing between cloud).

## RESULT

The purpose of designing this cloud computing system is to make adjustments between the Business Model Canvas (BMC) and the Enterprise Architecture in this case using the ArchiMate tool (Hindarto et al., 2021). This design discusses the development of cloud computing to meet customer needs. The Business Model Canvas is expected to be a business model that can explain current customer needs and focus on nine business aspects with a solid strategy. ArchiMate core framework study is the framework used to classify ArchiMate core language elements. These two methods are expected to be able to design an enterprise information system architecture consisting of business architecture, application architecture, information architecture, and technology architecture, Opportunities and Solution, Architectural Change Management (Hindarto et al., 2021). The result is a complete system design to meet the system requirements of the customer.

## DISCUSSIONS

### Business Architecture

The technology architecture in figure 3 shows that Cloud Consumer, Cloud Auditor (Security Audit, Privacy Impact Audit, Performance Audit) has been grouped based on the function and role of each group. Layer services are also divided into SAAS, PAAS, and IAAS. Cloud Service Management is divided into Business Support, Provisioning/Configuration, and Portability/Interoperability. Cloud Brokers are also divided according to their functions such as Service Intermediation, Service Aggregation, and Service Arbitrage.

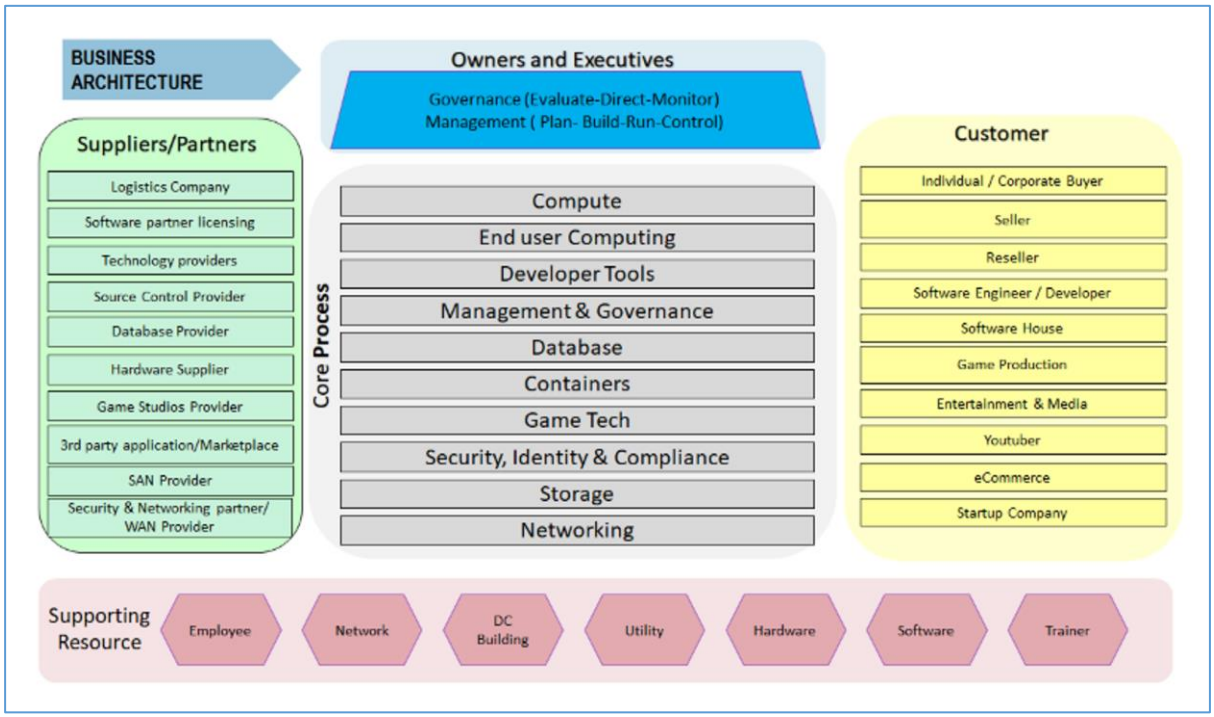


Figure. 3 Business Architecture
**Source : researcher property**

The figure 3, shows the development of a Target Business Architecture that describes how the company needs to operate to achieve business goals and responds to the strategic drivers set out in the Architectural Vision, in a way that addresses the Architectural Work Statement and stakeholder concerns.

### Application Architecture

The figure. 4 shows the development of the Target Information System Architecture, explaining how the company's Information System Architecture will enable the Business Architecture and Architectural Vision, in a way that addresses the Architecture Statement of Work and stakeholder concerns. Providing a combination of technology infrastructure and business application logic, some organizations take an application-driven approach, in which they recognize certain key applications as the core foundation of mission-critical business

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processes, and take implementation and integration of these core applications as the main focus of their architectural efforts (issues). Integration is often the main challenge). Minimum system or application specifications needed to support business processes in the cloud computing industry's core business.

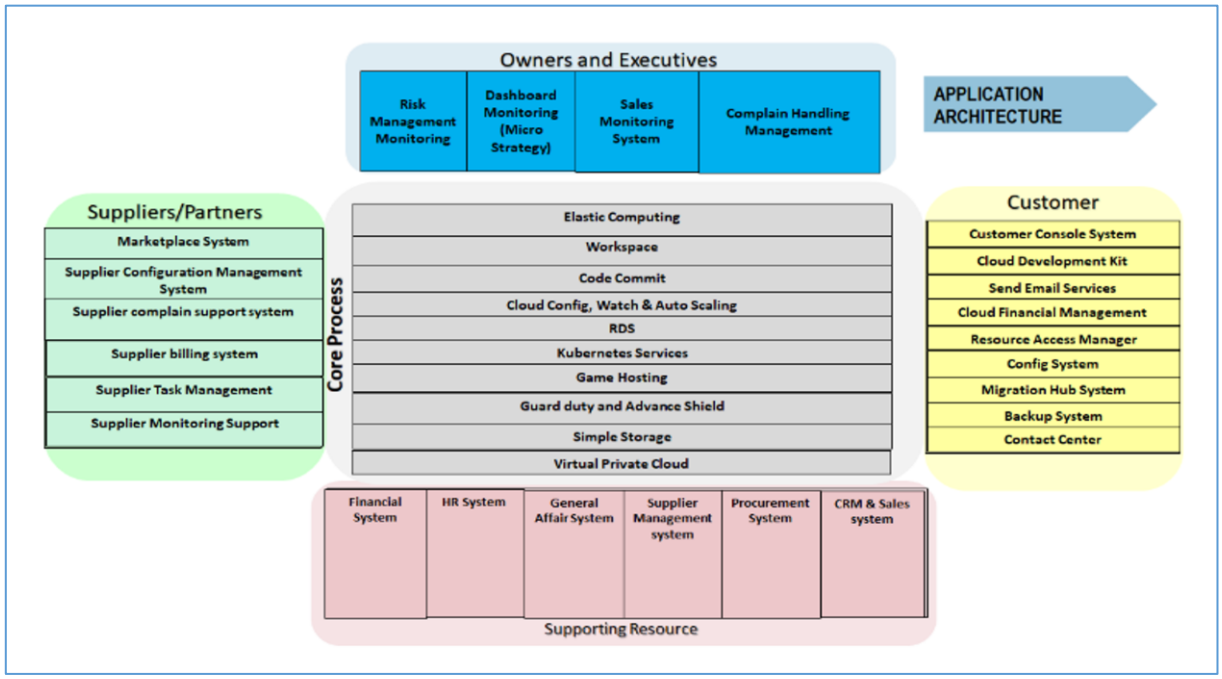


Figure. 4 Architecture Application
**Source : researcher property**

1. Elastic Computing, It is a service system that provides secure, flexible, and scalable computing capacity in cloud computing.
2. Workspace, It is a service system that can be fully managed by users so that they can access the data, applications, and resources they need, from anywhere, anytime, of course from devices supported by the system.
3. Code Commit, Is a user service system to be able to control the source code of the system code that is safe and scalable and fully managed and controlled by the user and can be integrated with other private source control service systems.
4. Cloud Config, Watch & Auto Scaling, It is a user service system that allows them to access, audit, and evaluate the configuration of your system resources. In addition, customers can monitor your application system resources in the cloud, including monitoring your application and automatically adjusting the capacity of your system in the cloud so that you can maintain stable and predictable performance at the lowest possible cost.
5. RDS, It is a Relational Database Service user service system that helps users to prepare, operate, and scale relational databases in the cloud.
6. Kubernetes Services, It is a user service system similar to an open-source Orchestration platform that can help users to manage distributed containers on a large scale.
7. Game Hosting, Is a user service system for hosting dedicated game servers that can deploy, operate and scale cloud servers for multiplayer games.
8. Guard duty and Advance Shield, Is a user service system to be able to detect threats continuously including monitoring suspicious activity and unauthorized behavior, workloads, on user data stored in storage.
9. Simple Storage, It is a user service system for storing objects and offers industry-leading scalability, data availability, security, and performance in the cloud.
10. Virtual Private Cloud, A user service system that allows users to deploy system resources in the cloud on a user-defined logically isolated virtual network, including the user having full control over the virtual network environment, including selecting your IP address range, creating subnets, and configuring routing tables and network gateways.

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**Information Architecture**

Develop a Targeted Data Architecture that enables the Business Architecture and Architectural Vision, in a way that addresses the Architectural Work Statement and stakeholder concerns. The minimum database required for core business systems or applications in the cloud computing industry more or less includes:

1. Product Master Database, to store all master product catalog data, specifications, and rules from the Core Process group application.
2. Database Transaction Master, to store all transaction data that is processed for all product applications of the Core Process group.
3. Database Source Control, to store all source code data from the application code commit in the Core Process group.
4. Process log database, to store all flow and process logs of all activities that occur in the Core Process group application.
5. Database Configuration, to store all configuration data from all applications in the Core Process group.

The minimum database required for customer systems or applications in the cloud computing industry more or less includes:

1. Customer Master Database, to store all customer master data, specifications, and rules from the customer group application.
2. Database Transaction Master, to store all transaction data processed for all applications used by the Customer group.
3. Database Billing Management, to store and process all billing data, use of application systems, and products used by the Customer group.
4. Database Process Log, to store all flow and process logs of all activities that occur in the Customer group application.
5. Database Configuration, to store all configuration data from customers through all applications in the Customer group.

The minimum database required for a system or supplier application in the cloud computing industry more or less includes:

1. Supplier master database, to store all supplier master data, specifications, and rules from the Supplier group application.
2. Database Transaction master, to store all transaction data processed from all applications used by the Supplier group.
3. Database process log, to store all flow and process logs of all activities that occur in the Supplier group application.
4. Invoice management database, to store and process all supplier billing data from meeting the needs of application systems and products used by the Core Process group.
5. Database Configuration, to store all configuration data from suppliers through all applications in the Supplier group.

The minimum database required for a cloud company's internal system or application in the cloud computing industry more or less includes:

1. Database Finance, to store all data and processes performed by the Financial System.
2. Database Transaction Master, to store all transaction data processed from all applications used by the Support group outside the Financial System which is also integrated with the Finance Database.
3. Employee master database, to store all employee master data, specifications and job descriptions, and salaries from the HR system application, including the employee process in the Procurement System.
4. Global Support Database, to store all operational data, customers, sales leads, supplier information from the General Affairs system application, CRM & Sales System, Supplier Management System which is also integrated with the Customer and Supplier group databases.

The minimum database required for internal cloud company management systems or applications in the cloud computing industry more or less includes:

1. Replica Master Database, to store all replication data from all Core Process, Customer, Support, and Supplier group master databases.
2. Replica Transaction Database, to store all replication data of all transaction databases from Core Process, Customer, Support, and Supplier groups.
3. Database Replica log, to store all replication data from all database flows and process logs from Core Process, Customer, Support, and Supplier groups.

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**Technology Architecture**

Develop a Target Technology Architecture (Jose et al., 2020) that enables the Architectural Vision, target business building blocks, data, and applications to be delivered through component technologies and technology services, in a manner that addresses the Architectural Work Statement and stakeholder concerns.

The architecture technology (Geng et al., 2021) proposed by the author is divided into 5 large node groups plus 1 node for the replication process. 5 large node groups that support 35 applications and 22 databases that are used to support data processing or information from all applications in the Application Architecture and all databases in the Database Architecture. All proposed nodes use large capacity and are supported by high-level and renewable computing technology (HA / High Availability) so that they can serve various user segments and support all existing products. Collaborating with multiple WAN/IS providers including using load balancers to share the load and also using layered security/firewalls to ensure security and ensure access sources are opened according to the configuration and needs of each user. All services can be accessed via a WAN network with a VPN which makes it easier for customers to access services from separate locations wherever and whenever using their respective devices via the internet network.

**Opportunities and Solutions**

The four elements previously discussed by the author were applied to ArchiMate modeling from Business Architecture, Application Architecture, and Data Architecture to Technology Architecture, resulting in an Enterprise Architecture Model as shown in figure 5.

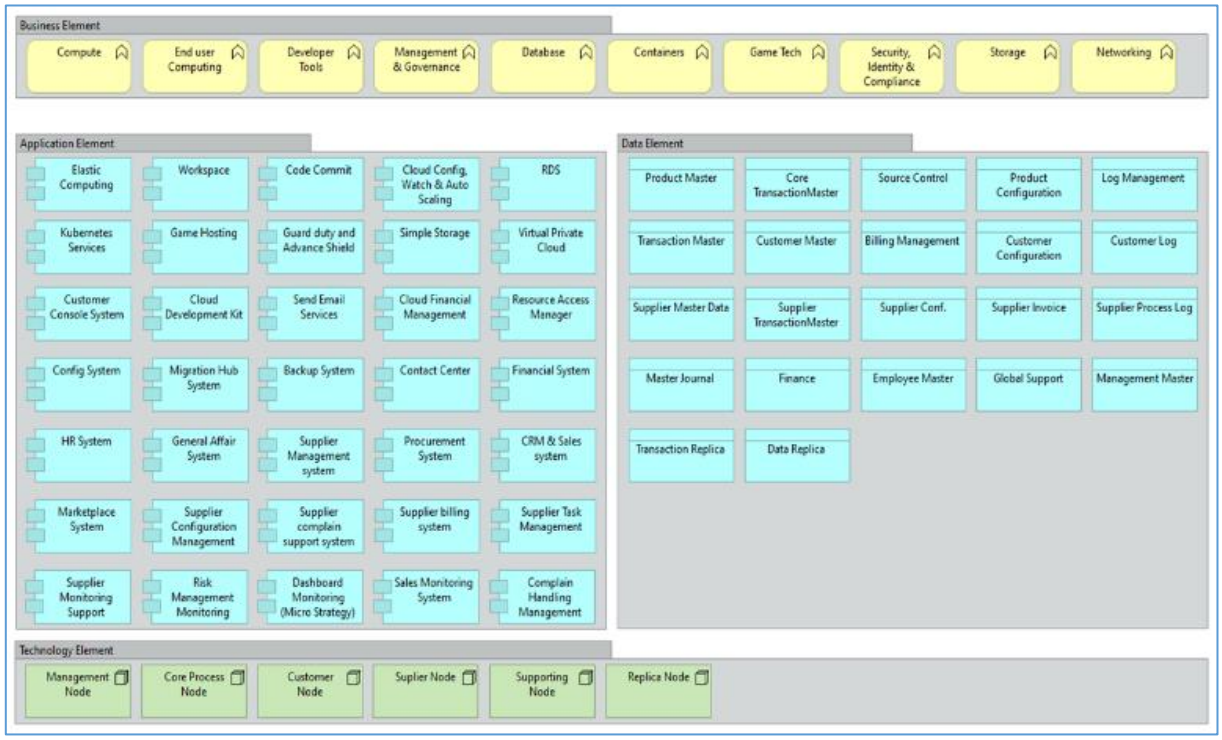


Figure. 5 ArchiMate

**Source : researcher property**

The enterprise architecture modeling (Kornyshova & Barrios, 2020) above is made in more detail for the 3 main revenues in the cloud computing industry using ArchiMate modeling. The three largest business processes that become the main revenue from cloud computing are assumed to include elastic computing, workspace, and database. The process starts with 2 categories of customers, namely old customers and new customers. For new customers, it is necessary to start by creating an account using the Customer Console application whose data and configuration will be stored in the Customer node group. Then the user will select the billing model desired by the user whose data and billing process will be processed at the Customer node through the Cloud Financial Management application and the Supporting node for the financial posting process by the Financial System application. This process includes the recording of the CRM application on the Supporting node.

After that users can start logging into the cloud to choose from 3 main customer services namely Compute, Workspace, and Database. The third creation uses the Customer Console application where Compute will relate

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to elastic computing applications, Workspace with workspace applications and databases will relate to RDS applications. The three applications of elastic computing, workspace, and RDS will be recorded and their configuration will be stored in the Core Process node group. To access the three applications (RDS, Elastic Compute, or Workspace) users need to use the Customer Console application which is connected to the Resource Access Manager application for resource access and must be accessed via a VPC (Virtual Private Cloud). For security, there is always a checking procedure by the Data Guard application and it is protected by an advanced shield to protect users from possible DDOS attacks.

**Architecture Change Management**

Implementation of Change Management Architecture can provide maximum business value. There are several strategic steps in carrying out change management

1. Continuous improvement of enterprise architecture capabilities in transforming enterprise business processes.
2. Performance improvement in the operational department that allows for efficient decision making so as to provide satisfaction to customers (internal and external).
3. The need to change the way customers, suppliers, and distributors interact with the enterprise architecture in the Cloud Computing business.
4. Conduct periodic risk assessments on enterprise architecture in Cloud Computing companies to minimize system errors and failures.

## CONCLUSION

The conclusion of implementing Enterprise Architecture in Cloud Computing companies is used to provide insight to stakeholders, that before implementing Information Technology. Stakeholder needs can be mapped so that the implementation of the application of information technology can be directed and controlled. Architecture Enterprise is aimed at planning information technology in carrying out digital transformation in the industrial era 4.0. With the presence of information technology planning, the company is not misguided in the application of information technology.

## SUGGESTION

This research can be continued by discussing deeper into the eight domains of TOGAF ADM, to be able to see deeper and broader Enterprise Architecture in Cloud Computing companies, in order to get ideas about the development of complete information technology.

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