Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 7, Number 3, Juli 2023 e-ISSN : 2541-2019
DOI : https://doi.org/10.33395/sinkron.v8i3.12477 p-ISSN : 2541-044X

# Proposed use of TOGAF-Based Enterprise Architecture in Drinking Water Companies

**Djaja Amanda[1)], Djarot Hindarto[2)*], Eko Indrajit[3)], Erick Dazki[4)]**
[1,3,4)] Pradita University, Serpong, Tangerang
[2)]Prodi Informatika, Fakultas Teknologi Komunikasi dan Informatika, Universitas Nasional, Jakarta
[1)]djaja.amanda@student.pradita.ac.id, [2)]djarot.hindarto@civitas.unas.ac.id,
[3)]eko.indrajit@pradita.ac.id, [4)]erick.dazki@pradita.ac.id

**Submitted** : May 30, 2023 | **Accepted** : May 31, 2023 | **Published** : Jul 1, 2023

**Abstract:** The purpose of this research is to propose an enterprise architecture framework for planning a drinking water company blueprint. In drinking water companies, it is very important to ensure that the systems and information technology used meet business needs effectively and efficiently. However, the information system that supports the company's operations still needs to be improved, to get better operational quality. In this case, companies need a framework that can assist companies in designing and developing business architectures that strengthen competitive advantage, optimize operational performance, and ensure compliance with applicable regulations and standards. Therefore, the author proposes the selection of an enterprise architecture framework based on The Open Group Architecture Framework or TOGAF. The Open Group Architecture Framework is a widely used framework for developing and implementing enterprise architectures. TOGAF consists of four main components, namely business architecture, application architecture, technology architecture, and data architecture. Enterprise Architecture helps companies develop application and technology architectures that can accelerate product and service innovation and improve operational efficiency. Data architecture, managing and utilizing data effectively in making the right business decisions. By adopting the TOGAF-based Enterprise Architecture framework, water companies optimize the use of information systems and technology, increase flexibility in anticipating changes in community needs and accelerate innovation in products and services.

**Keywords:** Application Architecture; Blueprint; Data Architecture; Drinking Water; Enterprise Architecture Framework; TOGAF

## INTRODUCTION

Drinking water companies (Fischer et al., 2020) have a very important role in meeting the community's need for clean and healthy water. Water is a very vital basic need for human life, so water companies must ensure that the water supply (Xu et al., 2022) (Liu et al., 2020) they provide is always available, of good quality and affordable to the community. Along with the rapid development of information technology and business, drinking water companies are also required to be able to optimize the use of information resources and information technology in order to improve operational efficiency and provide better services to the community. To achieve this goal, water companies need a framework that can assist them in designing, developing, and managing information systems and information technology that are integrated with their business. One framework that can be used is the Enterprise Architecture (EA) which is based on the TOGAF framework (The Open Group Architecture Framework) (de Oliveira et al., 2021) (Prawira et al., 2023) (Benito et al., 2023). In this

*name of corresponding author

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introduction, we will discuss the importance of TOGAF-based EA for water companies in optimizing the use of information resources and information technology to achieve business goals and meet community needs for clean and healthy water.

Enterprise Architecture (EA) (Hindarto et al., 2021) is a systematic approach used in designing, developing, and managing organizational architecture, including information systems and information technology. EA serves as a framework that assists companies in achieving business goals by ensuring that the information technology used can be integrated effectively with the business and meet user needs. In the context of a water utility, EA is critical in ensuring that the information systems and information technology used support operational needs, improve the customer experience, and meet regulatory requirements and industry standards. In Enterprise Architecture, there are several main components which include business architecture, application architecture, technology architecture, and data architecture. Business architecture deals with business strategy, business processes, organization and performance measurement (Latifi et al., 2021). Application architecture is related to the application systems used in the company, while technology architecture is related to the technology infrastructure used in the company. Data architecture deals with data and information management within the company. In drinking water companies, EA based on TOGAF (The Open Group Architecture Framework) can assist in ensuring that the information systems and information technology used can be integrated effectively with the business and meet user needs. By adopting the TOGAF-based EA framework, water companies can optimize the use of information resources and information technology, increase flexibility in responding to market changes, and accelerate product and service innovation.

Enterprise Architecture in drinking water companies can include four main components contained in the TOGAF framework, namely business architecture, application architecture, technology architecture, and data architecture. Business Architecture in Enterprise Architecture for drinking water companies includes business strategy development, business process modeling, organizational and human resource development, and business performance development. By having a clear business architecture, drinking water companies can strengthen their competitive advantage, improve operational efficiency, and ensure compliance with applicable regulations and standards. Application Architecture in Enterprise Architecture for drinking water companies includes the development and integration of applications needed in business operations, such as water supply management systems, customer management systems, financial management systems, and so on. By having an integrated application architecture, water companies can accelerate product and service innovation, improve customer experience, and improve operational efficiency. Technology Architecture in Enterprise Architecture for drinking water companies includes the development and integration of information and communication technology needed in business operations, such as communication networks, information security systems, data management systems, and so on. By having an integrated technology architecture, water companies can optimize the use of information technology resources, increase flexibility in responding to market changes, and accelerate product and service innovation. Data Architecture (Cao & Iansiti, 2022) (Ahaidous et al., 2023) in utility Enterprise Architecture includes managing and effectively utilizing data to make informed business decisions and improve operational performance. By having an integrated data architecture, drinking water companies can ensure that their data is well organized, easily accessible, and can be used effectively in making business decisions. By adopting the TOGAF-based EA framework, water companies can optimize the use of information resources and information technology, increase flexibility in responding to market changes, and accelerate product and service innovation to meet people's needs for clean water. The purpose of research on the topic "Enterprise Architecture in TOGAF-Based Water Companies" is to provide understanding and guidance for water supply companies in adopting the TOGAF-based Enterprise Architecture (EA) (Oberle et al., 2023) framework to optimize the use of information resources and information technology in business operations. In addition, another goal is to design and implement business architecture, application architecture, technology architecture, and data architecture within the TOGAF-based Enterprise Architecture framework for drinking water companies. From the description of the introductory section, there are Research Questions (RQ) on the topic of enterprise architecture for drinking water companies:

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How can water utilities utilize the TOGAF-based Enterprise Architecture framework to improve operational efficiency and ensure compliance with applicable standards in meeting community needs for clean and healthy water? (RQ1).

How can the business architecture, application architecture, technology architecture, and data architecture be implemented in a TOGAF-based framework in water utilities to improve operational effectiveness, customer experience, and product and service innovation? (RQ2)

## LITERATURE REVIEW

In this research there are several studies that will be compared as a literature review. Enterprise Architecture as Process Optimization and Information Technology Development Using TOGAF ADM (Case Study: PT XYZ) (Robi Dewi Asih Pramesti, Asti Amalia Nur Fajrillah, 2021). The use of IT that has not been optimal has had an impact on the company's internal and external factors, which has resulted in a decrease in customer loyalty by 46.43% over the past year. For this reason, an Enterprise Architecture (EA) solution is needed to align business and technology needs, as well as optimize the development of information technology. Enterprise architecture is designed using the TOGAF ADM method. The EA design starts from the Preliminary Phase to the Information System Architecture (Application Architecture). Enterprise architecture for digital transformation (Korhonen & Halen, 2017). Digital transformation (Antonopoulou et al., 2023) (Xie & Wang, 2023) requires an entirely new institutional logic and effective response. While Enterprise Architecture is used to facilitate enterprise transformation, the focus has traditionally been on process standardization and integration rather than continuous adaptation to changing business and technology landscapes. For EA to have the desired impact, a more adaptive conceptualization of EA that meets the requirements of the new digital environment is needed. Designing the Enterprise Architecture of SPBE Services (E-Government) in the Sukabumi Regency Government (Wulandari et al., 2021). One of the frameworks used to design the SPBE architecture is to use Enterprise Architecture (EA). EA aims to fill the gap between stakeholder needs and the availability of government administration services. The focus of the journal on the design of this SPBE EA is on the SPBE Service Domain on Electronic-Based Government Administration Services. The design was carried out using a combination of references to the SPBE Presidential Decree and the Attachment to the National SPBE Master Plan as well as one of the main components of the EA framework, namely TOGAF ADM.

## METHOD

Methodology is the method or system used to carry out a research or project, which includes plans, strategies, techniques, and tools used to collect and analyze data or information, as well as formulate conclusions and recommendations. The methodology aims to ensure that a research or project is carried out in an organized and systematic manner, so that the results can be trusted and relied upon. The research methodology used for the topic "Enterprise Architecture in TOGAF-Based Water Companies" is as follows:

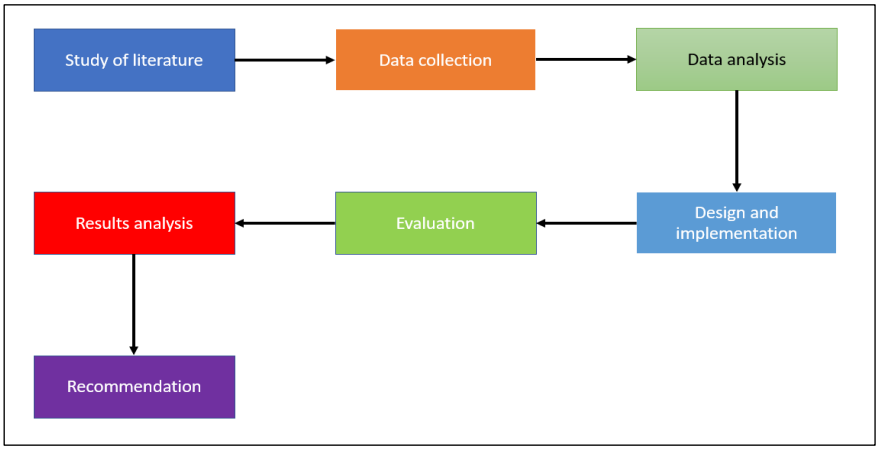


Figure 1. Proposed methodology
Source: Researcher Property

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In this research methodology seen in Figure 1, a qualitative approach was carried out using interview techniques, observation, and literature studies to collect the required data and information. Apart from that, a descriptive approach was also used to describe in detail about the drinking water company and the implementation of the TOGAF-based EA framework.

Phase 1. Literature study: conducting a literature search and review related to the Enterprise Architecture framework, TOGAF, and Enterprise Architecture implementation in drinking water companies.

Phase 2. Data collection: collecting data through interviews with related parties in the water company, such as IT management, business management, and end users. Apart from that, they also make direct observations on the systems and business processes of drinking water companies.

Phase 3. Data analysis: analyze the data that has been collected to identify business needs, challenges, advantages, and factors that may affect the implementation of the TOGAF-based EA framework in water companies.

Phase 4. Design and implementation: design and implement business architecture, application architecture, technology architecture, and data architecture within the TOGAF-based EA framework for drinking water companies.

Phase 5. Evaluation: evaluate the effectiveness of implementing the TOGAF-based EA framework in improving operational efficiency, customer experience, and product and service innovation in drinking water companies.

Phase 6. Analysis of results: analyzing the results of the evaluation to identify the successful implementation of the TOGAF-based Enterprise Architecture framework in water companies, as well as the factors that play a role in the success or failure of this implementation.

Phase 7. Recommendations provide for water supply companies to improve or increase the implementation of the TOGAF-based Enterprise Architecture framework, so that it can provide optimal benefits for the company and the community.

TOGAF (The Open Group Architecture Framework) is an enterprise architecture framework that is used to develop an integrated and standardized enterprise architecture. TOGAF provides in Figure 2, a structure and approach to the development of enterprise architecture which consists of four important elements, namely:

Architecture Vision is a general view of the desired future enterprise architecture. This view includes the architecture's vision, mission, goals, and objectives, as well as scenarios or descriptions of how the enterprise architecture can support business needs and achieve business goals. Within the TOGAF (The Open Group Architecture Framework) framework, Architecture Vision is the first step in developing enterprise architecture. This step aims to form a shared understanding between the parties involved in the development of the company's architecture, about the direction and vision of the company in the future. In this step, it is necessary to clearly understand the needs and problems that the enterprise architecture wants to solve, as well as the strategies that will be implemented to achieve these goals.

Business Architecture addresses strategy, organizational structure, business processes, and understanding user needs. Business Architecture describes how an organization creates value and profit, and bridges business goals and strategies with the implementation of information technology.

Application Architecture addresses the design and development of business and information technology applications. Application Architecture considers the availability and requirements of information technology to ensure that business applications support business objectives and user needs.

Data Architecture addresses the structure, management, and use of data within an organization. Data Architecture is concerned with how data is used, stored, and managed efficiently and effectively to support business and applications.

Technology Architecture addresses the information technology and infrastructure needed to support business, application, and data architectures. Technology Architecture pays attention to how information technology is used and implemented effectively and efficiently to support business objectives.

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Opportunities and Solutions is one of the stages in the TOGAF framework (Kornyshova & Deneckère, 2022) (The Open Group Architecture Framework) which aims to identify opportunities and solutions that can be implemented by companies to achieve the vision and goals of the company's architecture that have been set at the Architecture Vision stage. In the Opportunities and Solutions stage, the company identifies existing business opportunities and problems being faced and seeks appropriate solutions to solve these problems and take existing business opportunities. This solution can be in the form of developing applications, buying new technology, or changing business processes. In the Opportunities and Solutions stage, companies may consider various solution options, including solutions that involve the use of new technology or solutions that involve changing business processes. At this stage, the company must also consider the availability of existing resources, such as human, financial, and technological resources, so that it can choose the most feasible and feasible solution to implement.

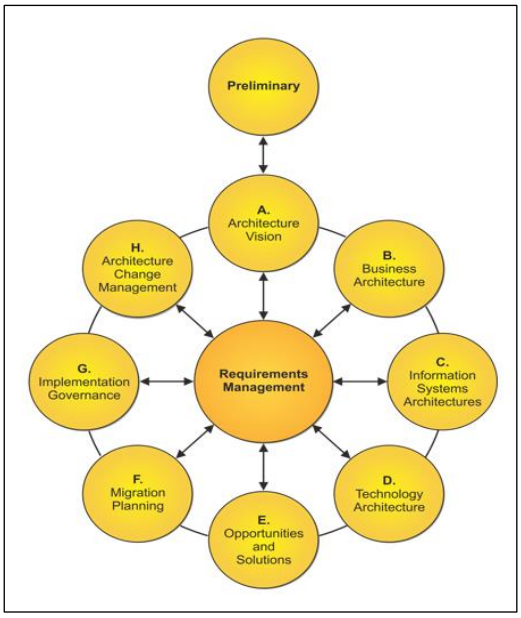


Figure 2. Nine TOGAF Framework domains
Source: TOGAF Property

Migration Planning is one of the stages in the TOGAF (The Open Group Architecture Framework) framework which aims to plan a move or migration from the existing architecture to the new architecture. In the Migration Planning stage, the company plans in detail the steps needed to update or change the company's architecture. This stage involves identifying and planning the activities, resources, and financing needed to complete the architecture migration. In the Migration Planning stage, companies need to consider factors that might affect the migration process, such as costs, time, resources, and risks associated with the migration process. Companies must also ensure that the migration process can be carried out without disrupting ongoing business operations and meeting existing business needs.

Implementation Governance is an important stage in the TOGAF framework (The Open Group Architecture Framework) which aims to manage the implementation of the architecture that has been designed and ensure that the architecture is implemented correctly and effectively. This stage includes planning, monitoring, and controlling implementation activities. In the Implementation Governance stage, the company must ensure that the architecture that has been designed is implemented according to the agreed plans and specifications. The Implementation Governance stage is very important to ensure that the architecture that has been designed is implemented properly and effectively. In this stage, the company needs to pay attention to aspects such as the availability of resources, costs, time and risks associated with the implementation process. By managing the implementation of the architecture well, the company can ensure that the system implemented is in accordance with the

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specifications and architecture that has been designed and can help improve the company's business performance and operational efficiency.

Architecture Change Management (Quintana et al., 2022) is a process that involves managing changes to the information system architecture. Information system architecture can be interpreted as the structure, components, and connections used to support an organization's information system. The main objective of Architecture Change Management is to ensure that any changes made to the information system architecture are properly documented, thoroughly analyzed, and implemented in an orderly and controlled manner. This process also includes identifying the risks and impacts of any changes to the architecture and managing the changes in a systematic manner to minimize risks and negative impacts. The Architecture Change Management process involves several stages, namely change identification, impact analysis, development of change plans, change implementation, and evaluation of change results. During the change identification stage, the proposed architectural changes will be identified and documented. Furthermore, in the impact analysis stage, the impact of the change on the overall information system will be analyzed and assessed. After the impact of the change is well understood, the change plan development stage will be carried out, where the change plan will be made and presented to the relevant parties for approval. The change implementation stage is carried out after the change plan is approved, and the changes are implemented in a controlled and orderly manner. Finally, the evaluation of the results of the changes is carried out to assess the results of the changes and ensure that the information system functions properly after the changes are made. Overall, Architecture Change Management is a very important process in the management of organizational information systems because it ensures that any changes to the information system architecture are carried out in an orderly, controlled manner, and produce a positive impact on the information system.

TOGAF also introduces the concept of developing enterprise architecture in a continuous life cycle, from planning to implementing and managing architecture. In addition, TOGAF also includes approaches to evaluate, measure, and improve enterprise architectures using reference architectures, open standards, and performance measurement. Thus, TOGAF provides a comprehensive and integrated approach and framework in developing and managing enterprise architecture. This can help water companies improve operational efficiency, optimize information technology investments, and ensure compliance with applicable standards and regulations.

## RESULT

In this section, the results of the research and the proposed design in this research can be described. The discussion carried out in this research concerns the planning of the application architecture, data architecture and technology architecture.

Table 1. Architecture Application

| No | Application | No | Application |
|---|---|---|---|
| 1 | Sales Dashbard - Billing - Collection | 11 | Company Promotions |
| 2 | Vendor Management | 12 | Leak Management |
| 3 | Ormas - Order Management | 13 | Management Asset |
| 4 | Finance | 14 | Inventory |
| 5 | IT - Management Training | 15 | Standart Product |
| 6 | Water Meter Reading | 16 | Order Management |
| 7 | Production Maintenance | 17 | Contact Center |
| 8 | Billing | 18 | Customer SIMAS |
| 9 | Network Water Flow Monitoring | 19 | Human Resource |
| 10 | Front Liners | 20 | Market Potensial |

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Figure 3, Application architecture used for proposals to drinking water companies. Customer SIMAS, an application that is in charge of handling customers. Contact Center, is an application that is used to connect companies or organizations with their customers or consumers through various communication channels such as telephone, email, text messages, social media, live chat, and so on. This application is designed to facilitate easy and efficient interaction between companies and customers, thereby helping to improve service quality, customer satisfaction and operational effectiveness.

Market Potential application is an application designed to assist companies or businesses in identifying and analyzing potential markets for their products or services. This application can provide information about market size, consumer trends, customer preferences, and competitors in the market. The Complaint Resolution Application is an application designed to help companies or organizations deal with customer complaints more effectively and efficiently. This application allows customers to report their complaints online, and allows companies to monitor and handle these complaints in one centralized platform. The Vendor Management application is an application designed to assist companies or organizations in managing relationships with their vendors or suppliers. This application allows companies to manage the entire vendor life cycle, from receiving vendor requests to payment and performance evaluation.

Order Management is a process of managing orders from start to finish. This process includes order handling, processing, shipping, payment, and reporting. Order Management aims to ensure that customer orders are processed quickly and accurately and provide a positive buying experience. The Financial Application is an application designed to help manage company or individual finances more effectively and efficiently. This application can help manage assets and liabilities, monitor cash flow, and generate accurate and timely financial reports. The Training Management Application is an application designed to assist companies or organizations in managing the training and development of their employees. This application helps companies plan, implement and monitor training and development programs provided to employees. The Network Construction Planning Application is an application designed to assist in planning and managing infrastructure network construction projects, such as telecommunication networks, electricity networks, or clean water networks. This application can assist in planning and managing every stage of a construction project, from planning, designing, construction, to testing and maintenance. The Construction Monitoring Application is an application designed to assist in the supervision and control of construction projects, from the planning stage to the completion stage. This application allows users to monitor project progress in real-time, track project team performance, manage changes, and ensure adherence to established schedules and budgets. The Install Water Meter application is an application designed to assist the process of installing water meters in water installations in homes or buildings. This application allows customers to register requests for installing new water meters, submit requests for moving or replacing old water meters, and track the status of user requests. The Water Meter Reading Application is an application that is used to assist in the process of reading and managing water meters in water installations in homes or buildings. This application allows field workers to read and record water usage, as well as send data to a water meter data management system. The Billing Application is an application designed to assist the customer's receivable billing process. This application allows companies to manage and monitor unpaid invoices, send payment reminders, and handle collection of overdue receivables. Network and Customer Mapping Application is an application designed to assist companies in mapping and managing customer data and their network infrastructure. This application allows companies to map customer locations, manage customer and network data, and monitor network performance. Product Standards and Specifications Application is an application used to manage product standards and specifications implemented by a company or organization. This application allows companies to manage and update their product specifications, as well as monitor and ensure the quality of the products produced are in accordance with predetermined standards.

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Table 2. Architecture Data

| No | Database | No | Database |
|---|---|---|---|
| 1 | Vendor Management | 5 | Geography Information System |
| 2 | Construction | 6 | Finance |
| 3 | Assets | 7 | Events |
| 4 | Human Resource | 8 | Customers |

Table 2, Architecture Data; Event/Activity database is a type of database designed to store information about various kinds of events or activities that occur in an organization or a certain place. This database is usually used to manage and track information about events or activities held in a place, such as conferences, seminars, concerts or sporting events. The Event/Activity database usually consists of several tables that are interrelated and store various kinds of information about events or activities. The Event/Activity Database can be used by various types of organizations, ranging from companies, universities, non-profit organizations, or the government. By using this database, event or event organizers can manage information efficiently, create useful reports and analysis, and enhance the experience of event or activity attendees.

Database Vendor Management is a database system that is used to manage information related to vendors or suppliers of a company or organization. The goal of Database Vendor Management is to ensure that a company has vendors that are reliable, effective and efficient in meeting business needs. Database Vendor Management enables companies to manage vendors more effectively, including selecting the best vendors, monitoring vendor performance, managing risks associated with vendors, and making better business decisions. With the effective use of Database Vendor Management, companies can improve operational efficiency, improve product or service quality, and strengthen relationships with vendors.

Construction Database is a database system used to manage information related to construction projects. This database stores information about the design, planning, execution and maintenance of construction projects. The goal is to ensure that all project-related information is centrally and regularly available. The Construction Database enables more effective management of construction projects, including more accurate monitoring of project progress, management of project costs, and time planning. With the effective use of the Construction Database, companies can improve operational efficiency, reduce risks, and speed up the completion of construction projects.

Asset Database is a database system that is used to manage information related to the assets of an organization or company. Assets can be property, equipment, vehicles or other items owned by the company. The Asset Database aims to facilitate asset management and maximize the value of assets owned. Asset database is very important in managing company assets because it allows more efficient and effective management of assets. With the Asset Database, companies can optimize the use of assets and minimize maintenance costs and extend the useful life of assets. In addition, this database also assists companies in obtaining accurate information about the state and condition of assets and determines when it is appropriate to replace or sell assets.

A GIS (Geographic Information System) database is a database system designed to store, manage and analyze data related to geographic locations. GIS databases allow users to visualize, manipulate and analyze data by location. GIS databases can be used in various fields such as mapping and managing natural resources, environmental monitoring, urban planning, disaster management, monitoring and managing infrastructure networks, and other fields that require information related to geographic location.

Financial Database is a database designed to store, manage and process financial data of a company or organization. This database serves to record all financial transactions, track cash flow, and produce accurate financial reports. The Finance Database can be used to monitor a company's cash flow and finances, calculate profit and loss, and create a better financial plan. In addition, this database also facilitates financial management and supervision, including the management of accounts payable and receivables, as well as the preparation of accurate and timely financial reports.

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Customer Database is a database system that is used to store and manage information about customers of a company or organization. This information includes personal data, contact information, purchase history, customer preferences, and more. Customer databases can help companies improve customer experience, as they can be used to identify customer preferences and needs. This can help companies to design more effective marketing strategies and ensure that the products and services offered are in accordance with customer needs. In addition, customer databases can also be used to monitor purchase history and gain insight into customer purchasing trends, thereby helping companies plan production and inventory.

Database Human Resources (HR) is a database system used to manage information about employees of a company or organization. Information stored in the HR database includes personal data, qualifications, work experience, employee performance, and administrative data such as attendance, salary and benefits. HR database can help companies to manage human resources more effectively. By storing employee information in one place, companies can easily track employee data, including absences, performance and salaries. This can assist companies in evaluating employees, providing training and development, and monitoring employee performance. HR databases can also assist companies in planning for future human resource needs and ensure that the company has an adequate workforce.

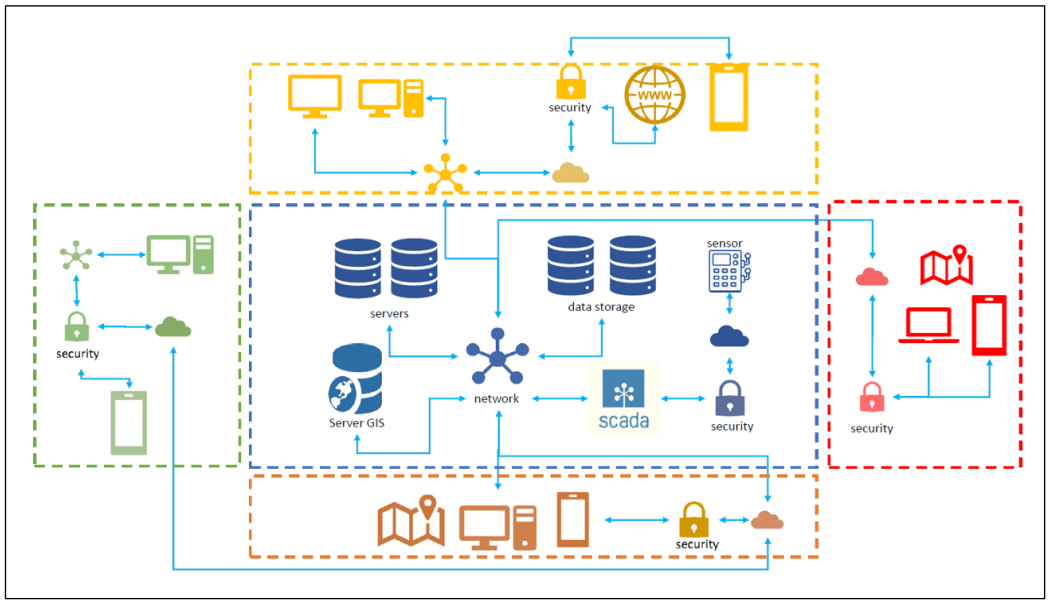


Figure 5. Technology Architecture

Figure 5, Technology Architecture for drinking water companies from the hardware side includes several main components such as:

Cloud Computing: Cloud Computing can be used to store and access huge company data such as financial data, customer data, operational data and others. By using the cloud, companies can save on investment costs in physical servers, data backup, and other infrastructure. Router: Routers are used to direct data traffic on the water supply network to and from the internet and internal networks. Routers can maintain network security and manage data traffic to increase the speed and efficiency of data transmission. Switch: Switches are used to connect devices in the water company's network, such as computers, servers, printers, and others. Switches can help optimize network performance by better managing data flows and minimizing data collisions. Server: Servers are used to store and manage company data, such as customer data, financial data, and operational data. Servers can also be used to run enterprise applications and services. Storage: Storage is used to store digital data and information from the company. Drinking water companies need a large storage capacity to store operational data such as customer data, production data, financial data, and others. UPS (Uninterruptible Power Supply): UPS is used to provide a backup power source in the event of a power outage. This is very important to ensure that company data is not lost and company systems are kept running at all times.

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The company's operations are equipped with a system to protect the system so that it becomes safe. Detection devices such as Intrusion Detection Prevention System, Anti Malware (Hindarto & Santoso, 2022), (Hindarto & Handri Santoso, 2021), (Hindarto, 2022), (Titi et al., 2023) are also used as a system to protect against various security threats.

To achieve maximum operational efficiency, the utility must have a unified architectural technology that can make good use of all of these hardware components. In addition, this architectural technology must be flexible and easy to upgrade so that companies can adapt quickly to changing market conditions and demands.

## DISCUSSIONS

How can water utilities utilize the TOGAF-based Enterprise Architecture (EA) framework to improve operational efficiency and ensure compliance with applicable standards in meeting community needs for clean and healthy water? (RQ1)

Research with a qualitative approach involving several stages as follows:

Literature study: Conducting a literature study on the concept of Enterprise Architecture, the TOGAF framework, and applicable standards in the provision of clean and healthy water. Literature study on the concept of Enterprise Architecture (EA) in drinking water companies covers several aspects, such as the definition and basic concepts of EA, the benefits of using EA, and the methods or frameworks that can be used to develop enterprise architecture. Here are some more detailed explanations of these aspects:

- EA definitions and basic concepts: Enterprise Architecture is a structured approach to describe and manage organizational resources and capabilities holistically, including aspects of business, applications, data, and information technology. EA aims to show an overview of the entire organization and make it easier to make business decisions.
- Benefits of using EA: The use of EA in drinking water companies can provide many benefits, including increasing operational efficiency, ensuring the availability and reliability of clean and healthy water for the community, facilitating the planning and development of new products and services, and reducing costs and risks in developing and information technology implementation.
- Enterprise architecture development method or framework: One method or framework that can be used in developing enterprise architecture is TOGAF (The Open Group Architecture Framework). TOGAF is a framework that assists in developing an integrated and flexible enterprise architecture, taking into account business, application, data and information technology aspects.
- Apart from that, a literature study on the concept of EA in drinking water companies can also cover a number of other topics, such as the role of the company architect, the enterprise architectural model used, the use of standards in the development of enterprise architecture, and so on.

Conducting a case study on a water company that has implemented the TOGAF-based EA framework. In this case study, interviews were conducted with several stakeholders, such as operational managers, IT managers, and quality managers, to understand how companies adopt and implement the TOGAF-based EA framework, and its impact on operational efficiency and compliance with standards. Analyze data from literature studies and case studies to find patterns and conclusions regarding the benefits and challenges of adopting a TOGAF-based EA framework for water utilities. In this data analysis, it is also possible to make comparisons between water companies that have implemented the TOGAF-based EA framework and water companies that have not implemented it. Formulate conclusions and recommendations regarding the benefits and challenges of adopting a TOGAF-based EA framework for water utilities, as well as ways to maximize benefits and overcome challenges that may arise.

How can the business architecture, application architecture, technology architecture, and data architecture be implemented in a TOGAF-based EA framework in water utilities to improve operational effectiveness, customer experience, and product and service innovation? (RQ2)

Business Architecture, Application Architecture, Technology Architecture, and Data Architecture are part of the TOGAF-based Enterprise Architecture (EA) framework used to manage an organization's

*name of corresponding author

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IT architecture. Below are some of the ways in which the four types of architecture can be implemented within an EA framework in water utilities to improve operational effectiveness, customer experience, and product and service innovation:

- Business Architecture: Business Architecture can assist water utilities in designing and managing their business processes effectively. For example, by using the Business Process Management (BPM) and Business Process Reengineering (BPR) methods, water utilities can improve and optimize their business processes, including in terms of resolving customer complaints or management of water meter installation orders. In doing so, water utilities can improve their operational effectiveness and customer experience.
- Application Architecture: Application Architecture can assist water utilities in optimizing the IT applications they use to manage their business. For example, by developing a construction monitoring application or a water meter installation application, water utilities can improve their operational efficiency and effectiveness, as well as enhance the customer experience.
- Technology Architecture: Technology Architecture can assist water utilities in selecting, designing, and implementing the right IT technology to support their business. For example, water utilities can adopt Internet of Things (IoT) technology to monitor customers' water consumption in real-time or Big Data technology to analyze water meter data and predict future water demand.
- Data Architecture: Data Architecture can assist water utilities in managing and integrating their data from multiple sources to support better business decisions. For example, by using an integrated data architecture, water utilities can make decisions based on accurate and reliable data and can speed up the decision-making process.

In the implementation of these four types of architecture, the TOGAF-based EA framework can assist water utilities in developing and managing their IT architecture in a more effective and structured manner. Using such a holistic and integrated approach, water utilities can improve their operational effectiveness, customer experience, and product and service innovation.

## CONCLUSION

From the explanation of the Enterprise Architecture in a TOGAF-based drinking water company, it can be concluded that EA is an enterprise architectural framework that assists in developing and managing integrated and standardized enterprise architecture. EA consists of four important elements, namely Business Architecture, Application Architecture, Data Architecture, and Technology Architecture, which enable companies to develop business strategies, design and develop information technology applications, manage data efficiently, and use information technology infrastructure appropriately.

In the context of drinking water companies, the use of TOGAF-based EA can help increase the company's operational efficiency, ensure compliance with applicable standards and regulations, and provide clean and healthy water services that meet community needs. EA also helps water companies to plan and optimize information technology investments, thereby reducing costs and increasing efficiency in company operations.

In research on EA in TOGAF-based drinking water companies, the research methodology used includes literature studies, interviews, and data analysis. Literature study was used to gather information about the EA concept and framework, and its application to water utilities. Interviews were conducted with related parties in the water supply company to understand the needs and challenges faced in the development and management of the company's architecture. Data analysis was carried out to collect and analyze data obtained from literature studies and interviews, so as to produce appropriate recommendations and solutions for drinking water companies.

By using TOGAF-based EA, water companies can develop and manage corporate architecture in an integrated and standardized manner, thereby increasing the company's operational efficiency, ensuring compliance with applicable standards and regulations, and providing clean and healthy water services that meet community needs.

*name of corresponding author

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