

## ENTERPRISE ARCHITECTURE FOR BANKING IN THE INDUSTRIAL REVOLUTION ERA 4.0

Firman Pradana Rachman <sup>a\*)</sup>, Eko Indrajid <sup>a)</sup>, Erick Dazki <sup>a)</sup>

<sup>a)</sup>Universitas Pradita, Tangerang, Indonesia

<sup>\*)</sup>Corresponding Author: [alfirmanpr@gmail.com](mailto:alfirmanpr@gmail.com)

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**Abstract.** The banking industry must keep up with the latest technological developments. If not, the banking industry will start to be abandoned by customers. This study presents enterprise architecture recommendations for the banking industry in the era of the industrial revolution 4.0. The architecture contained in this research consists of business architecture, information systems architecture, application architecture and technology architecture. The hope is that with the recommended architecture, we can adopt the latest technology and the banking industry can still compete in the midst of change.

**Keywords:** banking; enterprise; banking technology architecture.

### I. INTRODUCTION

The Industrial Revolution 4.0 has an impact on the financial industry. The banking financial industry is facing competition from financial technology companies or fintech. If banking companies cannot adopt the latest technology and do not innovate, it will cause disruption to the banking industry. Especially for retail banking that focuses on individual consumers and small businesses. Its market will be eroded by technology-based financial companies. This is because consumers are given convenience and better service with the technology offered by the fintech company.

The banking industry must be able to reach consumers as close as possible without any limitations on distance or place. This can be done by banking industry players if they adopt the latest information technology. Several banks have made breakthroughs by presenting internet banking and mobile banking technology so that consumers do not have to come to the branch to open an account but simply type with their fingers on the cellphone screen. Several digital trends using IoT that have a direct impact on financial services include mobile banking and internet banking, crowd-based financing, virtual money, cyber security and big data [1].

This research creates an enterprise architecture for banking which is designed by applying the latest technology in the industrial revolution era. Cloud computing technology, cyber security, machine learning, artificial intelligence, internet of things are part of today's technology that must be accommodated in the banking enterprise architecture. That way the bank can adapt to changes in technology so that the business continues to run better.

Enterprise architecture is an organization for business processes and IT infrastructure that describes the integration and standardization of the company's operating model [2]. Enterprise architecture provides a long-term vision and view

of a company's processes, systems and technologies. Many companies use frameworks for enterprise architecture design. Examples that are widely used for companies include The Federal Enterprise Architecture Framework (FEAF), Zachman Enterprise Framework (ZEF), Reference Model for Open Distributed Processing (RM-ODP), The Open Group Architecture Framework (TOGAF), Generalized Enterprise Reference Architecture & Methodology (GERAM), Service-Oriented Architecture (SOA) and so on.

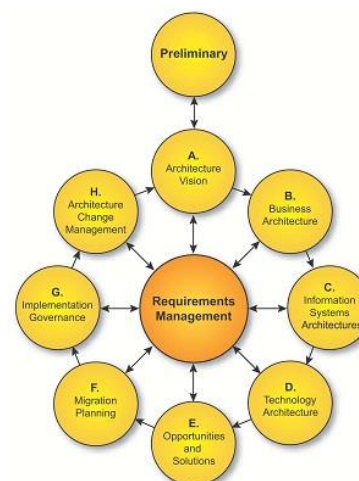


Figure 1. Architectural Design Stages of TOGAF

There is no framework that is definitely better than other frameworks, because its use is adjusted to the needs of the company. Some studies consider TOGAF to be better than others because of its wide and complete coverage [3]. Other studies also prove TOGAF can be applied in universities [4]. However, there are other studies showing that Service-Oriented Architecture (SOA) is better applied in small and medium-sized companies because the costs can be

reduced lower [5]. The ZAHMAN framework can also be applied in pharmaceutical companies [6] and foreign investment (PMA) [7]. The enterprise architecture approach can also be applied in performing digital transformation [8]. However, the implementation of enterprise architecture can use a small part of the existing framework model or even not use any framework model at all [9] [10]. The methodology for architectural design in TOGAF is called the Architecture Development Method (ADM). ADM consists of a comprehensive, integrated process for developing and maintaining an enterprise architecture [11]. Some of the stages of ADM can be seen from the following picture:

The bank is a financial institution that operates looking for profits that are obtained from net interest income minus Supriono's net interest expense [12]. However, banks do not only benefit from interest but also from transaction fees, the difference between buying and selling foreign exchange, bank guarantees and so on. The bank's own products consist of several types including demand deposits, savings, deposits, bank guarantees, credit, insurance, securities and so on. Different bank products depend on the business model itself.

The banking business model consists of 4 models, namely socialist, enabler, facilitator and financier [13]. The socialist business model upholds the value of responsible behavior towards society and the distribution of wealth as the goal of banking practice. The enabler business model aims to empower small, medium and large businesses by maintaining innovative relationships between banks and businesses. The main value proposition of the enabler business model is to offer businesses through banking capabilities. While the facilitator business model focuses on service sales and customer satisfaction. Finally, the financier business model is a general bank business model that carries out routine activities such as selling services and products, marketing, and managing customer accounts.

## II. RESEARCH METHODS

The methodology used in this research is a qualitative method. Qualitative methods are research methods that collect data in the form of words rather than numbers [14]. Qualitative methods produce a detailed description, analysis and interpretation of a phenomenon. Several techniques used in data collection in qualitative methods are participant observation, field observation, in-depth interviews, literature, documents and artifacts and additional techniques [14]. This research consists of several stages including, (1) Understanding business processes. Understanding of business processes is obtained from field observations to a private bank and from literature studies such as books, journals and other documents. The results of this process conclude that the research will focus on 4 stages taken from the 9 stages contained in the ADM toGaf. The 4 stages are business architecture, technology architecture and information architecture which are divided into two, namely information/data architecture and application architecture. (2)

Business architectural design. This stage is designing a business architecture which is described in the form of a canvas model consisting of 9 blocks [15], namely: (a) Customer segment, containing information on targeted customers. (b) Customer relationship, contains a list of parts that maintain relationships with customers. (c) Channel, consisting of a list of information and promotional media. (d) Value propositions, containing the added value offered to customers. (e) Key activities, a list of the main activities in the business. (f) Key resources, containing data on people or parts that are important in running the business. (g) Key partnership, list of partners or vendors that are bound to cooperate. (h) Cost structure, consisting of costs or operating expenses. (i) Revenue Stream, in the form of information on sources of business income. (3) Application architecture design. This section describes the application architecture and the functions of each application that is used. (4) Information and data architecture design. This section describes how information is stored in databases and how they relate to the applications used. (5) Technology architectural design. This technology architecture describes the technology used and how the technology is connected in a network. (6) Business process flow design. This section describes the flow of business processes that run conventionally and which have been added to the latest technology [16].

## III. RESULTS AND DISCUSSION

The results of observations and literature studies provide the idea that enterprise architecture consists of several parts, namely business architecture, application architecture, information architecture and technology architecture. The following are detailed details of the enterprise architecture that will be built:

### Business Architecture

The architectural business is designed in the form of a canvas model consisting of 9 blocks, which are mapped in the image below.

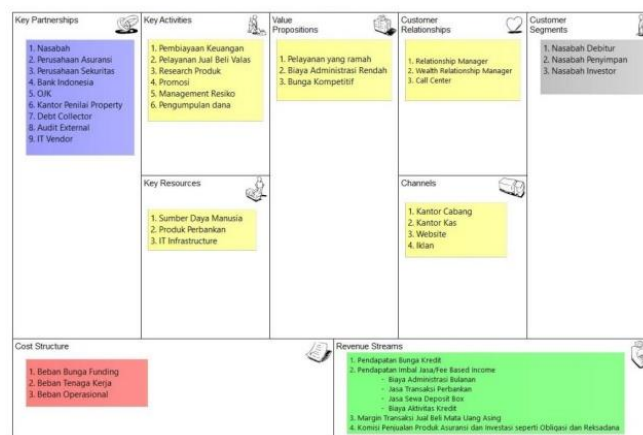


Figure 2. Business Architecture Design

**Customer Segments.** Customers are classified into 3 parts according to their nature, namely (1) Debtor customers, are customers who use credit products or loans from banks. These customers are classified into two parts, namely retail loans for individuals or MSMEs (Micro, Small and Medium Enterprises) and corporate loans, namely loans on behalf of large companies. (2) Depositing customers are customers who place their funds in a bank in the form of deposits. (3) Investor Customers, are customers who are interested in buying investment products from banks. For example, securities, mutual funds or unit links sold by banks.

**Customer Relationships.** Customer relationship serves to maintain good relationships with customers. Customer relationship management is handled by a relationship manager for funding or lending product customers. As for investment products, responsibility is assigned to the wealth relationship manager. In addition, there is a call center that accommodates complaints and questions from customers. Meanwhile, at the branch there is customer service who is ready to help with customer problems.

**Channels.** Channel is a medium to promote products. Banks can do promotions at branch offices, cash offices, websites and advertisements such as brochures, banners or social media.

**Value Propositions.** Banks must have good value propositions to attract customers. One of them is friendly service, competitive interest and low administration fees.

**Key Activities.** The following are the main activities in running a bank business. (1) Fundraising is a bank activity to collect funds from customers which will later be channeled through credit. This form of fundraising is in the form of demand deposits, savings and time deposits. (2) Financial financing, is a bank activity to channel funds to customers who want to borrow money. This type of financing varies, for example, home ownership loans, motor vehicle loans, business capital loans, consumption loans and so on. (3) Risk management, is a process that measures and calculates the level of risk from bank activities in order to keep it under control and run in the right direction. (4) Foreign exchange trading services, the Bank provides foreign currency trading services that can be accessed by customers who wish to exchange money with foreign currencies. (5) Product research, is an internal bank activity to create products that attract customers. (6) Promotion, is an activity of offering products to everyone.

**Key resources.** In carrying out its business activities, banks have key resources, the main of which are human resources, competitive products and IT infrastructure that supports bank activities. **Key partnerships.** Banks have partners in running their business, including (1) Customers, apart from being a customer, a customer can become a partner. For example, as a media campaign and so on. (2) Insurance companies, banks cooperate with insurance companies because insurance products can be offered to customers, including in the form of bancassurance and unit links. (3) Securities Companies, Cooperation between banks and securities companies includes the sale of investment

products such as mutual funds, securities and so on. (4) Bank Indonesia, is the central bank whose function is to determine monetary policy and maintain banking financial stability. Bank Indonesia indirectly controls the banking economy at the macro level through bank regulations and banking laws. (5) The Financial Services Authority (OJK), has a role as a supervisor for all activities in the financial services sector in order to create a fair and transparent system and protect the interests of consumers. OJK requires all banks to provide regular reports to OJK. (6) Property Appraisal Office, Banks often use Property Appraisal Company Services to calculate the value of assets that are pledged or guaranteed. (7) Debt Collector Service, it is almost certain that the bank has used the services of a Debt Collector to collect bad credit. (8) External Audit Company, the Bank uses the services of an external audit company to control and ensure that the processes within the company run safely and according to operating standards and can be accounted for. (9) IT Vendor, the Bank uses IT Vendor services to maximize the function of Information technology that will support banking business activities.

**Revenue Streams.** Banks have sources of income including:, (1) Credit interest income, namely income obtained from loan interest given on loans to customers. (2) Fee-based income is income obtained from general banking transaction services, including (a) Monthly administration fees. (b) Banking transaction fees. (c) Deposit box rental services. (d) Credit administration fee. (e) Credit card annual fee. (3) Income earned from buying and selling foreign currency transactions. (4) Commissions from the sale of investment or insurance products such as mutual funds, securities or bancassurance. (5) Bank guarantee services. **Cost structure.** The costs incurred by the bank can be divided into 3 main parts, namely (1) Funding interest costs, namely the interest expense that must be paid by the bank to customers for bank deposit products such as savings and time deposits. (2) Operational costs are costs incurred by banks in carrying out banking operations. (3) Labor costs, are costs incurred for employee salaries and bonuses.



Figure 3. Application Architecture Design

*Application architecture*

The application architecture describes the applications available in the banking system. The application division is divided into 5 parts, namely those related to

customers, main applications, internal parties, partners and top management. Below is an overview and explanation.

Applications related to customers, the list is (1) Teller Module (AC1), used to record banking activities between customers and tellers such as depositing and withdrawing money. (2) Smart Customer Service (AC2), serves to record banking activities between customers and customer service, for example opening a new account. (3) Smart Mobile Banking (AC3), can be used by customers to carry out banking transactions such as transfers, balance checks and smartphone application-based bill payments. (4) Smart Internet Banking (AC4), used by customers to perform banking transactions such as transfers, balance checks and web-based bill payments and through the internet network. (5) Smart Deposit Box (AC5), for deposit box rental service. (6) My E-money (AC6), functions to regulate or monitor electronic money in the form of cards, including for checks, top ups and balance transfers. (7) Smart Virtual CS (AC7), using a combination of artificial intelligence and machine learning technology to answer general and recurring customer questions by chat bots before going to customer service. (8) Smart Virtual Branch (AC8), aims to provide recommendations for suitable savings, credit, investment and insurance products for customers according to their profile using AI (artificial intelligence). (9) Queue management system (AC9), to manage customer queues at tellers and Customer Service. (10) The main banking application, namely the main core banking application consisting of (a) Funding (AP1), to record all demand deposits, savings and time deposits transactions. (b) Loan (AP2), to record all customer loan product transactions. (c) Smart Bancass (AP3), to record sales of insurance products in collaboration with banks. (d) Smart Invest (AP4), providing services to customers to make investments in the form of mutual funds and bonds/securities sold by banks. (e) Bank Guarantee (AP5), This application stores all data and bank guarantee transactions. (f) General transaction banking (AP6), aims to record general banking transactions such as transfers, withdrawals of funds and deposit of funds. (g) Smart Forex (AP7), serving customers for foreign currency exchange. (h) Risk management (AP8), aims to measure and calculate risks that may occur in banking operations. For example, the risk of bad credit, liquidity risk and so on. (i) Smart Datawarehouse System (AP9), functions as the main data warehouse that can distribute data to other datamarts or datawarehouses.

Applications related to partners, including (1) Payment Module System (AS1), aims to record every payment from a bank to a partner company or vendor. (2) Bank Indonesia Report System (AS2), functions to generate reports to be sent to Bank Indonesia as a regulator, both daily reports such as Commercial Bank Daily Reports and monthly reports such as Commercial Bank Reports. (3) OJK Report system (AS3), functions to generate reports sent by OJK as the Financial Institution Supervisory Agency. (4) API Integrated System (AS4), is an application programming interface that connects bank partners to get access and services to banking services such as payments,

balance checks, account mutations and exchange rate info. (5) Debt Information System (AS5), is used by External Debt Collectors whose services are used by the Bank to collect customer debts that have not been paid off or are in arrears. (6) Collateral Information System (AS6), This system displays data on collateral owned by the bank so that it can be given to the Appraisal or property appraiser to estimate the liquidity price of a collateral that can be used for auction purposes or for credit terms. (7) Smart Investment Management (AS7), regulates the purchase of investment products such as mutual funds, bonds and securities from banks to securities companies or investment product issuers. (8) Smart Bancass Management (AS8), manages the purchase of insurance products or unit links from banks to insurance companies. (9) Audit information System (AS9), a system that displays data or reports used by external audit service companies.

Applications related to the company's internal parties, namely (1) Human Resource Module (AR1), serves to store employee data such as attendance, training and promotion of employees. (2) Treasury System (AR2), is a treasury operational application such as money market, money exchange and cash management. (3) Monitoring Inventory System (AR3), aims to monitor and manage assets, both tangible fixed assets and intangible fixed assets. (4) CRM system (AR4), used by Relationship Manager and Wealth Relationship Manager for customer management and maintenance. (5) Financial Report System (AR5), is a report based on data warehouse and business intelligence for financial reports in the form of balance sheets, profit and loss and other financial analysis reports. (6) The KPI Customer Service (AR6) Portal is used by branch managers to monitor customer service performance and for HRD as the basis for scoring raises, bonuses and ranks. (7) The Sales KPI Portal (AR7), is used by branch managers to monitor sales performance and for HRD as the basis for scoring for salary increases, bonuses and ranks. (8) Fraud Detection System (AR8), functions to detect fraudulent or fraudulent transactions using machine learning techniques. (9) Anti Money Laundering System (AR9), to observe customer profiles, risks, transactions and behavior in detecting money laundering patterns. (10) Smart Prospect Customers (AR10), using machine learning concepts in displaying potential customer data. (11) ATM Monitoring System (AR11), This application functions to monitor ATM machines. (12) Network Monitoring System (AR12), functions to monitor computer networks, operating systems, applications and services so that they are always available and running properly.

Applications intended for management or owners, including (1) Executive Financial Report (AM1), a portal that displays banking financial reports in the form of balance sheets, profit and loss and cash flows. (2) Executive Branch Performance Report (AM2), a report that displays the performance of each branch so that the board of directors and top management can assess which branches are generating profits or losses. (3) Executive Inventory Asset (AM3), Portal report that displays the assets currently owned.

(4) Executive Ratio Report (AM4). The data displayed by this report is data on banking financial ratios, including (a) CAR (Capital Adequacy Ratio), which is a capital adequacy ratio that shows the ability of banks to provide funds used to overcome the possibility of risk of loss. (b) ROA (Return on Assets) is a ratio that measures a bank's ability to generate profit or profit by comparing net income with resources or total assets owned. (c) LDR (Loan to Deposits Ratio), is a ratio that measures a bank's ability to meet short-term obligations (can be called liquidity) by dividing the total credit to the total Third Party Funds (TPF). (d) NPL (Non-Performing Loans) is a ratio that measures how many loans are not performing or are non-performing compared to the total number of loans. € BOPO (Operational Expenditure to Operating Income) is a ratio that describes the efficiency of banks in conducting business activities. Operational expenditure is the interest expense given to customers while operating income is the interest earned from customers.

#### Information and Data Architecture

Information and data architecture describes how the data is stored and the flow of information, as illustrated below:

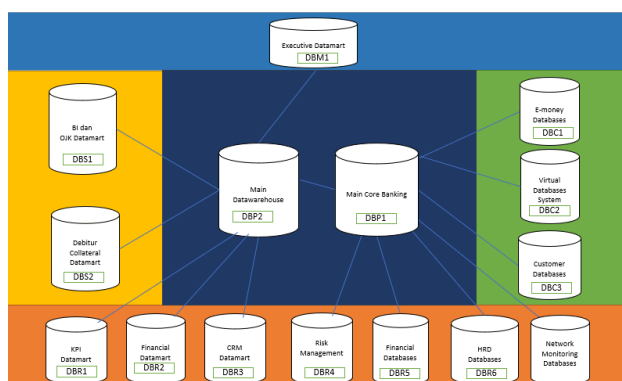


Figure 4. Application and Database Architecture Design

Information architecture consists of 4 parts, namely:

The customer-related information architecture is depicted on the right and linked to the main databases. List of databases include (1) E-money databases, which are databases that store data and transactions from customers' electronic money. (2) Virtual databases system, contains databases needed by virtual branch and virtual customer service applications. (3) Customer databases, contains databases that store all customer data

The main information architecture, depicted in the middle and serves as the main database that is connected to all databases. (1) Main Core banking, is the main database that stores all operational data from the main banking application and is connected to all databases. (2) Main data warehouse, are databases that store historical data for data analysis, and for other data sources. The data in these databases is updated from the main core banking data which is processed every night automatically. The goal is that the data for the analysis process is separate from the operational

data, so that the load on the operational server is not heavy. (3) Information architecture related to Partners or Vendors, is depicted on the left, which consists of several databases among them. (4) BI and OJK datamart, are databases whose data is derived from the main data warehouse containing data for reporting to Bank Indonesia and OJK. (5) Debtors and Collateral datamart, are databases containing data on debtors and creditors along with the guarantees or collateral they use.

Information architecture related to the company's internals is described below, consisting of several databases, namely (1) KPI datamart, which are databases that contain employee performance calculations which will later affect the score performance indicators for salary increases and bonuses. (2) Financial datamart, are databases containing historical financial data used for banking financial reporting and analysis. (3) CRM datamart, namely databases containing data used in CRM (Customer Relationship Management) applications. (4) Risk Management, are databases that store data and risk management activities such as credit reviews, fraud detection and anti-money laundry. (5) Financial databases, are databases that store data on banking financial transactions. (6) HRD databases, are databases that store employee data and activities in the manpower department. (7) Network monitoring databases, are databases that store data related to networking logs and data traffic

Information architecture related to executive reporting for management. In this information architecture, it only consists of one database, namely the Executive Datamart whose data is derived from the main data warehouse.

#### Technology Architecture

Some elements in the technology architecture include networks, operating systems and applications [17]. The image below is the technology architecture in the banking industry. The technology used uses LAN and WAN networks. Meanwhile, web and android based applications can use the internet network. The number of server computers that are used is exactly the same as the number of databases that are used. This means one computer server for one database. The grouping is divided into 5 segments, exactly the same as the grouping in the previous architecture.

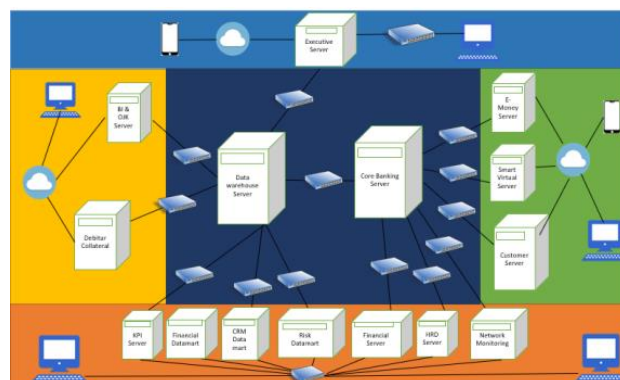


Figure 5. Technology Architecture Design

Technology architecture related to the customer. The picture can be seen on the right side consisting of 3 servers, namely e-money server, smart virtual server and customer server. This server can be accessed using a computer or mobile device via the internet. Main technology architecture. It is a technology architecture consisting of 2 server computers, namely a core banking server and a data warehouse server, both of which are connected by a LAN. The two main servers are also connected to other servers related to customers, vendors or partners, internal companies and servers for top management. Technological architects who deal with vendors or partners. The picture on the left consists of 2 servers, namely the BI/OJK server and the debtor collateral system server. Both of these servers can be accessed via the internet. Technology architecture related to the company's internals. The details can be seen at the bottom consisting of 7 servers including Kpi server, Financial datamart, CRM datamart, Risk Datamart, financial server, HRD server and Network Monitoring. Servers can be accessed via WAN and LAN networks.

Technology architecture related to top management. It only consists of one server, namely the executive server. This server can be accessed via a LAN network or the internet. The banking business process flow and its architecture are depicted in a diagram. Broadly speaking, the process starts from the business actor described by the yellow box on the far left, consisting of three, namely depositors, debtor customers and investor customers. The following is a diagram and sequence of business processes from the customer side.

The process of opening an account or opening an account. Before making a transaction, every customer is required to open an account first. This process is carried out in the customer service section for customers who come to the branch and is also carried out through mobile banking or internet banking applications. The applications used are the customer service module (AC2), Smart Mobile Banking (AC3) and Smart Internet Banking (AC4) which are connected to customer databases.

Banking Transaction Process. Customers can make transactions including (1) Current Accounts, Savings and Time Deposits. This transaction is carried out by customers whose purpose is to save funds. This process is accommodated by the funding application (AP1) which uses the main core banking (DBP1) databases. Proof of transaction from the process in the form of Slip for those who transact at the branch office. Meanwhile, for those who transact on internet banking or mobile banking, the proof of transaction is in the form of a pdf file. (2) Invest transactions. This transaction is carried out by investor customers who want to invest with investment products sold by banks. Applications that handle this process are Smart Invest (AP4), Smart Mobile Banking (AC3) and Smart Internet Banking (AC4) whose data is stored in main core banking databases (DBP1). (4) Open bancass. This process is used by customers who want to buy bancass products that are accommodated by the Smart Bancass (AP3), Smart Mobile Banking (AC3) and Smart Internet Banking (AC4)

applications that are connected to the main core banking (DBP1) databases. (5) The process of lending or borrowing. Is a process carried out by debtor customers who want to borrow money according to their needs. The application that handles the lending process is a loan (AP2) whose databases are stored in the main core banking (DBP1). (6) Bank guarantee transactions. This Bank Guarantee process is accommodated by the bank guarantee application (AP5). The databases used are core banking databases (DBP1). When the process of opening a bank guarantee cannot be directly approved because it will be analyzed and reviewed by the bank as well as the review process for credit, because this bank guarantee is an indirect credit. (7) Forex transactions. This process is used by customers who want to exchange foreign currencies. The application that handles this process is smart forex (AP7) whose data is stored in main core banking (DBP1) databases. (8) General transactions. This process is accommodated by the teller module (AC1), Smart Mobile Banking (AC3) and Smart Internet Banking (AC4) applications. The databases connected to this application are the main core banking (DBP1) databases. (9) The review process. This process analyzes the creditworthiness of the customer. This review stage runs after the lending process and bank guarantee. The application that handles this review process is Risk Management (AP8). The credit review process is complex and complex, so the databases used are separate from the main databases, using the Risk Databases (DBR4). These databases are also stored on a separate server, namely the Risk Server. (10) Approval process. The final stage of the loan process is the approval stage. When approved, the loan funds will be transferred to the customer.

#### IV. CONCLUSION

This banking enterprise architecture was created by incorporating elements of technology that developed in the era of the industrial revolution 4.0. Some of the latest industrial revolution technology trends are contained in the banking application architecture. For example, the IoT (Internet of Thing) trend is manifested in mobile banking and internet banking applications. Artificial intelligence or artificial intelligence in virtual customer service and virtual branch applications. The phenomenon of the emergence of big data is used to process data into useful information using machine learning methods. For example, to see which customer prospects are potential, credit scoring and fraud transaction detection. Report presentation also becomes sharper and more in-depth because it is built in a data warehouse and business intelligence. In general, the enterprise architecture is divided into four main parts, namely business architecture, application architecture, information architecture and technology architecture. The business process will change slightly compared to the conventional way because it adds the latest technology. If in the past the customer made a transaction, he had to come to the branch, then the process can be replaced with an application on the cellphone. For the bank itself will increase

efficiency and effectiveness. For example, the use of chat bots as virtual customer service can reduce the burden on the call center. In general, the hope is that the technology used can create added value for banking businesses and customers. So that the bank does not lose its customers and the customers themselves are well served.

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