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MICROSERVICE ARCHITECTURE DESIGN: PROPOSED FOR E-OFFICE APPLICATION

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ABSTRACT

Analysis and design of e-office application on ministry health of Republic of Indonesia based on microservice architecture. The system is converting from monolithic architecture into microservice architecture by using domain driven design framework to breaking the domain business of the system. Microservice architecture is an important part to agile, resilience, and high-availability. By improvement the feature and the high intention to use to the system by regulation of e-government of Republic of Indonesia at Ministry bureaucracy. By using the Microservice Architecture will improve the productivity of employee, increase the public services, adaptable in current condition of pandemic covid-19 cases in Indonesia.

Keywords: Microservice, Domain Driven Design, Monolithic, SOA and Ministry of Health,

1. INTRODUCTION

The development of technology and information occurs very rapidly making changes in the world order from being limited to borderless. The role of information technology is quite important to make information technology a primary need to support the organization's business activities [3]. With advances in information technology, it changes the way companies or organizations in activities collect information, process information, and also report information. So that it can simplify all operational processes, because almost all operational processes carried out by the company require and produce information. Not only in the company, the government also has the obligation to provide equitable public services to all citizens in accordance with the duties mandated by the president [21]. So government organizations must always try to improve the quality of services provided. This increase can be implemented by using information technology in accordance with the needs of the organization. Technology must be able to manage data quickly, effectively and efficiently [18].

Currently, the Ministry of Health has implemented an e-office which can be accessed at http://eoffice.kemkes.go.id. However, there are several weaknesses and shortcomings to the system that is currently running, namely it has not been able to accommodate all organizational needs within the Ministry of Health of the Republic of Indonesia, development for additional services takes a long time, databases are not well integrated, and errors often occur when used. In its development, the Ministry of Health's e-office will help a lot in implementing e-government in government, especially the ministry of health. Over time, there have been a lot of inputs from users for the development of e-office towards a better direction, especially during the Covid-19 pandemic which requires limiting activities to interact directly and limiting the number of employees by doing work from home (WFH) [12].

In connection with the development of an eoffice system using a monolithic architecture that is currently used [1]. This architecture uses a uniform code base and technology in its application to facilitate the process of making systems with few resources and low levels of difficulty. By using the architecture changes in function and system upgrades on systems that are difficult and too frequent errors in the system this is related to the malfunction of one function that has an overall impact on the system. The system was transformed into a Microservice architecture (MSA). MSA is an SOA-based architecture by using the independent service and each service has own storage to making © 2022 Little Lion Scientific

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the application were scalable, resilience, and high-availability [19].

The objective of this study is to analysis the existing architecture and to design the new architecture based on MSA by using Domain Driven Design approach. The scope of this research is the analysis and design of an application module based on Microservice Architecture (MSA) through a case study at the Ministry of Health of the Republic of Indonesia (Kemenkes RI), through a Domain Driven Design (DDD) approach in mapping business domains and making e-offce application prototypes. using the Microservice Architecture. The objectives to be achieved from the research carried out are the stages that can be implemented in adapting the microservice architecture (MSA) to the existing conditions of the ongoing infrastructure.

The Ministry of Health Republic of Indonesia the blue print to transform e-office application was based on Monolithic into microservice architecture. Research scope is the analysis and design of an application module based on Microservice Architecture (MSA) through a case study at the Ministry of Health of the Republic of Indonesia (Kemenkes RI) by using a Domain Driven Design (DDD) approach in mapping business domains and describing the results of the monolith information stages. to microservices.

2. LITERATURE REVIEW

A microservice is a collection of processes that communicate with other services to form a application complex in anv application programming interface language. Microservice itself is a further development of Service-oriented Architecture because microservices are systems consisting of service components, small, separate blocks and focus on their tasks or work in a modular, autonomous method for their respective purposes but connected to each other independently. protocol. With this architecture, one particular main goal in software development is achieved. The functions contained in the architecture can be created using a technology stack that suits the needs of each function and can be different from one another. Each function can be built by a separate team with its own code base and can be tested independently [13].

2.1 E-Office Architecture

E-Office is an office application that replaces the manual-based administrative process to an electronic-based process by utilizing local network (LAN) facilities, as well as internet (online) networks. With the development of today's telecommunications technology, high-speed broadband networks and the internet, offices have become electronically electronic. The e-office framework and architecture must evolve for eoffice product development in any organization. The suggested architecture should be in line with the standards. Scalability, security, interoperability and open standards, performance and productivity improvements need to be considered when defining overall architecture. Architectural the recommendations include enterprise architecture, technology architecture and application deployment architecture with separations in hardware components and service level performance seen in figure 1.



Figure 1: E-office Architecture [28]

2.2 Service Oriented Architecture

SOA or Service Oriented Architecture is a term that is becoming a trend in the latest technology in the IT world. Referring to the name Service Oriented Architecture is an approach in designing (architect) systems where the services that exist in each existing system. In this case, these components provide a certain type of business service, such as: making payments, transferring payments, checking bank account status [13]. SOA Advantages for the company are reuse, efficient, agility, alignment dan Flexibility [14].

2.3 Microservice Architecture

Microservice is a collection of several processes that communicate between other services to form a complex application to the application programming interface of any language. Microservice itself is a further development of Service-oriented Architecture because microservices are systems consisting of service components, small blocks, separate and focus on their tasks or work in a modular method, autonomous for their respective purposes but

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connected to each other independently. together. protocol. With this architecture, one particular main goal in software development is achieved [4]. The functions contained in the architecture can be created using a technology stack that suits the needs of each function and can be different from one another. Each function can be built by a separate team with its own code base and can be tested independentl as shown in **Fig. 2**.



Figure 2: Microservice Architecture [29]

2.4 Previous Research

Subsub Previous research related to microservice architecture as follows:

- i. DP Jayanto [23] Back-end Design "SIAP"": Information system aspiration and customer complaint based on web by Microservice Springboot Methods. The research was used Microservice design using Springboot to develop Information System for the customer Website based by mapping the service into complaint, citizen and customer.
- ii. Sendiang [24] *Microservce implementation on Mobile learning Development.* This research was mobile learning implementasian based on website. This research aimed to learning facilities for the student, image sharing, GPS Mapping by realtime.
- iii. Kawa Muhammad Angga [25] *REST API* Development on Storage Service by Rapid Application Development methods (Case study: *PT XYZ*). The research was developed system by using API Framework Restify by using javascript program language and MySQL for the database.
- iv. Ponce et al. [26] Migrating from monolithic architecture to microservices: A Rapid Review. The research By using the study review from to twenty different migration technique to migrate the monolithic and microservice architecture. The migrate of the service from monolithic was trivial due to dependency from modules and database mapping. The result of this journal is

90% of the technique by using the design element approach.

v. Steinegger et al. [27] Overview of a Domain-Driven Design Approach to Build Microservice-Based Applications. This journal was overview of Domain-Driven Design concept to build microservice architecture the lack of software development and the limitation of DDD when to classify of software development process for building of resource-oriented Microservice.

3. ANALYISIS AND PLANNING

3.1 Research Methodology

In the Design method, it will be explained about the stages that will be carried out to identify and design the use of Domain-Driven Design approach from [27] in modeling - based architecture microservices on the object of research. The framework used in the research can be seen in the following figure:



Figure 3: Design Methods

As in Figure 3 which explains the steps research that starts from data collection to get overview of the existing architecture into design the e-office microservice by using DDD Framework. This Research was beginning by mapping the conversion of the monolithic architecture into microservice architecture. Domain Driven Design framework was adopted from [13] and domain-driven design is an approach by mapping the complexity of business domain. Microservice Architecture modelling using the Domain Driven Design (DDD) method consists of four steps or stages, namely the stage of analyzing the domain, determining the Bounded

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context, determining aggregate entities and services and identifying microservices from the platform.

The data collection method in this research consists of primary data and secondary data to produce a more accurate design to be implemented in the system at Ministry Health of Republic of Indonesia interviews were conducted with stakeholders involved in decision maker of the institution that has role to developing the e-office application including determine the function of administrator, operator and user. The services have developing letter, employee presence, domestic travel request, public relation. Based on primary data collection for analysis of existing conditions and needs from the Ministry of Health of the Republic of Indonesia, primary information is needed from Pusdatin stakeholders who play a role in the initiation and development of e-office.



Figure 4: Domain Driven Design Steps

Next, analyze the architectural models that are in The system architecture used is still a monolith application for all these services, functional systems that are still interrelated each other in one large codebase, this makes it difficult for institutions to move quickly in case of changes and additions to service features, Based on these problems, it is necessary to review the architecture that can be used provide more benefits for the company in terms of development iterations software, both in terms of architecture and harmonization between departments. The current infrastructure is through the website using internet access by firing at one server as a data base for all services used. Microservice Architecture modelling using the Domain Driven Design (DDD) method consists of four steps or stages, namely the stage of analyzing the domain, determining the Bounded context, determining aggregate entities and services and identifying microservices from the platform as shown in figure 3 the stage are:

- Analyze the domain, is the initial stage to be able to analyze the domain model which will be the model for the business domain of the application
- Determine the boundaries of the domain context, in each domain context has certain functions that can be determined in several contexts. Limitations have certain functional

contexts in supporting existing services on the Microservice architecture.

- 3) Determine the Entities, aggregates, and services of the application.
- 4) Identify the shape of the Microservice architectural design in the application.

3.2 Infrastructure Analysis

The infrastructure was used web-based e-office Ministry of Health Republic of Indonesia. User directly access the website using PC or Gadget. Monolithic architecture will provide all service in one container or we called self-contained. The program component is Interdependent and Interconnected the application was designed for multiple related tasks [17]. Then user will directly access to service but if the number of users was increasing significantly the application will decrease performance, failed to access, and one service error will affect the entire application. The existing of e-office Ministry of Health Republic of Indonesia as shown at **fig.5**.



Figure 5: Existing E-office

3.3 Business Domain Analysis

The object of research is Ministry of Health of the Republic of Indonesia (Kemenkes RI) is a Ministry within the Government of Indonesia in charge of health affairs. The Ministry of Health is under and responsible to the President. In carrying out its functions, the Ministry of Health is supported by the Center for Data and Information Systems (Pusdatin) which plays a role in supporting data management, providing information and developing information technology to support the ministry's performance in carrying out its duties and functions.

Analysis of the domain that will be used to analyze the needs and services needed to carry out the design. At this stage, 13 domains have been determined which will be developed to become services for the Ministry of Health's e-office application. This domain as shown in figure 5 will become a guide for future development and mapping processes.

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Figure 6: E-office Domain

Initial phase of the Domain Driven Design approach (DDD) This is a domain analysis. In this stage it will be known domains that are directly involved in system development or system integration. After conducting an analysis of the system running, it is found a description of the domain analysis that is appropriate in figure 5 Analysis of the domain that will be used to analyze the needs and services needed to carry out the design. At this stage, 13 domains have been determined which will be developed to become services for the Ministry of Health's e-office application. This domain as shown in figure 6 will become a guide for future development and mapping processes. The Microservice Architecture model has three layers consisting of the application layer, the domain model layer, and the infrastructure layer, which are as follows as shown in figure 6.



Figure 7: Microservice Architecture in one Service

Existing services on e-office using microservice architecture are services on existing eoffice and new additional services according to the results of interviews with stakeholders by arrange the module of each service.

Attendance module is used to monitor employee attendance, application for leave, permission, and sickness. Attendance module contains dispensation (permission, sick, not at work, and not recording attendance). Recap attendance (recap daily attendance, monthly satkel, monthly and annual attendance recap individual. Application for leave (annual leave, major leave, sick leave, maternity leave, leave for important reasons). Other recaps (tukin calculation, money calculation eating, discipline, and tardiness). User can immediately pick the employee service at attendance module by end-to-end service. The attendance module as shown in figure 8.



Figure 8: Attendance Module

Employee data search module user search employee data, employees enter the e-office application select search employee data, then the e-office application displays to enter the menu search, select the ministry of health staffing database in the form of name, Id number (NIP), position, and work unit (satker) then the information about the employee will shown the work flow of employe data search module was shown in Figure 9.



Figure 9: Employee data search Module

The Business Travel module is used to facilitate the administrative process Civil Servant (ASN) official trip. The Business Travel Letter (SPD) module consists of finger type Business Travel (perjadin) (in town or out of town), type of financing (self work unit fee, other work unit fee), users (perjadin implementer, structural officer, SPD admin, and financial admin), features (making letter of assignment, process and print sheet official travel order (SPPD), process and print receipts of advances for events, process and print accountability letter (SPJ). The workflow of business travel was shown in Figure 10.

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Figure 10: Business Travel Module

Public complain module. The workflow forms public accesses the website of the Ministry of Health, then E-office provides API for complaints, public or user fills out the complaint service on the e-office website. Then, website stores the complaint file. After that, Complaints are verified by Pusdatin to forwarded to the related section. The officer Follow up on complaints and closing of complaints. The e-office submits the results of the complaint to the Ministry of Health website. After that The Ministry of Health website displays complaints suggested by the public whether accepted or rejected. Finally public sees the results of the complaints and the status of the complaints made. Whole workflows shown in Figure 11.



Figure 11: Public Complain Module

3.4 Bounded Context Analysis

Bounded context was is context specific for semantic contextual boundary which contain inside all the component of the software. The component has their own specific things and meaning [14].

The boundary that has a domain that has applies and well-defined at particular boundary context. The responsibility area of the business domain with aim as the boundary of pilling the business model to do the development. The concept of Domain Driven Design is when we arrange the concept from the small scope into the complex one. The break out the complexity of the business domain. The microservice concept has no limitation when using the language program of each service of the application [15].



Figure 12: Presence Context

Subdomain Presence context, these presence of all staff and the status updated and the file can be recorded as a staff history. That can be a reference of employee presence and tracking their work activity based on the regulation of civil servant that attendance affects performance allowance this activity as shown in figure 12.



Figure 13: Procurement Context

Subdomain procurement context has function to do a bidding by work unit need. This can be done by inputting a request to the procurement system. The sistem will be automatically direct to online bidding system that has been provided by state agencies. The procurement function as shown in figure 13.

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Figure 14: Business Travel Context

Business travel (Perjadin) subdomain context to give acces the employee to submit a request for a business trip to be carried out. then if approved, the funding will be processed in the finance and administration department to prepare costs in accordance with applicable regulations. This business travel request as shown in figure 14.



Figure 15: KMS Context

Knowledge Management System (KMS) subdomain context provided to be able to improve the ability to complete work accurately and quickly in accordance with applicable laws and regulations and serve as guidelines for employees in making decisions. KMS function as shown in figure 15.

Figure 16: Administration and Finance Context

Administration and Finance Subdomain context will conduct an examination of the submissions made and will proceed to the severing official and if it has been approved automatically to the cos center to credit the funds needed by the organization, both business trips and other activities. Administration and finance context as shown in figure 16.



Figure 17: Public Complaint Context

Public complaint Subdomain context in accordance with the analysis of the agency's needs to be able to provide special services related to public complaints about the services and needs needed. this can be directly given input and will openly appear on the dashboard of the service level agreement process in resolving each complaint. Public complaint context as shown in figure 17.

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Figure 18: Reporting Context

Reporting Subdomain context in accordance with reporting of every activity carried out by the agency is carried out by the system so that the reporting is monitored and will be directly used as material in re-checking the accountability of the budget that has been used by certain work units or staff. in addition, it can directly conduct dispositions related to the approval of the severing official. Reporting context as shown in figure 18,



Figure 19: IT Management Context

IT management subdomain context provided to perform floating and repair if there is a problem with the system. In addition, it also accommodates the need for procurement of IT systems in certain work units. IT management function context as shwon in figure 19.



Figure 20: Task Context

Task subdomain context will be used to monitor the activities and progress of the work that will be done, is being done, and that has been done. So that it will be a measure of the KPI of each employee in accordance with the jobdesk that has been regulated in accordance with the duties of the position. The work that has been completed will then be forwarded to the immediate supervisor for inspection and approval. Task Context as shown in figure 20.



Figure 21: Dashboard Context

Dashboard subdomain context this service will display the performance of all employees, activities, ongoing projects, and the budget used in real time, making reporting carried out in real time and to be able to be monitored and make policies based on valid data. Dashboard context as shown in figure 21.

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Figure 22: User Context

User subdomain context provide information for all employees of the ministry of health to be able to access the eoffice system and adjust to the total addition of new accounts, account mutations, and account deletions. This service will accommodate all staff of the Ministry of Health with a total of twenty five thousand employees properly and systematically. User context as shown figure 20.



Figure 23: Staffing Context

Staffing subdomain context this service will provide the needs of employees in applying for permits, leave, or illness. Inputting overtime and doing databased of all information from position and career history. Information on family, education, and achievements. In addition, this service also provides the need for tax reporting and salary slips. So that it can accommodate all employee needs by system 3.5 Entities, aggregate, and services.



Figure 24 : Domain Entity Pattern

The entities candidate is the object that will be used as data by the attribute form the order entity class. The e-office microservice has identified the identities data as shown in table 1 bellow. Table 1: a office artities

< <context>></context>	Entities Data	
Presence	Presencedate, presencestatus,	
	presenceID, Presencedetail	
Task	Task data, task information,	
	task_status, task_list	
Business travel	UserID, travel location,	
	Business_Request, BusinesReport	
Staffing	Staffing information,	
•	staffingfamily, staffingid,	
	staffingleave, staffingovertime,	
	staffingpayslip, staffingperformance	
KMS	KMSItem, KMSDetail,	
	KMSInformation, KMSEvaluation	
Administration	AdministrationStatus,	
Finance	FinancePending, FinanceDetail,	
	FinanceStatus, FinanceCalculation,	
	FinanceCostCenter,	
Dashboard	DashbordDetail,	
	DashboardPerformance,	
	DashboardReport	
Workflow	WorkflowID, workflowdetail,	
	workflowInformation	
Procurement	ProcurementRequest,	
	procurementID,	
	procurementinformatioan,	
	procurementstatus	
Reporting	ReportingID, ReportingStatus,	
	ReportingInfromation	
Public	PublicID, PublicInformation.	
	PublicStatus	
IT Management	ITManagemenID,	
	ITManegementDetail, IT	
	ManagementHistory	
Public Relation	PublicRelationChannel,	
	PublicRelationNotification,	
	PublicRelationtStatus	

The service candidate is the object that will be used as a service. Service candidates are determined based on the functional requirements of the microservice architecture. Based on the results at the requirements stage, the service candidate obtained as shown in table 2 below.

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Table 2: e-office Services		
Service Name	Description	
Presence	used for attendance	
Task	used for activities and tasks	
Business travel	used for business travel applications	
Staffing	used to provide information and staffing needs	
KMS	used to access the knowledge management system	
Administration	used for payment and administrative	
Finance	purposes	
Dashboard	used to display the performance of employees	
Workflow	used to assist service in workflow	
Procurement	used to procure goods and services	
Reporting	used to carry out accountability	
	reports and other activity reports	
Public	used to carry out accountability	
	reports and other activity reports	
IT Management	used to monitor IT systems and IT	
	procurement in work units	
Public Relation	used to carry out public relations	
	activities	

Aggregate root modelling is based on invariants that must persist when dealing with data. In Figure 4.16, presence will perform aggregate functions on staffing, for example searching for employee names, obtaining employee information, and detailed employee leave and attendance information. because doing so will potentially all paths Presence at the same time. Aggregates are basically business transactions and include everything that must remain consistent.

3.6 Microservice Design

Microservice consist of small service. Based on aggregate analysis. Identifying service candidate is clearer as shown as figure 23. There are 13 services candidates will packaged as microservice application.



Figure 25: E-office Microservice Architecture

Each service can deploy independently without interrupt other service performance it makes the microservice more resilient. Each service has own storage and one service to other service will communicate by using well-defined APIs.

All service will be packaged into one container and will one or two more service will interact each other by using Enterprise Service bus as a middleware tool in microservice architecture.



Figure 26: Service Communication

Service communication through APIs. Consider the case where the employee request for presence about the presence time from Presence Service as shown in Figure 24.

3.7 System Evaluation



Figure 27: Gorilla Testing and Blackbox Testing Result by JMeter

The framework Load Testing is a performance testing technique where system response is measured in various loads conditions. This research helps determine how e-office behaves when multiple users access simultaneously. Testing using Black Box Testing and Gorilla Testing methods as Test Case Sampling. Black Box Testing is Testing functional e-office without knowing the internal structure program (no knowledge). Gorilla Testing is a Technique testing in which the program module is repeatedly tested for ensure that the module is functioning properly and no bug [22].

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The module can be tested more than one hundred times, and in the same way. Gorilla Testing too known as "Frustrating Testing". The purpose is to test robustness E-office by using Microservice Architecture by JMeter Result In 100 users with 1 request every 1 second, the maximum sample time obtained e-office microservice architecture the get method obtained a maximum sample time of 1,201 ms with a throughput value of 60,279/minute. So, the current e-office server can handle 60,279 login requests per minute. This value is quite impressive with the number of requests that exist if we compared for the total number of employees.

Table 3: Comparison E-office based on Monolithic and Microservice Architecture

Parameter	Monolitihic	Microservice
Maximum	5,148 ms	1,201 ms
Running Time		
Throughput	60.48/minute	60,279/minute
Max. Number of	60 Users	60,279 Users
user		
Access/Minute		
Number of Service	4 Services	13 Services
Deployment	Slower due to	More flexible and
	need to deploy	faster, deployment
	large code at a	can be done
	time and	separately for each
	inflexible	service

The running time of e-office was increase impressively from maximum running time is 5,148 ms into only 1,201 ms by using microservice Architecture. By using e-office based on microservice architecture the scalability of application was improve by shorting time development until time implementation. The short time of time testing and penetration test was more shorten by applied of CI/CD tools as the part of microservice architecture implementation from 3 mandays into 1 mandays by using Gitlab to assist deployment and production stage of the code automatically. Moreover, development time to adding new service is only 3 mandays by using Microservice Architecture if compered to the existing architecture was need more than 21mandays to develop one new service.

4. SUMMMARY

Microservice is an application architecture by consist of each service which has specific function. This architecture was rapidly to develop, agile and more resilience because one service has their own storage. This architecture is easier because the team only responsible for one service with different language program with another services. The developer productive, faster and rapid for the deployment and utilizing the Microservice architecture using Domain Driven Design helps us to mapping the complexity of business model by defined the entities aggregates, and domain services. This design starts by analyzing the domain and define the bounded context as the basic arrange as specific contextual boundary which has specific function and specific meaning. Apply tactical DDD patterns is to help us break the service into a several smaller services.

A case study e-office application as reference to converting the monolithic architecture into a microservice architecture by Domain Driven Design approach to develop the service, scale up for business need, and to improve the application.

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