

Toward National One Health Data: Reconfiguring Local Health Information Systems through Enterprise Architecture

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Accepted 13 September 2021

Approved 03 January 2022

Abstract— Indonesian government is currently on the course of nationwide digital transformation, manifested through its ‘One-Data Policy’ recently introduced by top-level government. The initiative also includes the country’s health information systems (HIS) for which various technological choices are under consideration to be implemented. However, such a sound and ambitious initiative often overlook the configurational outlook of local systems where the data is created and aggregated to the national system. This study addresses this concern by exploring the issues pertaining to local HIS and developing its enterprise architecture proposed to reconfigure the existing arrangement of the systems. Using a case study of Palangka Raya municipal health government, this study contributes to this current important agenda by delineating the complexity that occurs at local HIS and proposing a set of enterprise architecture artifacts required toward Indonesian one health data.

Index Terms— Health Information Systems; Enterprise Architecture; TOGAF; Indonesia

I. INTRODUCTION

According to the Law of the Ministry of Health, Republic of Indonesia, Number 92 of 2014, Health Information Systems (HIS) is defined as a set of myriad components that includes data, information, indicators, procedures, devices, technology, and human resources. These components are interrelated and need to be managed in an integrated manner to direct actions or decisions making to support the health system [1]. That being said, Indonesian HIS is not a standalone entity but rather a functional component within the framework of a comprehensive health system. Effective HIS provides supporting information to the decision-making process at all levels of government entities, which WHO regards as effective management tools in healthcare [2].

Following the mandate to implement One-Data Policy in national government practices, the Indonesian health government is currently on the course to enact similar undertaken through One Health Data Policy in HIS. The Ministry of Health develops the policy through 3 main areas: interoperability (data sharing), standardization (improvement of data collection

processes), and accountability (data utilization that drives decision making). The enactment of these areas heavily relies on the strategies and programs in strengthening the HIS, particularly restructuring transaction data at health facilities, optimizing data flow and integration, and increasing the use of data and information [3]. As such, the successful actions toward One Health Data are contingent on the conditions of the current local HIS [4].

This study addresses this issue by investigating the complexity of the conditions of local HIS through a case study in the city of Palangka Raya, Central Kalimantan, Indonesia. We then propose an enterprise architecture for municipal health government as a way to redesign integrated business and information systems architecture of local HIS at the municipal level. As such, this study offers two contributions. First, this study reports the complexity that occurs at local HIS emanated from various applications and tools implemented and deployed at municipal and community health centers (CHC) [4], [5]. Second, this study offers a set of a reference architecture that can be used in future practice related to HIS implementation [3].

This paper is organized as follows. Section 2 describes our research methods, which consists of our framework in developing the enterprise architecture as well as our research design. We present the results in Section 3, structured along the line of the TOGAF framework on architecture development method (ADM). Section 4 concludes the paper.

II. METHODS

A. Framework

To pursue our research objectives, we used the conceptual foundations of Enterprise Architecture (EA) and subsequently its most well-received framework, that is, TOGAF®. In essence, EA relates to how an organization starts and produces a well-defined arrangement and alignment of business, information systems, and technology architecture [6], [7]. EA

supports an organization's actions in managing complex information technology to achieve business goals and objectives and to increase operational efficiency and effectiveness through integration and interoperability [8], [9]. EA can influence organizational management and technology in an organization to develop an information systems blueprint and roadmap [10], [11].

In brief, TOGAF® is a consortia-based EA framework developed by The Open Group, which is widely used to develop a step-by-step organizational EA [12]. TOGAF® contains a set of methodological guidelines in developing EA [13], [14] through Architecture Development Method (ADM), consisting of eight main phases. ADM forms an iterative cycle for the entire process, between phases, and each phase where each iteration a new decision must be made. This is done to determine the scope of the enterprise, the level, target time, and the architecture that will be used in the enterprise continuum.

B. Research design

We conducted a case study [15] in Palangka Raya Municipal Health Office as well as Menteng Community Health Centre (CHC). The primary data was interviews with related parties at municipal government (officials) and CHC (official and healthcare staff), which was aided with direct observations in the field. A total of fourteen participants was interviewed. The interviews were audio-recorded for subsequent data analysis through the permission of the participants. Meanwhile, the secondary data was documents obtained at municipal government and CHC such as reports and other documentation. The field study was conducted over a period of seven months from November 2020 to May 2021. The data that had been obtained was processed and analyzed for the identification of existing architecture, targets and expectations, all of which were used for the development of EA artifacts. In addition, we identified the gap of HIS at the Palangka Raya City Health Office and Menteng CHC to develop a blueprint and identify work projects.

III. RESULT

This section now presents a general overview of the conditions of local HIS in Palangka Raya and the proposed enterprise architecture of local HIS. The architecture is structured based on TOGAF ADM which consists of the preliminary phase, business architecture, data architecture, application architecture, and opportunities and solutions.

A. General overview of Palangka Raya HIS

Currently, no prevalent integrated systems that exist related to the HIS in Palangka Raya Municipal Health Office and its CHCs. All related applications are operating separately for each different program and agency. Also, some reporting is still performed

manually. This causes several issues in the reporting and recording process, such as data redundancy, inadequate technical capacity, and frequent submission delays. In addition, the main purpose of current applications is solely to collect as much data as possible. This causes the workers at CHC as a data source to feel overloaded.

B. Preliminary phase

The preliminary phase is the initial preparation phase in enterprise architecture design needed in preparation for HIS activities to support business needs. In this phase, the architectural principles are identified, consisting of business, data, and application architectures are carried out according to needs, as presented in Table I.

TABLE 1. PRINCIPLE CATALOG OF PALANGKA RAYA HIS EA

| Architecture | Principle | Description |
|--------------------------|-----------------------------------|---|
| Business Architecture | Legal Compliance | Activities at the Palangka Raya City Health Office and Menteng Health Center must comply with the provisions of the Ministry of Health Regulation Number 92 of 2014 and Number 75 of 2014 |
| | Health services | Community health service activities at the Menteng Health Center and its network and the Health Office as a regulator of the health system, as well as health service operators |
| | Public health | Health socialization activities to the community by the Palangka Raya Municipal Health Office and Menteng CHC to improve the health status of the community. |
| | Good documentation | Data and information storage activities from all stakeholders |
| | Sustainable Business Development | All organizations in the Palangka Raya City Health Office and Menteng Health Center are responsible for carrying out operational activities. |
| Data Architecture | Data Transparency | Dissemination of information transparently to stakeholders |
| | Data Assets | Data is an organizational asset that must be managed |
| | Sharing Data | Data can be obtained from users who have predefined access rights |
| | Data Integration | Data on the company can be connected with users who need it for business support |
| Application Architecture | Ease of Application | The application can be used easily by all users |
| | Integration | Applications are interconnected |
| | Usage permissions of applications | Assign access rights for users according to their respective positions and responsibilities |

C. Architecture Vision

The architecture vision phase is a description of the initial phase of the TOGAF ADM cycle. In this phase, the importance of top-level management of the Palangka Raya City Health Office and Menteng CHC is presented to the business value that exists in Palangka Raya. In Table II, the Requirements catalog describes the mapping of the requirements used to meet the objectives. This catalog is needed to provide an objective description of the strategic plans of the Palangka Raya City Health Office and Menteng CHC when changes occur in the business environment.

TABLE 2. REQUIREMENT CATALOG OF PALANGKA RAYA HIS EA

| Capability | Objective | Requirements |
|--|---------------------------|--|
| Improving Public Health Efforts | Health Information System | Improving the quality of health data and information |
| | | Develop the provision of information on IT applications/systems to the public |
| | | Develop an effective and efficient delivery of health information |
| Improving the quality of health services | | The health service process runs effectively and efficiently to improve quality |
| | | Developing equitable health service coverage |
| | | Develop an easy health service process |
| | | Developing health standards |

On the other hand, the solution concept diagram illustrates the overall overview of the proposed architectural solution to be implemented based on the analysis of the target needs of the Palangka Raya City Health Office and Menteng CHC, which are presented in Figures 1 and 2 respectively.

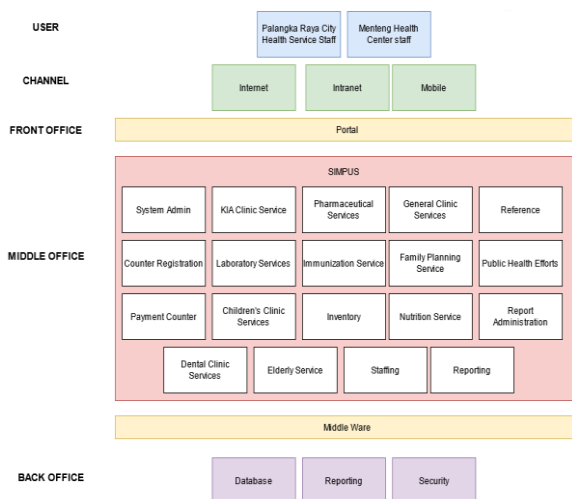


Figure 1. Solution Concept Diagram for CHC

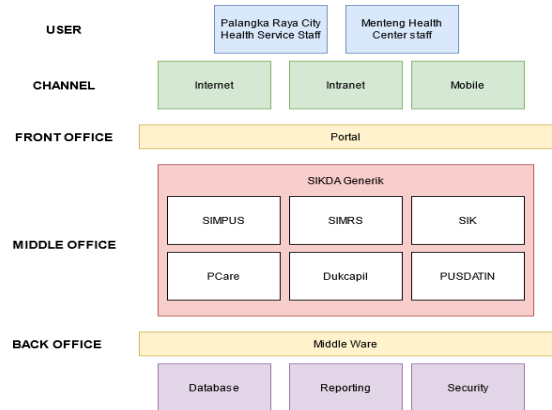


Figure 2. Solution Concept Diagram for Municipal Health Government

D. Business Architecture

The business architecture is a phase that delineates the organization's needs in carrying out its business functions to achieve the desired target. This phase describes how the target businesses interact with each other. This goal/objective/requirement catalog, as shown in Table III, presents the relationship between goals, objectives, and requirements. This catalog serves to fulfill the function objectives and identify the need to achieve the objectives of the Palangka Raya Municipal Health Office and Menteng CHC to improve their business processes.

TABLE 3. GOAL/OBJECTIVE/REQUIREMENT CATALOG OF PALANGKA RAYA HIS EA

| Goal | Objective | Requirement |
|---------------------------------|--|--|
| Improving Public Health Efforts | Improving nutritional status, maternal and child health | Improving nutrition and health of mothers and children in the community |
| | Prevention and Control of Communicable and Non-Communicable Diseases | Improving prevention programs for communicable and non-communicable diseases |
| | Health quality improvement | Reducing health problems related to people's behavior |
| | Increase community independence in health | Increase public awareness of health |
| Improving Health Services | Implementing health sector standards | Implementing good health standards in health services |
| | Improving public access to health services | Improving access to health services and information evenly throughout the community in all regions |

Table IV, on the other hand, presents the service catalog which maps the requisite service that exists in the function according to the needs or requirements of that function. This service catalog outlines the key public health service enacted by local health facilities to population related to particularly in health data management and reporting.

TABLE 4. SERVICE CATALOG OF PALANGKA RAYA HIS EA

| Service | Requirement |
|-------------------------------------|--|
| Improvement of Public Health Status | Improving public health status by optimizing health information systems |
| Health Service Operations | Improving the quality of public services by optimizing the health information system |
| Application/IT System Development | Development of IT applications/systems to improve the quality of integrated health information systems at the Palangka Raya City Health Office and Menteng Health Center |

E. Data Architecture

The data architecture describes the data types and data sources needed in the development of the enterprise architecture to meet the needs identified in the business architecture phase. In this phase, the data entities relevant to the organization are determined. As shown in Table V, the data architecture requirements identify the data needs of the Palangka Raya Municipal Health Office and Menteng CHC.

The conceptual data diagram, as presented in Fig. 3, describes the relationship between data entities. This artifact presents the target conditions in the data architecture of the Palangka Raya Municipal Health

Office and Menteng CHC, in which it proposes an integrated data flow between CHC and Municipal Health Office. The flow of data in an integrated fashion makes it easier for the Municipal Health Office as the superordinate of CHC to carry out monitoring and evaluation more efficiently and effectively. The integration specifically includes the Generic Regional Health Information System (SIKDA) and CHC Information Systems (SIMPUS).

TABLE 5. DATA ARCHITECTURE REQUIREMENT OF PALANGKA RAYA HIS EA

| Capability | Objective | Requirements |
|--|---------------------------|---|
| Improving Public Health Efforts | Health Information System | Improving the quality of health data and information |
| | | Improve integrated data management |
| Improving the quality of health services | Health Information System | The data can be used by users who have the authority that has been set |
| | | Improve the process of sending data to the top level more quickly and effectively |
| | | No data duplication |
| | | Eliminate manual reporting and recording |

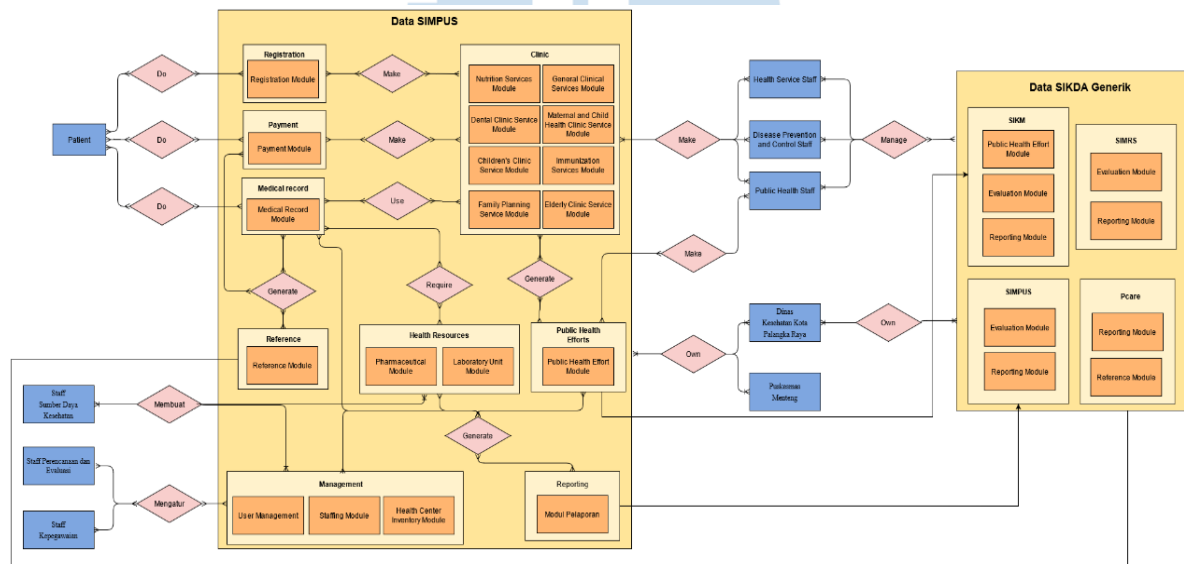


Figure 3. Proposed Conceptual Data Diagram

F. Application Architecture

Application architecture depicts the application systems needed to process data and support businesses. This phase aims to define the type of application and the integration between these types to support the business processes of the Palangka Raya Municipal Health Office and Menteng CHC. Application Architecture Requirements, presented in Table VI, identifies the requirements for the HIS applications.

TABLE 6. REQUIREMENT CATALOG OF PALANGKA RAYA HIS APPLICATIONS

| Capability | Objective | Requirement |
|--|---------------------------|---|
| Improving Public Health Efforts | Health Information System | Applications can provide real-time reporting recaps. |
| | | Applications can manage and validate data in real-time |
| Improving the quality of health services | Health Information System | The application is able to facilitate the duties/work of employees in carrying out health service activities. |
| | | All applications used are interrelated and connected both at the Palangka Raya City Health |

| Capability | Objective | Requirement |
|------------|-----------|--|
| | | Office and Menteng Health Center |
| | | Assign access rights according to the level of authority according to the position and responsibility for each user. |
| | | Applications ease of use |

Currently, there are 18 applications used by the Health Office and HIS in recording and reporting. The existing, SIMPUS application has not been fully implemented. It is only used for reporting and

recording employees' data, which is integrated with other applications namely SIMPEG (HR IS), SISKAS (Performance Monitoring IS), SIMSKP (MIS), and Renbut SDK applications (Health Resources IS). Other interconnected applications are SIGIZI and E-PPGBM (reporting for nutrition). These existing applications are operated separately and not integrated. Therefore, an interconnected system is proposed as presented in the application communication diagram in Figure 4.

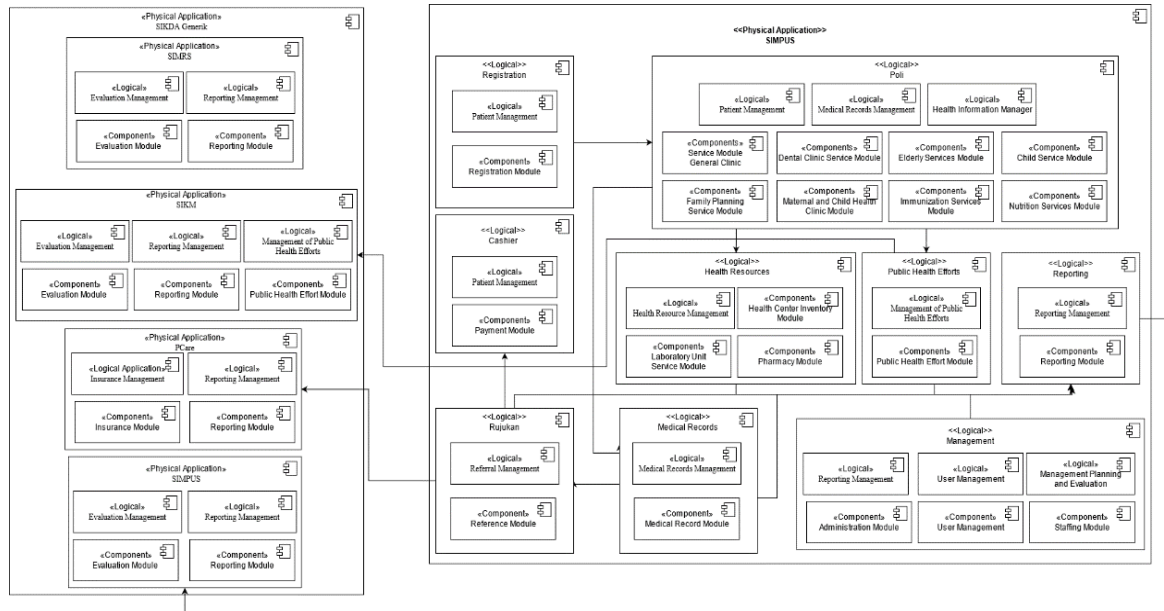


Figure 4. Proposed Application Communication Diagram

G. Opportunities and Solution

The proposed EA, in this study, proceeds to the phase of Opportunities and Solution. Opportunities and Solution is a phase that delineates the evaluation of the architectural design from previous phases which serves as the basis for preparing an implementation plan to achieve the architectural design objectives. Table VII identifies the required projects for the Palangka Raya Municipal Health Office and Menteng CHC along with the possible options for executing them according to the results of the identification of the gaps that have been carried out. The identified projects also serve as the basis for the roadmap of implementation of HIS EA.

TABLE 7. PROJECT CATALOG FOR PALANGKA RAYA HIS EA

| Project | Sub-project | Service/Application |
|--|---|---|
| Integration of Municipal Health Information System | HIS for 'in-room' (e.g., doctors' room) and 'out-room' (e.g., field workers, cadres) of CHC | Sistem Informasi Manajemen Puskesmas (SIMPUS) and Sistem Informasi Kesehatan Daerah (SIKDA) Generik |
| | Integration of CHC and municipal government system | |

| Project | Sub-project | Service/Application |
|---|---|------------------------|
| | Information services that are publicly accessible | Health Open Government |
| Implementation of Management and Governance | Implementation of international standards of management and governance (e.g., ISO 20000) | N/A |
| | Implementation of information security management and governance (e.g., ISO 27000 series) | |
| Skills development | Capability development for officials and staffs | N/A |

IV. DISCUSSION

This study aims to explore issues that emerge at local HIS with regard to Indonesian goal on nationwide one health data and to propose a set of enterprise architecture artifacts as a way to reconfigure such local HIS. Overall, we have attained the study's objectives through identifying the architectural principles and the subsequent artifacts using TOGAF as our methodological framework.

A. Research Implications

This paper offers key lessons to current literature and practices. First, in line with an early discussion [3], this study provides an empirical example of the multiple overlapping information systems in district health information systems, prompting the need to conduct an architectural analysis of such systems. Using the case of the municipal health system of Palangka Raya, our study presents an ongoing complexity of national monitoring and reporting systems in Indonesia in response to recent calls on better health data management in developing countries [1], [16].

Second, this paper shows how enterprise architecture can be used to decompose the complexity in the overlapped and dispersed HIS in the local setting and subsequently to provide a basis for policymakers in reconfiguring systems. Ultimately, the development of architectural artifacts ranging from business, data, application, to technology domains, offers a well-aligned approach so that the solutions, as identified in the opportunities and solutions phase, are in line with key objectives in health data management [11].

B. Practical Implications

This paper offers practical implications to those districts who now pursue healthcare digitalization and, further, integration. Specifically, the Opportunities and Solution phase of our study consolidates and proposes executable projects for stakeholders in the district health government. As presented in Table VII, nine sub-projects are proposed: 1) HIS for 'in-room' (e.g., doctors' room) and 'out-room' (e.g., field workers, cadres) of CHC, 2) Integration of CHC and municipal government system, 3) Information services that are publicly accessible, 4) Implementation of international standards of management and governance (e.g., ISO 20000), 5) Implementation of information security management and governance (e.g., ISO 27000 series), 6) Capability development for officials and staffs. Even though the relationships between the present paper with health government's objectives are beyond our study, the subsequent artifacts based on TOGAF's phases (e.g., benefits diagram) could extend the current architectural propositions.

V. CONCLUSION

In this study, we have conducted a study aimed to identify the conditions of local HIS of our case and to develop Health Information Systems Enterprise Architecture to prepare for Indonesian One Health Data. In business architecture, this study identifies several business processes that require reconfigurations to optimize the municipal process regarding public health status and health service operations. In the information system architecture phase, this study proposes the integration of substantial data and application integration encompassing the 18

applications that currently operate separately across Palangka Raya Municipal Health Office and Menteng CHC. This study concludes with the opportunities and solutions phase in which it identifies potential projects that can be used by related stakeholders in the respective local government toward achieving integrated local HIS.

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