Designing of IT master plan based on TOGAF ADM framework in the regional water utility company

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Abstract. This study was conducted to generate an Enterprise Architecture planning using The Open Group Architecture Framework (TOGAF), Architecture Development Method (ADM) Framework through phases from Preliminary, Requirement Management, Architecture Vision, Business Architecture, Information System Architecture, Technology Architecture, until Opportunity and Solution. Contribution of Information Systems and Information Technology were required by companies to provide an easy way in the exchange information systematically within the company, and its application was in line with the company's business goals. However, there were still found a company where this case study was conducted that had not yet comprehensively considered the implementation of it. This indicated that the implementation of Information Systems and Information Technology within the company are not well planned. Research conducted was a case study that paid attention to a particular case conducted on individuals or organizations as a study material. In the case study, research was focused on finding and collecting data on research objects to provide solutions to problems that are happening so that this research is descriptive and exploratory. This study, resulting in the IT Master Plan, consists of enterprise architecture planning to overcome the existing problems through the proposed solution concepts in modularity, integrated systems, standardized platforms, and service-oriented.

Keyword: Regional Water Utility, Enterprise Architecture, TOGAF ADM, Business Process Integration, Enterprise Resource Planning (ERP), Service Oriented Architecture (SOA)

1. Introduction

The provision of clean water is important because it is the main basic needs consumed by the community [1]. Usually, there is an official agency to implement it selected by the government authority, such as the water utility company in the regency areas. It is in order to provide water resources, to process the quality, to distribute to customers, and to ensure the water could be consumed, provide correct meter reading, billing, and other services [2]. Currently, the role of information systems and information technology cannot be separated to provide support and make an easy to the business process of the water supply system [3]. Information technology has excellent opportunities to improve and strengthen the governance process of drinking water supply systems. These include creating accountability, providing information that is accessible and relevant, expanding

networks, and making it possible to share knowledge and develop partnerships between stakeholders. [4].

However, there are still many companies that have not considered the implementation of information technology and information systems comprehensively. So they have not been able to provide optimal support for improving company performance. One of them is the regional water supply company, where the study was conducted. This company has been up and running for a long time, but the existence of its business processes to date is still indicated by the existing business processes which are still done manually and not integrated. Moreover, there are still some information system applications along various supporting information technology devices and platforms within. The existence of such a system or known with the legacy system [5], is identified by separate applications from one another, accompanied by many and scattered data islands within the organization. This separation has an impact on low data availability; besides that, consistency and effectiveness of data provision are unable to be reached. This condition makes the information system unusable in accordance with its mission of providing and processing information effectively for organizational units that need it. This indicated that the development of information systems is not well planned.

According to [6], developing a good information system must be seen from a variety of systems development perspectives, starting from defining architectural aspects on business, data, and application until technology that provides support for the information system network. That is why conformity in the implementation of information systems to the company business process needs will be able to be explained by taking into consideration aspects in the integration of the system development process to reduce the gaps that may take place. Enterprise Architecture (EA) is a paradigm in planning, designing, and managing information systems in order to achieve the availability of well-formatted data, acceptable integrated applications, and supporting technologies that can be fulfilled [7][8]. EA conducts an important aspect for an organization where the existence of user-oriented front-end applications and the need to be connected to several back-end applications. It has placed the enterprise architecture as a need to integrate services and applications [9][10]. Moreover, EA is considered a blueprint in an organization that guides the business direction, information systems, and information technology [11][12].

2. Literature review

Enterprise Architecture (EA) is a series of heterogeneous and integrated organizational processes that propose obtaining and increasing harmony between the business process and the application of information technology in an organization or company [10]. It can typically be explained in regards to a four-stage consecutive process. These include to register the existing condition of the company (*as-is*), establish the destination of the organizational needs to achieve (*to-be*), to analyze gaps between baseline conditions and targets, and then promote a transformation plan or roadmap, which provide a picture how to shift from present circumstance into prospective conditions ahead, and implementing the transition plan [7][8]. An EA's presence becomes a necessity and priority, especially when the company business process operational becomes large and more complicated [13].

At present, many frameworks are used by companies as a reference in designing the EA [14]. Some frameworks that are quite widely used today include Zachman Framework [15], Federated Enterprise Architecture Framework [16], and The Open Group Architecture Framework [17]. In practice, there is no perfect framework that can be used as a reference because each has advantages and disadvantages. Besides, the use of the framework in each company can differ depending on the existing business processes, the characteristics of the company itself, and the main focus to be achieved. Each EA framework differs in terminology, approach, and detail structure. Several propose as instruction or guideline while another has a methodology and specific term of reference to be followed. Most frameworks are abstract because of their general nature, where the validity and capability to perform accurately is called into question.

This study conducted refers to several enterprise architectures planning with the background of case studies and the methodology used. Research is conducted on the design of information technology architecture using the Business System Planning analysis method introduced by IBM, combined with the Zachman framework [18]. The research was then conducted by adopting EA planning that applied Zachman's framework as a method in designing information technology architecture [19][20]. Furthermore, research was conducted using the TOGAF Framework as a method in arranging information technology architecture [21][22]. The final results of all these studies produce an Information Technology architecture blueprint as a manifestation of the company's strategic information system strategic plan. Based on several methods used in EA planning in previous studies, the TOGAF framework has advantages in explaining the architectural design process thoroughly in terms of business and information technology compared with the Zachman and the Four Types of Enterprise Architecture Framework (FEAF). So, the TOGAF framework is considered appropriate for use as a method of EA planning in this study due to having an advantage in principles. It provides to support decision-making throughout the organization function, provides to IT capability guidance, support to architecture principles for arrangement and practice purpose.

TOGAF contributes to methodology elements of how to design, govern, and conduct an EA planning known as Architecture Development Method (ADM) [23]. This comprehensive mechanism accommodates phases used in the development model of EA planning. It is as guidance or reference for the plan, design, development, and implementation of information systems architecture within an organization [24]. Conforming to the TOGAF ADM methodology standard, the early step considered is defined as the formation by identifying the architecture context. It will be constructed, then defined the architecture strategy, and determine the architecture elements that will be designed, initiated from Preliminary, Requirements Management, Architecture Vision (Phase A), Business Architecture (Phase B), Information System Architecture (Phase C), Technology Architecture (Phase D), Opportunity and Solution (Phase E), Migration Planning (Phase F), Implementation Governance (G), then Architecture Change Management (Phase H). A study on business process integration is about implementing business process automation at the company level, which needs to pay attention to architectural planning to obtain the improvement of business optimally [25]. While information technology solutions to automate business processes refer to the results of research conducted by applying the concept of solutions to business processes that are managed manually by utilizing application software based on Enterprise Resource Planning (ERP) [4][26][27]. An automated business process will make all the units involved in it connected to simplify and speed up the work. Besides, the output produced by the information system becomes more optimal that contributes to more appropriate decision making for the organization effectively and efficiently. ERP is an enterprise planning system application that consists of several integrated software modules as a support system for its business processes [28].

The service-oriented architecture (SOA) approach is also applied at the architecture design stage as a concept solution for the integration mechanism that affects the IT architecture design in elements of the information systems, technology, and infrastructure. The SOA design created is influenced by existing services in applications formed from existing applications (legacy systems) and solutions for application systems by implementing open source ERP modules. Through application integration, a process of integrating a variety of independent applications to share data and processes carried out without making changes to the application and data structure through web services and middleware. It is in order for organizations can develop systems through modules that are easier and simpler [10][11][29].

3. Research method

Research conducted is a case study that pays attention to a particular case conducted on individuals or organizations as a study material. In the case study, research is focused on finding and collecting data on research objects to provide solutions to problems that are happening so that this research is descriptive and exploratory [30].
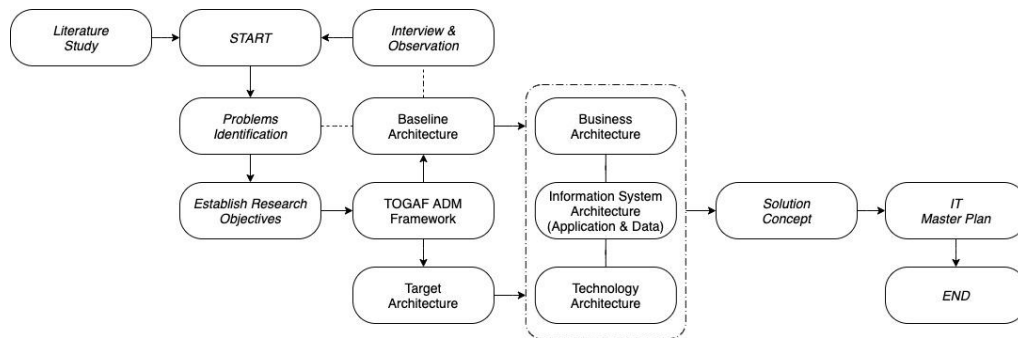
Figure 1. Research Framework

EA planning process was conducted in this study following the basic structure phases in TOGAF ADM. Figure 1 illustrates a research framework following steps: 1) Searching of theoretical references through literature study; 2) Conducting of an interview with stakeholders and business process study through an observation; 3) Summarizing of problems identification based on finding in the previous step; 4) Establishing of research objectives to be achieved; 5) Conducting analysis based on artifacts used in the TOGAF ADM [17] phases in the representation of the existing architecture and destination architecture; 6) Reviewing a concept solution in accordance with mapping of architecture principles and business requirements; 7) providing an IT master plan consist a solution platform to become candidates nominated on the migration and implementation planning roadmap. This study framework methodology with refers to the phases in TOGAF ADM as included in a) Steps in point 2, 3 and 4, is an initial process with regards to phases on Preliminary, Requirements Management, and Architecture Vision (Phase A); b) Steps in point 5, is constitutes the examination process of the existing architecture (baseline) and destination architecture (target) in conjunction with a gap analysis which refers to following phases on Business Architecture (Phase B), Information System Architecture (Phase C), and Technology Architecture (Phase D); and c) Steps in point 6 and 7, is producing of solution concept platform and generating of an IT Master Plan which is following with regards to phase on Opportunity and Solution (Phase E). At the same time, the last three phases are excluded from this study.

4. Results and discussions

In the Preliminary phase to build an EA related to TOGAF ADM phases, it includes in establishing of Architecture Principles, examining Requirements Management, and formulating Architecture Vision. Architecture Principles are established as a reference for the architecture landscape to be built and ensure that the personnel involvement will be led to accomplish the enterprise architecture planning success. Architecture principles consist of a) Shortened Process; b) Increased Monitoring; c) Centralized Process; d) Secured Information; e) Consolidated Platform; f) Integrated System; g) User Friendly; h) Service Orientation; i) Interoperability; and j) Identity and Access Management. Whereas Requirements Management is required to provide an overview of what conditions are expected by stakeholders in enterprise architectural planning. It consists of a) Achieve to the company's economies of scale obtained through business process improvement; b) Delivery of services that meet the standards service excellence, c) Improve the capability for monitoring of all operational activities within the company, d) Accomplish to digital transformation by business process integration and automation in a transparent and accountable manner. Furthermore, in the Architecture Vision phase, there are the company's goals, what must be done, and accomplished in a notably and comprehensively manner. Regarding the shape, it then required a company business model identification through value chain analysis. It can assist in providing a wide picture of each organizational functions and business activities. Defining a value chain diagram in Figure 2 to model

the company functional areas consist of primary activity and support activity as the initial stage in enterprise architecture planning to identify which area concern to be improved. Based on the value chain diagram, the company's primary business activities currently come from three main process functions. It consists of Production Management, Transmission and Distribution Service, and Managing of Marketing and Customer Service. While supporting activities for these primary activities come from such as managing of accounting and finance, human resources management, and another activity support process related to general affairs, procurement and logistics, and support activity to deliver of IS / IT services within the company.
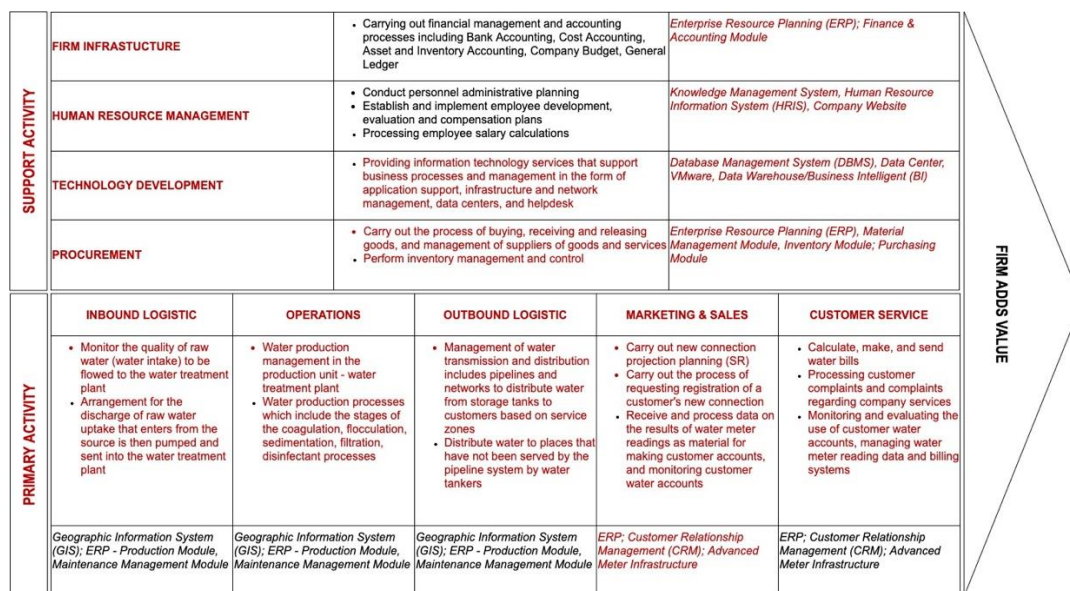

Figure 2. Value Chain Diagram

Depart from the analysis of the value chain and identifying the business processes in every organizational function in the company, then the solution concept is proposed based on the problems faced by stakeholders who identify the existence of the business process is still done manually and not integrated. Furthermore, it is also found that there are still information systems and technology applications consist of various platforms and appliances that are not aligned with the needs of the company's business processes. Table 1 provides of summary of architectural aspects on Business, Information System, and Technology with regard to consecutive process including to register the existing condition of the company (as-is), establish the destination of the organizational needs to achieve (to-be), and then promote a transformation plan in a prospective IT/IS solution

Table 1. Summary of Company's Architectural Aspects on Business,
Information System and Technology

No.	Baseline Condition	Target Improvement	IT/IS Solution Patterns
1.	Existing business processes are still being done manually and without regard to the needs of business processes in	Digital transformation is integrating and automating business processes in the framework of managing a water utility system. The development	ERP system application which consists of several integrated software modules as support system to the company's business

	other functional units. Each application system has its own database and is not centralized so that duplication of data sources occurs, which causes the redundant data and makes the data out of sync.	of resource sharing data configuration needs to be applied to the application system.	processes, such OpenERP. It is built using modular architecture and open source technologies. Featured in OpenERP is packaged in an independent module thereby making it easy for users to install modules as needed.
2.	Integration mechanism unavailable that accommodates interoperability between applications on different platforms.	The integration mechanism is carried out by taking into account the effectiveness and efficiency through developing SOA based integration architecture using services in the middleware section.	Implementation of Enterprise Service Bus (ESB) approach which makes integration complexity lower because integration is loosely coupled.
3.	The function of monitoring business processes performance at the enterprise level is not available.	A performance monitoring system and the availability of real-time information are fundamental to support the success of the company's strategic management process, namely in the form of an Enterprise Dashboard Management System.	Building a data warehouse mechanism which is the key enabler of a business intelligence to improve the quality of business decision support system. Enterprise dashboard management system is a platform to meet the needs of reports that have not been provided by ERP.
4.	Unavailable standards for managing and implementing Data Centers infrastructure Unavailable Disaster Recovery Center facility	Implementation of Data Center and DRC to ensure business continuity.	Provide of Data Center infrastructure, and for DRC Server with consideration of the use of Cloud Provider (DRaaS).
5.	The application of identity management and access is not yet available for security of data, application, and network traffic	Improving the level of data security by standardizing data security and database access authentication.	Configuration setting of Single Sign On (SSO) and Lightweight Directory Access Protocol (LDAP).
6.	There is only a physical server that handles applications, networks, operating systems, and is not worth the resources used	Optimize server capacity and automate all data center resources.	Utilizing a server with virtualization functions such virtual machine technology that enables hardware consolidation, easy system recovery, and running software.
7.	Process of backup and restore data is done manually by an external vendor and is not done periodically	Provide a backup and restore data system and infrastructure data resource sharing is needs to be implemented	Utilization of the system in cloud storage that provides services for use in storing data by utilizing third-party servers as service providers

The solution concept in the enterprise architecture planning to be built must be able to overcome the existing problems through the proposed concepts in the form of modularity, integrated systems, standardize platforms, and service-oriented. Modularity has a system characteristic in which a system is developed into several programs called modules that will provide convenience for users when experiencing constraints identify with a specific program; then, the enhancement will be pointed on that problem. The integrated system as a series of processes that interrelated all systems and applications to data retrieval will become simple and uncomplicated. Standardize platform is used to simplify the process of system and technology development and maintenance. Service-oriented is an architecture that supports various applications to exchange data and is not tied up into the operating system and programming language that underlies these applications.

The application landscape illustrated through Figure 3 is constructed based on mapping made through a technical reference model (TRM). The proposed application system package is required in the architecture principles and to accommodate the needs of stakeholders (management requirements) to realize the vision of the company's architecture. The application landscape is an illustration to overview the relationship between planning and design and managing the company's architecture by taking into account the balance between service needs and the maintenance of existing resources within the company.
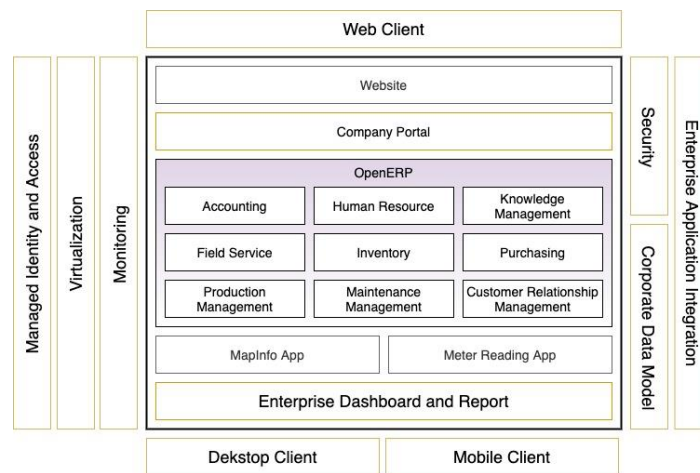

Figure 3. IT Architecture Landscape

Based on the selection of OpenERP modules and the proposed application, it is then developing an IT architecture platform. It is figured at each application layer consisting of *a) Client Interface; b) Network; c) Application; d) Application Integration; and e) Database*, as illustrated in Figure 4.
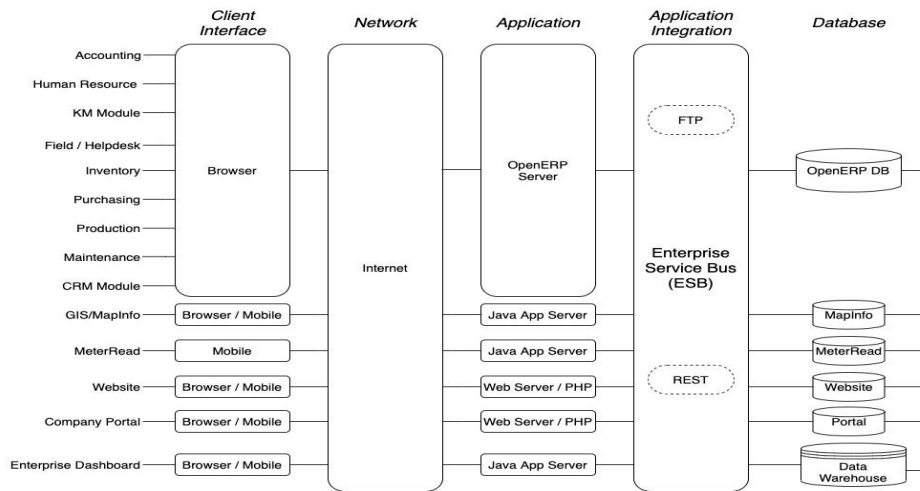
Figure 4. IT Architecture Platform

The integration mechanism is carried out by taking into account the effectiveness, efficiency, and mapping of technology architecture with the architectural principles. There are two possible approaches for the overall system integration mechanism, namely the point-to-point application and the implementation of an enterprise service bus (ESB). In REST, if the integration mechanism used is a point-to-point application, a format that other applications must also know is needed so that the application can communicate. The difference in format causes the need for modifications to the application. However, if the integration uses ESB, the application can use the existing format. If there are differences, adjustments are made to the ESB so that applications can continue to communicate and do not need to make changes to the application. Whereas in FTP, if the integration mechanism used is a point-to-point application, a separate FTP server implementation is needed. However, if we use ESB, the server is integrated into ESB. The use of ESB makes integration complexity lower because integration is loosely coupled. The use of ESB in terms of flexibility is very high because ESB provides data transformation functions. So one data source can be used by many other applications even though each application requires a different format. Thus, in general, it appears that ESB is better when compared to the point-to-point application mechanism. From these results, the integration mechanism proposed in the concept of this solution is the implementation of ESB. Based on the illustration in Figure 4 above, it can be seen that the position of ESB is in the middle, which functions as a middleware. Its task is to unify the process by connecting and distributing data to applications that require data sources in other applications. At the same time, implementation of a data warehouse is needed for configuration at the back end, wherein the process of forming it is known as the ETL (Extraction, Transformation, Loading) process. This ETL process is a process that must be passed in a data warehouse configuration consisting of data extraction, data transformation, and data filling. This data warehouse has the function to process master data history and transactional warehouse, which will then produce information to be predicted and analyzed in the future. The data warehouse is a key enabler of Business Intelligence that concept utilizes technology such as a decision support system application that is configured in the form of a dashboard or report to improve the quality of business decision making based on systems that can be accessed easily.

In the Opportunity and Solution phase, the concept of solutions available in the IT master plan that helping functional units involved in the company will easily coordinate and accelerate the completion of work. The benefits diagram illustrated in Figure 5 shows the opportunities identified in the enterprise architecture planning, which are classified based on features, impacts, benefits, indicators, and determining objectives. This benefit diagram is used by stakeholders to make choices and decisions based on the identified opportunities for consideration of implementation. This

enterprise architecture planning as a whole will be led to the achievement of service excellence, the economics of scale, and targeted KPI.
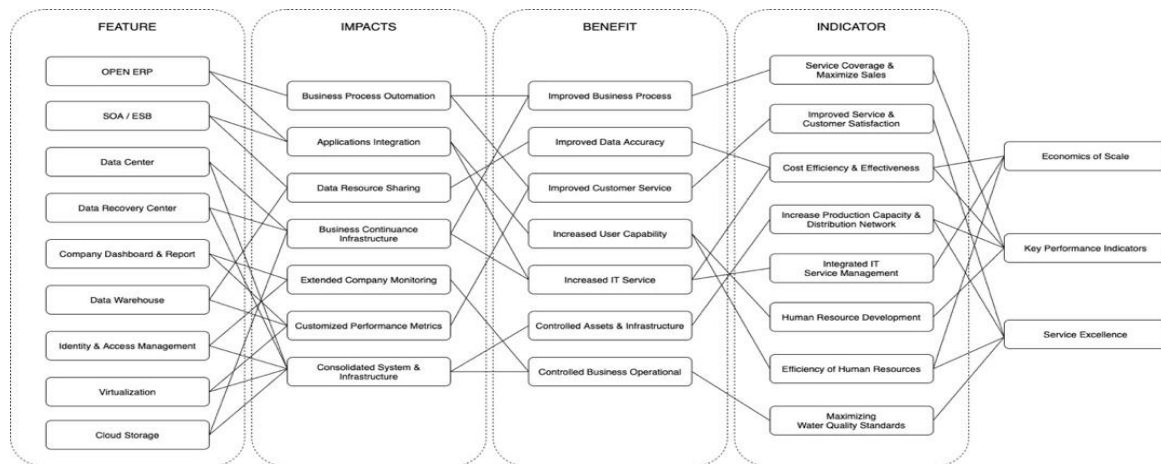

Figure 5. Benefit Diagram

5. Conclusion

The conclusions drawn from the results of this case study conducted through the TOGAF ADM approach are:

1. Targeted condition to automate and integrate company business processes has been achieved with the enterprise architecture planning produced in accordance with established architecture principles and following management requirements.
2. Based on the discussion of the baseline architecture conditions result that, for the data architecture consists of data are identified that are used for business process needs. It is found that data sources duplication that causes data to overlap (redundant data); for application architecture, there is no integration mechanism in the existing applications. For technology architecture, there is no implementation of Data Center or DRC management infrastructure, data backup and restore system, data warehouse, security management, and data access authentication.
3. Based on the solution pattern and through mapping of technical reference models that are adjusted to the principles of architecture, the target architecture solution platform to become a candidate who will later be focused on the migration planning roadmap including a) Implementation of the application is based on the OpenERP modules; b) Development of SOA-based infrastructure; c) Data warehouse implementation as a key enabler for decision support system applications; d) Utilizing of virtual machine technology that enables hardware consolidation and running software; e) Implementation data center infrastructure facility; f) Implementation of Data Recovery Center (DRC) Server and storage system with consideration of the use of Cloud Provider; g) Upgrade company website and design web portal; h) Improving the level of data security by standardizing data security and database access authentication through the setting of SSO/LDAP.

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