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Service Architecture Platform Based on OAIS Model for Data Preservation in The National Archives of Indonesia

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Abstract. Archives are one of the essential instruments in tracking changes in bureaucratic reform. Archive management itself is accommodated as a component of the evaluation of the Bureaucratic Reform evaluation. However, managing national archives is not a simple matter. Due to the large number of stakeholders involved in the archiving business process, archiving activities have an intensity that is quite frequent, and the documents produced in archiving have various formats. Archive volume is also an important matter that should be considered and preserved. One suitable strategy is to deliver the data preservation method toward the big data ecosystem utilizing OAIS as an information storage framework, as OAIS is the essence model for digital data preservation systems. Therefore, this study designed an integrated archive management system with data distributed in each agency using a microservice architecture that can quickly distribute and dynamically configure to support scalability and data preservation for ANRI's national archival system.

Keywords: *archives; data preservation; microservice; national archival system; OAIS; platform.*

1 Introduction

The Industrial Revolution 4.0 is an advancement breakthrough for the industrial and labor area where Information and Communication Technology (ICT) is a key determinant of competitiveness in this era. The roadmap of Making Indonesia 4.0 was planned by the Ministry of Industry as an integrated guideline to perform various approaches for the Industrial 4.0 era. In order to achieve this goal, collaborative steps need to connect different stakeholders covering government organizations, corporations, and business professionals to literary components. The application of Industry 4.0 not only has vast capability in modernizing industrial viewpoints; it is even capable of changing several aspects of people's habits. The unstoppable pace of ICT development brings with it fundamental changes in the organization of archiving. The National Archives of the Republic of Indonesia need to respond to the challenges of this change because the implementation of the national archives is aimed at the goal where the archives can become the backbone of government administration and are demanded to be effective and efficient.

In the context of archiving, archives have a strategic role. Archives as recorded information and events regarding the dynamics of social, national, and state life are objective information sources regarding various fields such as politics, social, economy, culture, science, and technology. History of the failures and other nations' achievements can be used as a reference to advance the nation further. Archives are one of the essential instruments in tracking changes in bureaucratic reform. Archive management is accommodated as one of the components of the evaluation of the Bureaucratic Reform evaluation as regulated in the Regulation of the Minister for Administrative Reform and Bureaucratic Reform of the Republic of Indonesia Number 30 of 2018 concerning Amendments to the Regulation of the Minister of Administrative Reform and Bureaucratic Reform Number 14 of 2014 concerning Guidelines for Evaluation of Bureaucratic Reforms of Government Agencies.

Management of national archives is undoubtedly not a simple matter. This is due to the large number of stakeholders involved in the archiving business process, archiving activities have an intensity that is quite frequent, documents produced in archiving have various formats, archives have a life cycle starting from creation, utilization, depreciation, appraisal, destruction, acquisition, and recovery of archives in one complete unit of information. Therefore, it can be said that the national archiving system is a complex system. Additionally, the archive volume is also an important thing to note. Over time, the volume of records has increased based on the digital universe data growth. Also, the demand for data preservation is increasing. The strategy to retain large amounts of data that are sometimes large in the media for an extended period that can be in months, years, or decades is now crucial to implement, due to national laws of Article 66 of the Republic Act. Indonesia Number 43 of 2009 concerning Archives, which are required to store static data for 25 years. As the amount of data to be retained increases, new strategies are needed to store data. One proper approach is to lead the information preservation mechanism toward the big data ecosystem applying OAIS as an information storage framework, as OAIS is the essence standard for digital data preservation practices.

The rapid development of information technology has caused the security of digital archive information to be increasingly concerned. Not only can digital archives be threatened by the storage environment, but also by virus infections, hackers, and other illegal users. In managing the archiving system, several implementing rules are needed, such as protection, utilization, and access authority and security of the system, including prevention of the risk of infiltration and the risk of changing archived data that may occur.

This research is intended to design an integrated archive management system with data distributed in each agency using microservice architecture and design a

system that can be distributed easily and quickly and can be dynamically configured to support scalability.

2 Related Researches

Many kinds of research related to archive management systems have been carried out. Wang conducted research on the design and implementation of electronic archives information systems under cloud platform [1]. However, this research has not applied standards or rules regarding the preservation management of digital archives. One of the standards related to digital archive preservation plan management and recognized by ISO is the Open Archive Information System (OAIS). OAIS is a model that applies information storage standards so that it can be stored in the long term, involving information producers, information users, information preservation, and archive management itself. The OAIS model provides a framework for creating information packages to create standards for generating, storing, and distributing information [2]. The long term in question is long enough to pay attention to the impact of technological changes, including new data formats and support or changing user communities [3].

The research conducted by Rahmanto & Setiawan on the choice of architecture and technology in building distributed archive systems with large data volumes [4]. Guided by the OAIS model, Falatiuk, Shirokopetleva, & Dudar designed an electronic archive system using a Microservice architecture combined with Event-Driven capable of horizontal scaling, modular updating, easy modification, and handling of large volumes [5]. However, the built system requires a large amount of upfront costs and is not necessarily applicable in all places. [4] also conducted other research related to archival management systems based on the OAIS model. This study proposes a data preservation process framework in big data architecture using the main components of OAIS, but the research has not focused on archive security, both authenticity and validity, so it cannot detect unauthorized changes in information [5].

Other research that focuses on archival management systems' security has been conducted by Mukti & Setiawan in [6] and Indriyawati, Winarti & Vydia in [7] about archival security by encrypting using symmetric encryption of AES [7] and asymmetric encryption utilizing RSA digital signature [6]. However, the systems created are not yet fully integrated into the affiliated system, so document integrity checks and encryption are still carried out separately [6]. In comparison, the research conducted by [7] did not scale well in term of the users' key management.

As a national archive management institution, the National Archives of the Republic of Indonesia (ANRI) must provide archival services to the public, who will use archives for the benefit of the government, development, and research and science in accordance with archival principles. However, in the archipelago's research on the level of readiness for implementing the electronic archive system at ANRI, it was stated that ANRI was relatively not ready to implement electronic archives. From the results of these assessments, a recommendation is formed for the priority order of improvements that place technology as the primary variable for improvement [8].

3 Bureaucratic Reform

The Bureaucratic Reform Program, which began in 2010 with the issuance of Presidential Regulation No. 81/2010 concerning the Grand Design of Bureaucratic Reform (GDRB), is an effort to make gradual and sustainable reforms and fundamental changes to the government administration system regarding institutional, management, and human resources aspects. The policy is manufactured to achieve good governance and is strengthened by issuing Presidential Regulation Number 95 of 2018 concerning Electronic-Based Government Systems (SPBE). All state administrators from central to regional must implement e-Gov in an integrated manner to manage all government affairs and community service. One of the mandates that must be implemented immediately is the acceleration of SPBE, which aims to accelerate the implementation of public sharing applications integrated into all government agencies. There are four quick wins in applying general applications: integration of planning, procurement, performance, and evaluation monitoring; staffing services integration; archiving services integration; and integration of public complaint services. Meanwhile, there are also two quick wins in SPBE infrastructure, namely the national data center and the intra-government network.

Based on the mandate of the Presidential Decree, it states that government administration services for archives and archival services are carried out in an integrated manner using an electronic system. Archiving services are integrated by integrating business processes for managing archives, integrating electronic archival systems, sharing archives and information between agencies, and organizing an integrated archiving database. In order to realize an integrated national archive, national archival architecture design is required, which includes the business process domain, application domain, data and information domain, infrastructure domain, service domain, and security domain by referring to the principles of electronic-based government systems, namely effectiveness, integration, sustainability, efficiency, accountability, interoperability, security.

With this system, it is hoped that an integrated national data center can be formed and can be accessed to improve public services. Bureaucratic reform will be in line with public service reform because every state administration will lead to the provision of public services.

4 The National Archive of Indonesia

Based on the strategic plan document, ANRI's strategic goal in 2020-2024 is to improve public compliance with archive policies, increase the availability of authentic, intact, and trusted archives nationally, and competently improve archival information services. The ongoing National Archives System is supported by several separate applications in the process of managing dynamic records, managing archives, and archiving services. Table 1 lists the applications in the archiving system that are currently running.

Tabel 1 Existing Archival System

Application Name	Description	Category	Owner	Current Condition
Dynamic Archival Information System (SIKD)	The information system that functions to collect and process data and archival information from various network nodes.	Internal	Archives Creator	SIKD has been used in several nodes of the archive creator network.
Static Archival Information System (SIKS)	The information system that functions to collect and process static files.	Internal	Archival Institution	The latest version of SIKS is still under development.
National Archives Information System (SIKN)	An information service system that functions to collect and process data and archival information from various network nodes which then provide it for user access through JIKN.	Internal	Archives Creator	SIKN has also been used by several nodes of the archive creator network.
National Archival Information Network (JIKN)	A website-based user interface for accessing archived data and information from the SIKN application as well	External	ANRI	JIKN has been used and well managed by ANRI

The four systems of SIKD, SIKS, SIKN, and JIKN are still not fully integrated between government agencies. In the Figure 1, the national archive system in the process of creating dynamic archives carried out by each archive processing unit is still not nationally integrated with the SIKD. After the process of creating dynamic archives, files that are not used can then be destroyed or stored as static archives. Creating static archives is currently re-entering data in the SIKS system that has not been integrated with SIKD. Similarly, between SIKD and SIKN and JIKN, archival institutions and ANRI input archive data manually archives that have been created by the archive processing unit so that archive data can be used

by the public. Based on these problems, an integrated system is needed through a bottom-up approach method so that the archive data received flows entirely to the center.

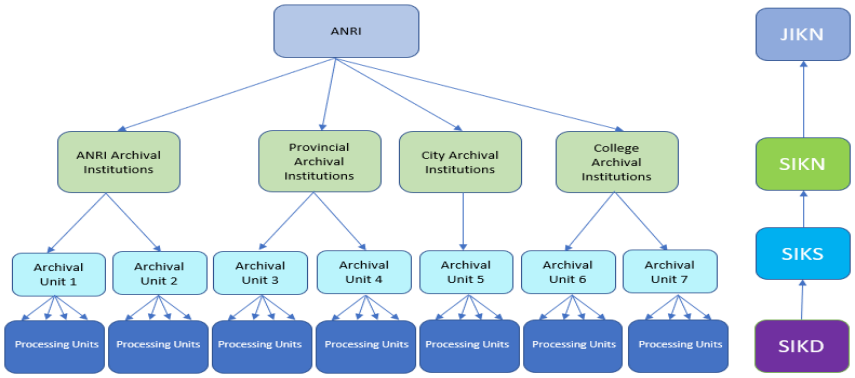

Figure 1 ANRI Archival Systems Process Flow

Evaluation of the existing electronic archives system becomes the material for developing a national archiving system. Not only that, but ANRI also needs to consider the filing demands mandated in SPBE. Table 2 describes some of the principles that must be adhered to when creating business architecture, data, applications, technology, and security in the field of archives.

Table 1 Architecture Principles of National Archive

No.	Category	Principle	Description
1	*Business Principles*	Based on Law	Archiving is carried out based on a legal basis and in accordance with statutory regulations, propriety, and justice in the policies of state administrators.
		Accountable	The organization of archiving must be able to guarantee the archive as a record of activities or events that can be provided or presented in authentic, intact, and reliable conditions so that it can function as valid evidence or as a source of information in carrying out activities in the future
		Service-oriented	The architecture is based on a design that reflects the real-world service business processes
		Usability	Architecture is made based on the principle that archives have usability properties.
2	*Data Principles*	Meets Data Standards	The data meets the standards set in accordance with applicable regulations
		Metadata	So that data has consistency in syntax, structure, composition, presentation and semantics so that it can be used across organizations
		Data Interoperability	Data can be utilized by various types of hardware and software
		Data security	Archival administration guarantees data security from possible leakage and misuse of information by unauthorized users.
3	*Application Principles*	Technology independence	Applications are independent of specific technologies so that they can be used with a variety of platforms

		Integrated Application	Applications are integrated with other applications related to their use.
		Ease of use	Applications must be easy to use so that the user can focus only on the task
		Shareable	Applications can be shared and used by all Creators of the archive
4	*Technology Principles*	Change based on needs	Changes to technology or applications are only made if there is a business need
		Technology Control	Technological diversity must be controlled to minimize unnecessary expenses
		Technology interoperability	Software and hardware must comply with interoperability standards in order to exchange information in a meaningful and useful way
5	*Security Principles*	Meet the basic principles of security	The National Archive architecture is made to meet aspects of information security, including Confidentiality (C), Integrity (I), and Availability (A).

Evaluation of the existing electronic filing system becomes the material for developing a national archive system. Not only that, ANRI needs to consider the archival demands mandated in Presidential Regulation Number 95 of 2018 concerning the Electronic-Based Government System (SPBE), which states that archiving government administration services and archiving services are carried out in an integrated manner using an electronic system. The national electronic archive system ensures the availability of authentic, intact, and reliable archives and can identify the existence of archives that have information linkages as an integral part of the information in all archival organizations. In research conducted by [9], it is stated that collaboration can be carried out from archives produced by related parties. However, according to [8], in their research on the level of readiness for implementing the electronic archive system at ANRI, it was stated that ANRI is relatively not ready to implement electronic archives. There is insufficient technological capability, which is significant for implementing electronic archives. There is also a lack of tools, procedures, and resources while policies and awareness are relatively in place. From the assessment results, a recommendation for a priority order for improvement is then formed that places technology as the primary variable to be improved. Technology to produce a better archival system is supported by various system features. The features integrated into the system support the goals and requirements of the archiving process. The following are some of the features contained in the archive system from previous research.

Table 2 Archival System Features

No	Features	Related Researches
1	User Management	[10], [11], [12], [13], [14]
2	Authentication	[10], [11], [12], [13], [14]
3	Authorization	[10], [11], [12], [13], [14]
4	Multi Agencies	[15], [16]

5	Upload Data	[10], [11], [12], [13], [14]
6	Send Data	[10], [11], [12], [13], [14]
7	Data Encryption	[17],[18]
8	Data Searching	[10], [11], [12], [13], [14]
9	Data Compression	[12]
10	Data Integrity Verification	[18], [19]
11	Digital Signature	[20]
12	Input Metadata	[15], [16], [21]
13	Metadata Standardization	[15], [16], [21]
14	Event Management	[22]

Along with the development of existing technology, the archives created in the era of the industrial revolution 4.0 no longer use conventional media but are electronic-based. The era of the Industrial Revolution 4.0 was marked by an abundance of data and information, cyber-physical systems, to big data management. This is the challenge for the archiving world in managing electronic-based records.

The business process in archiving is very dynamic and complex, so a suitable architecture is dynamic and responsive to changes and technological developments. That is what underlies the selection of the microservices architectural pattern to be implemented in the construction of the national archiving system.

5 Open Archives Information System

The Open Archival Information System (OAIS) regulates the data storage process so that data can be stored for a long time. OAIS defines how archives should be maintained for the user - from the moment the files are absorbed into the digital storage area, through subsequent preservation strategies, to the creation of the dissemination package for end-users [23]. OAIS itself is a framework that does not standardize technology application but only provides a conceptual model consisting of four main concepts.

1. The terminology of the archival system that outlines standard terms, processes, services, and data compositions.

2. The information package of archival system. It is divided into three package types: Submission Information Package (SIP) for sending information, Archival Information Package (AIP) for storing

information, Dissemination Information Package (DIP) for processing the information.

3. The mandatory responsibilities of archival system. It implies agreement with producers and consumers for the completeness and clarity of information being archived and resulting in the sets of methods for collecting, storing, validating, and presenting the information.

4. Collection of functions to achieve the mandatory duties of the archival system. There are six practical mechanisms: ingest functional entity, archival storage functional entity, data management functional entity, administration functional entity, access functional entity, and preservation planning functional entity.

Therefore, the OAIS model became the standard of preservation data as ISO 14721:2012 that provides overall ideas, terminologies, data models, and the archival system's obligations that need to carry out and approved functions to satisfy these engagements. Subsequently, the next phases are implementing the concept into an actual system that consists of architectural design, technology selections, data formats, transmission protocols, design internal and external API, and creating the deployment and maintenance strategy, so that all functional and non-functional specifications are satisfied. The main concepts categorized into six functions of ingest, data management, archival storage, preservation planning, administration, and access that describe in Figure 2. The six functions are used as reference model for developing archival system that could preserve the archival data that stated by the government regulations.

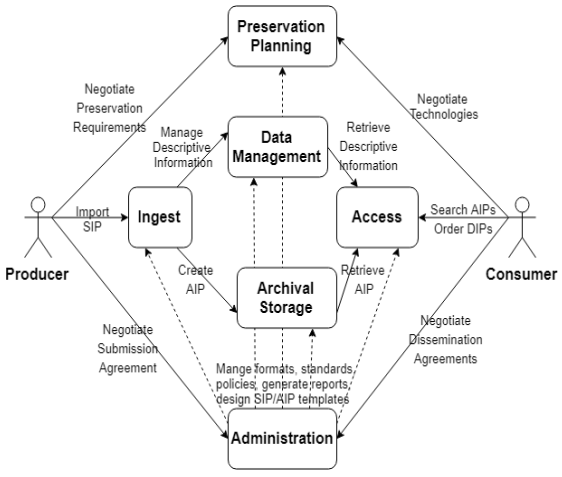

Figure 2 OAIS Reference Model [23]

6 Service Computing Systems Engineering Platform

Service computing have definitions from various perspectives [24] from the perspective of system design and software development, defined as a way of building application systems using services as their essential elements. From the perspective of distributed computing, service computing is a paradigm that evolved from object-oriented computing and component-oriented computing that makes various distributed application systems both inside and outside the company integrate quickly and flexibly [25] From the perspective of the application of service technology, namely a set of technologies that combine service concepts, service system architecture, service technology, and infrastructure to provide guidance on how to use services [26]. From a disciplinary perspective, [27] states that service computing is a cross-disciplinary discipline, namely computer science, information technology, information management, and consulting services, by applying service computing technology to eliminate the gap between business services and information technology services. [28] argue that service computing puts forward a dynamic, flexible, and complex internet environment. Service computing is a new computing discipline with web services and Service-Oriented Architecture (SOA) as the technology base, service composition as the leading software development approach, and software analysis and service-oriented design principles as the basic idea. According to [29] service computing focuses on applying computing technology and infrastructure (software, hardware, infrastructure, service technology, service architecture) for modeling, design and implementation of IT services to improve productivity and effectiveness of business services.

Based on the various definitions that have been described, it is concluded that service computing is a way of building a distributed system, using services as the basis so that it is dynamic, flexible, and complex by applying computing technology to be able to harmonize IT services and business services. Computing services can bridge the gap between ANRI's IT services and its business services by applying service computing technology to improve ANRI's business services.

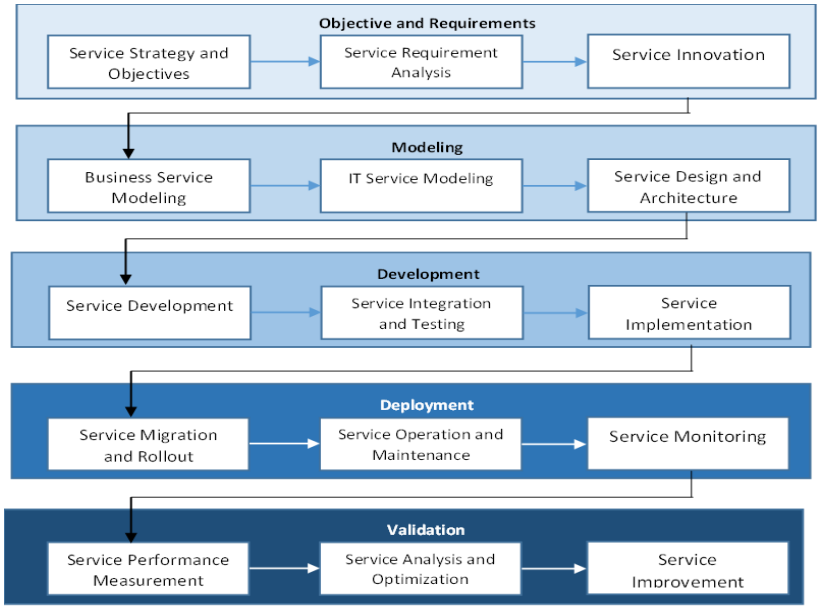

Figure 3 SCSE Steps

7 Implementation

In the implementation based on the outlined criteria, the archive system must be able to handle large data storage, also be scalable, in addition to mitigating a single point of failure by reducing existing services. With the application of the OAIS model in the form of communication with the three AIP, DIP, and SIP models, services are formed as follows:

Table 3 Archival System Features

	IT Services	Participants	
		Provider	Consumer
TS1	Agency Management	Institution Manager	ANRI
TS2	Operator Management	Operator Manager	ANRI Archival Institutions Archival Units Processing Units
TS3	Archive Code Classification Management	Archival Code Classification Manager	ANRI
TS4	Digital Signature Management	Digital Signature Manager	ANRI Archival Institutions Archival Units Processing Units
TS5	Notification	Notification Manager	ANRI Archival Institutions

			Archival Units Processing Units Public
TS6	Signing	Signing Manager	ANRI Archival Institutions Archival Units Processing Units
TS7	Event Management	Event Manager	ANRI Archival Institutions Archival Units Processing Units
TS8	User Management	User Manager	ANRI Archival Institutions Archival Units
TS9	Archive Management	Archive Manager	Archival Institutions Archival Units Processing Units
TS10	Payment Management	Payment Manager	ANRI Archival Institutions Public
TS11	Verification	Verification Manager	ANRI Archival Institutions
TS12	Archive Creation	Archive Creation Manager	Archival Units Processing Units
TS13	Archive Transfer	Archive Transfer Manager	Archival Units Processing Units
TS14	Archive Destruction	Archive Destruction Manager	Archival Units Processing Units
TS15	Archive Publication	Archive Publication Manager	ANRI Archival Institutions Public
TS16	Archive Usage	Archive Usage Manager	ANRI Archival Institutions Public
TS17	Archive Reporting	Archive Reporting Manager	ANRI Archival Institutions Archival Units
TS18	Archive Maintenance	Archive Maintenance Manager	ANRI Archival Institutions
TS19	Archive Digitalization	Archive Digitalization Manager	ANRI Archival Institutions
TS20	Archive Filing	Archive Filing Manager	ANRI Archival Institutions

The IT services define in table IV are classified into six main functions of OAIS model in Figure 4. In the ingest function, there is one service classified of archive creation. While in the data management function of managing the data created by the ingest function that enable users to access it, consists of archive transfer and archive destruction. In the archival storage function, the archive management and archive digitalization services are included, which could be used for storage repository of archival records. The access function consists three services of archive publication, usage, and reporting that give consumer to use the archive data. The next essential function is preservation planning, which utilize to

develop packaging design and migration plans of the archival data by developing archive maintenance and archive filing services. The last category is administration function, that manage and monitor the archival processes, consists of agency, operator, user, classification code, and event management.

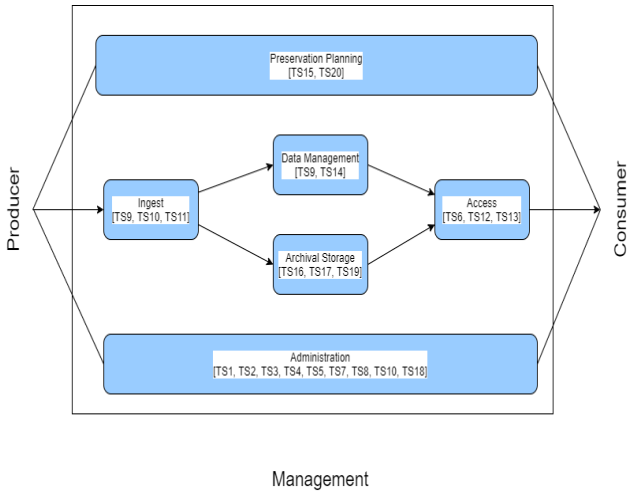

Figure 4 Categorization of Archival System Functions based on OAIS Reference Model

Based on the design made, the following is the technology stack used to build a microservice and OAIS-based archive system. The choice of programming language, framework, database server, and a webserver to be used is adjusted to the developer's expertise and each service's needs. Additional technologies that must be present in the microservices architecture are API gateway, container, orchestration, and message bus. By using a container, all services owned by the application will be packaged so that when it is run anywhere, the application can run the same as when it was developed. Developers no longer need to install servers with various applications, environments, and other needs, because everything needed by the application is installed in the container. One of the orchestration technologies is Kubernetes. It is an open-source platform used for container management. Kubernetes will manage the system so that it is reliable, always available, has no downtime, has strong security, and can access traffic. The microservices that provided by the national archival system platform is depicted in the Figure 5.

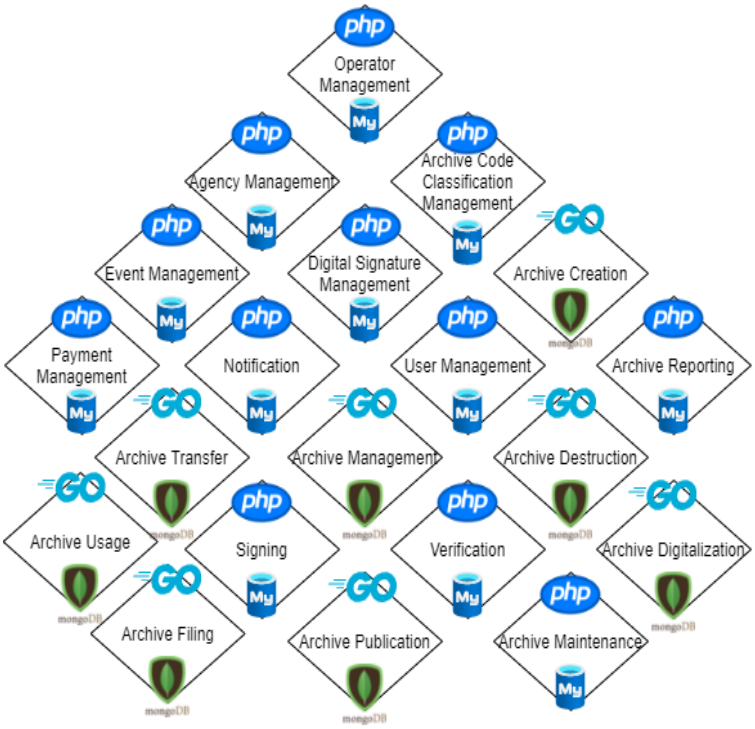

Figure 5 Microservices Architecture

Service creation in this research utilizes different programming languages, namely PHP and Go. The selection of this programming language is not only based on popularity and the number of communities that support it, namely, because the two facilities are different. PHP programming language is included in the interpreter category, while the Go programming language is included in the compiler category. The difference between compiler and interpreter types is that the compiler requires compiling the code before the system can execute it. Thus, the type interpreter is faster for code generation, but it is better to use a compiler for performance and standard code development. The PHP programming language will be used in most services due to its faster development, but it will be developed using Go for services with a high load, which has better performance.

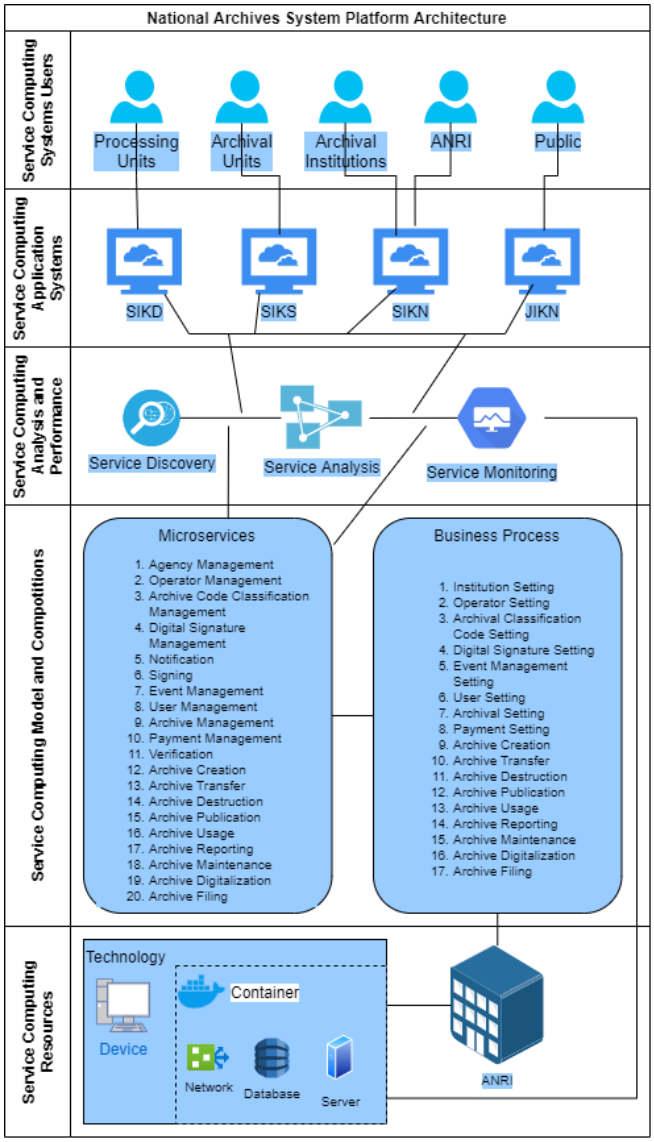

Figure 6 National Archives System Platform Architecture

The database system built consists of two different types of database systems, namely relational and non-relational. Transactional data is implemented using a relational database system, namely MySQL, and UUID is applied as a unique ID for each record in the database to maintain scalability in the relational database system. Meanwhile, for data storage, the uploaded file uses a non-relational database system, namely MongoDB. MongoDB is used to accommodate the ease

of high document scalability and the addition or subtraction of metadata that can be done dynamically in each document.

The microservice-based platform architecture used to build the national archive system is illustrated in Figure 6. Users of this service computing system consist of six types of users, namely processing units, archival units, archival institutions, ANRI, and public. There are four systems directly related to the platform of SIKD, SIKS, SIKN, and JIKN. With the availability of service discovery, outside parties can use services, while analysis and monitoring are needed to record and analyze service availability. The service computing model and composition consist of IT services based on microservices to realize ANRI's own national archival business process.

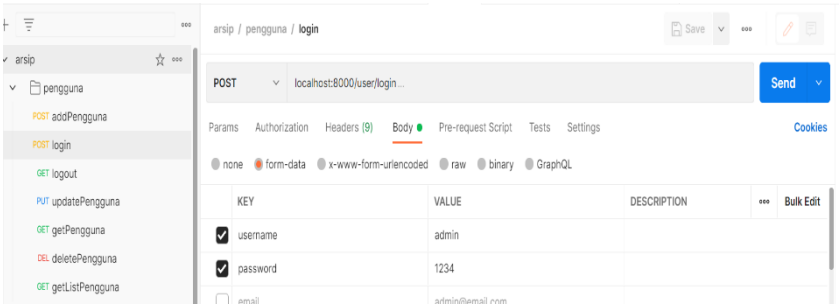

Figure 7 Service prototype

Based on this architecture, service creation is implemented using resources of:

1. Lumen, programming language framework for developing PHP API
2. Gin, programming language framework for developing Go API
3. Navicat, MySQL database manager application,
4. MongoDB Compass, database manager application for MongoDB,
5. Visual Studio Code, IDE application for writing program code,
6. Git, application to perform version control program code,
7. Docker, application for microservice creation,
8. Postman, application to check service functions.

Figure 7 is an example of a user management service testing display using Postman.

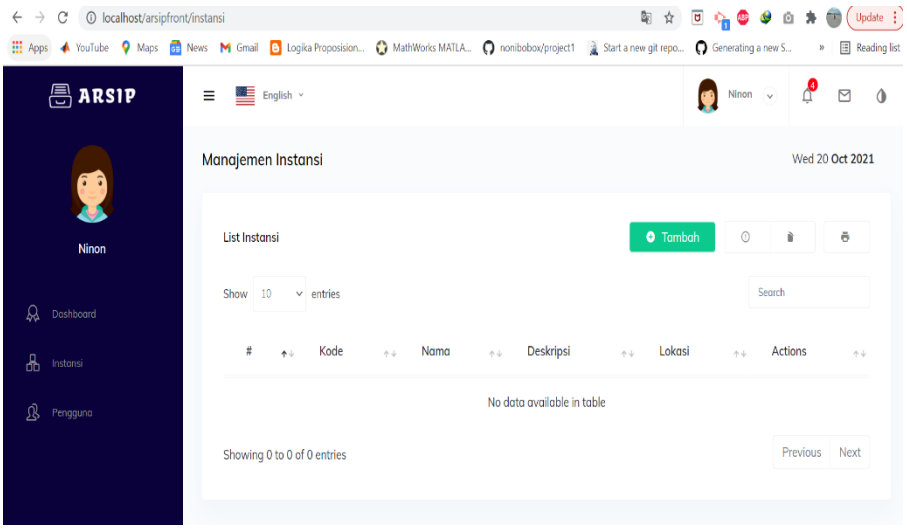

Figure 8 Front-end integration prototype

The microservice that has been built produces output in JSON, so it cannot be used directly by the user easily. Therefore, integration with the interface (frontend) needs to be done in building this platform. Figure 8 shows the application interface to perform institution management.

8 Conclusion

OAIS provides with requirements, considerations, and models to be applied in the archival system to support long run data preservation. It helps designing archival information system of Indonesia to accomplish the technology readiness level and SPBE regulations. The implementation architecture builds based on OAIS reference model by utilizing microservice architecture technology to provides scalability and mitigate single point of failure, and container to provide the auto scaling and easily distribute mechanism for the system, as for the archival security employs digital signature and encryption technique for processed documents. With the implementation of this platform, it is hoped that the data flowing from the archive processing unit in each stakeholder can be integrated. This architecture constituted to enhance current system for better public services.

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