Strategic Information Systems Planning Using The Togaf Architecture Development Method

M Sidiq[1], I D Sumitra[2]
[1]Postgraduate of Information System Department, Universitas Komputer Indonesia, Indonesia
[2]Management Information Department, Universitas Komputer Indonesia, Indonesia

Email: [1]maulanasidiq1304@gmail.com

Abstract. This paper proposed TOGAF to develop enterprise architecture at the University of Galuh Ciamis due to a sharp increase in the number of students. This development must keep in line the business goal and information system used in University to support all business function. The framework to develop architecture was the TOGAF Architecture Development Method (ADM). The model developed in this research could be used as guidance to develop the next enterprise architecture. The step of activity in TOGAF such as Business Architecture, Data Architecture, Application Architecture, and Technology Architecture. In the Data Architecture Model, all data principle were taken account such as data is our asset, data must be shared, data could be accessed, data security, data definition. Applications Architecture takes account of all application principle such as application is Technology Independent and easy to use. And the last in Technology Architecture we take account all Technology Architecture principle such as a change based on need, quick response to change, interoperation. The proposed enterprise architecture model is guidance for University of Galuh Ciamis to develop its enterprise architecture while keeping in line with business strategy.

1. Introduction

Currently, information technology, computers, and telecommunications have a revolutionary impact and structured as had been previously thought. Enterprise architecture is a tool or strategy to support business processes and to achieve business goals [1]. At this point, the development of technology in the education sector especially in the private higher education institutions already competes in providing services to users. One of them is the University of Galuh Ciamis (UNIGAL) that must compete in developing their own technology. This factor becomes the main background UNIGAL already should make strategic measures to increase the competitiveness of the technology against other universities. However, the development that has been done is not able to meet the needs of the business. Information systems many of which have not yet woken up, it can be seen from some systems are not integrated. The process of development that was not based on a strategic plan that resulted in the direction a purpose is not clear. IT blueprint is the result of the merger of the business architecture, applications and technologies become the reference on the development of information systems. One of the benefits of using enterprise architecture is to reduce operational costs and improve congruence between business and information technology [2].

In this study, University of Galuh Ciamis has not integrated information systems of the primary and supporting activities. Therefore, it requires an adaptation of the model a specific framework for achieving the Organization's architecture are integrated to achieve the target. It is proved by the lack of application of information technology for the daily operations and the absence of a strategic plan or a certain framework to support the business architecture of the organization [3]. The strategic plan of the information system is regarded as computer portfolio identification process with application-based in the purpose to help the organization to run the business plan and achieve the business goals [4].

TOGAF is a framework and method for enterprise architecture that provides the methodology to analyse a business architecture overall [5]. The advantages of using TOGAF are flexibility and open source [6]. The goal of the research is to create a suggestion to adopt enterprise architectural model by using the TOGAF framework. It aims to synchronize the purpose of the business and the information technology so that it runs effectively and efficiently. The result of TOGAF methodology is design and blueprint in order to develop an integrated information system [7]. The advantages of using TOGAF are flexibility and open source [8]. Working based on TOGAF ADM would have a clear step on how to develop the best architecture. The good enterprise architecture will guide the University to achieve the vision and mission and the strategic goal. The output of this redefining of enterprise architecture was the blueprint of Information System development. The blueprint of this Information System Development was holistic which regarding all the unit or component in the campus not partially or only for a certain unit.

2. Methods

TOGAF ADM has eight steps to do such as; Architecture Vision, Business Architecture, Information System Architecture, Technology Architecture, Opportunities and Solutions, Migration Planning, Implementation Governance and Architecture Change Management [9], [10]. These steps are shown in Figure 1. Architecture Vision has an objective to align the opinion of how important to have enterprise architecture to achieve the objective or the goals of the organization in a strategic form and to limit the scope of architecture that will be developed.
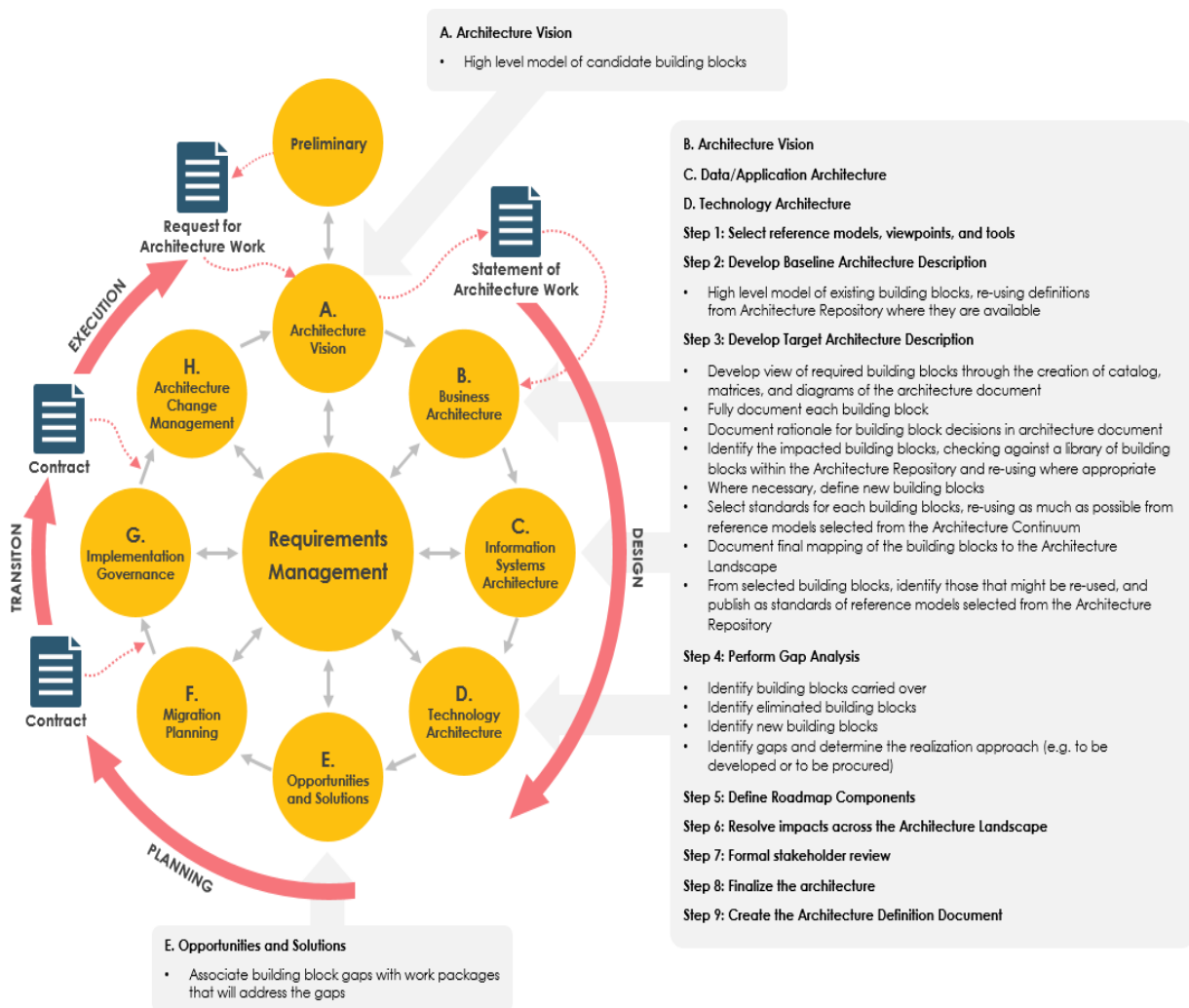
A. Architecture Vision
- High level model of candidate building blocks

B. Architecture Vision

C. Data/Application Architecture

D. Technology Architecture

Step 1: Select reference models, viewpoints, and tools

Step 2: Develop Baseline Architecture Description
- High level model of existing building blocks, re-using definitions from Architecture Repository where they are available

Step 3: Develop Target Architecture Description
- Develop view of required building blocks through the creation of catalog, matrices, and diagrams of the architecture document
- Fully document each building block
- Document rationale for building block decisions in architecture document
- Identify the impacted building blocks, checking against a library of building blocks within the Architecture Repository and re-using where appropriate
- Where necessary, define new building blocks
- Select standards for each building blocks, re-using as much as possible from reference models selected from the Architecture Continuum
- Document final mapping of the building blocks to the Architecture Landscape
- From selected building blocks, identify those that might be re-used, and publish as standards of reference models selected from the Architecture Repository

Step 4: Perform Gap Analysis
- Identify building blocks carried over
- Identify eliminated building blocks
- Identify new building blocks
- Identify gaps and determine the realization approach (e.g. to be developed or to be procured)

Step 5: Define Roadmap Components

Step 6: Resolve impacts across the Architecture Landscape

Step 7: Formal stakeholder review

Step 8: Finalize the architecture

Step 9: Create the Architecture Definition Document

E. Opportunities and Solutions
- Associate building block gaps with work packages that will address the gaps

Figure 1. The TOGAF ADM Cycle [9]

3. Results and Discussion

The flow stage of the TOGAF Architecture Development Method modelling must be done to create a blueprint for aligning IT infrastructure and solutions for technology to be built in the future. The following are the results of each phase using the TOGAF Architecture Development Method.

3.1 . Preliminary Phase:

The scope of the University of Galuh Ciamis modelled using the value chain Michael Porter [11], which consists of the primary and supporting activities (Figure 2).
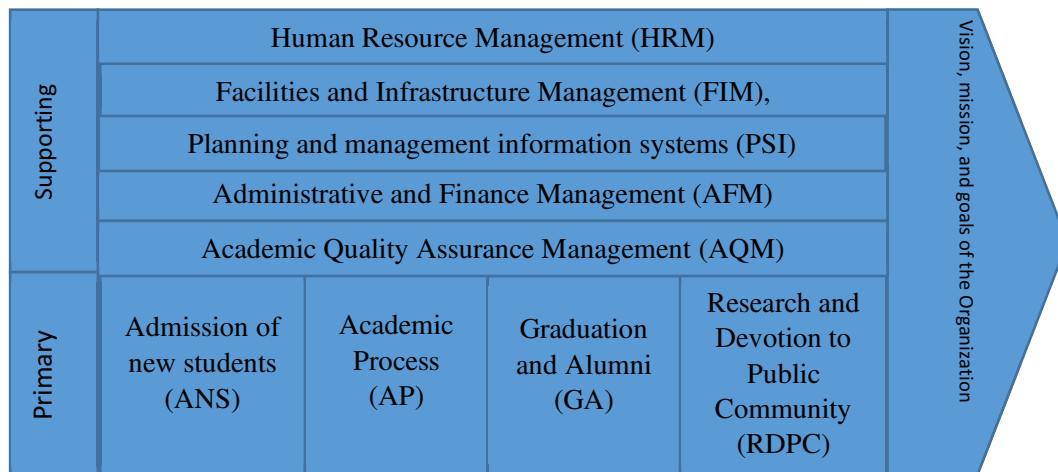
Figure 2. Value Chain Activity of UNIGAL Business Process

3.2. Management Requirements Phases:

The purpose of this phase is to provide the architectural requirements of all cycle architecture development method (ADM). Required business scenarios that used to be a source of requirements for each business Scenario ADM. The cycle should include key business, business processes and problems that exist in the organization. The fundamental problem for the development of technology in the managerial aspects of UNIGAL is so far not owned the main design for network and asset data. Based on the research results of UNIGAL's business processes, those have been obtained, then the solution to the existing problems can be seen in Table 1.

Table 1. Solutions to problems in UNIGAL

No Activity		Business Solution	Information System Solution
1.	ANS	- New student enrolment can be done online by filling the form in UNIGAL'S website. - Schedule of test selection and do the test with a computer based test (CBT) online at UNIGAL - Notification of the test result was announced online on the admissions information system	Development of web-based Online registration system. The process of scheduling a test selection, and integrate it with the registration process and announcements automatically. Integrating the announcement of test results with information systems.
2.	AP	- Making learning curriculums - Making regulations in the process of teaching and learning - Building E-Library - Scheduling the Lecture Hall in the integrated	Assessment of Apps Scheduling Apps E-Library Apps
3.	RDPC	- Using standard operating procedure IT - Identifying the needs of the application on this activity.	RDPC Applications
4.	FIM	- Creating a design for the management of infrastructure facilities - Asset management and calculation of total assets	FIM Applications
5.	HRM	- Development of Human management systems - Recruitment, employee training, and employee assessment	HRM Applications
6.	PSI	- Creating Planning Development - Implementation of Information System	PSI Applications

No Activity		Business Solution	Information System Solution
7.	AFM	- Requirements Analysis and System Integration	System Integration
8.	AQM	- Program Planning	AQM Applications
		- Document Management Standard	
		- Internal Monitoring and Evaluation	

3.3. Phase B: Business Architecture

The primary activity consists of: admission of new students (ANS), academic process (AP), graduated Alumni (GA), Research and Devotion to Public Community (RDPC). Supporting activity: Human Resource Management (HRM), Facilities and Infrastructure Management (FIM), Planning and management information systems (PSI), Administrative and Finance Management (AFM), and Academic Quality Assurance Management (AQM) will be described using Functional Decomposition Diagrams of TOGAF [11] the US is illustrated at Figure 3.
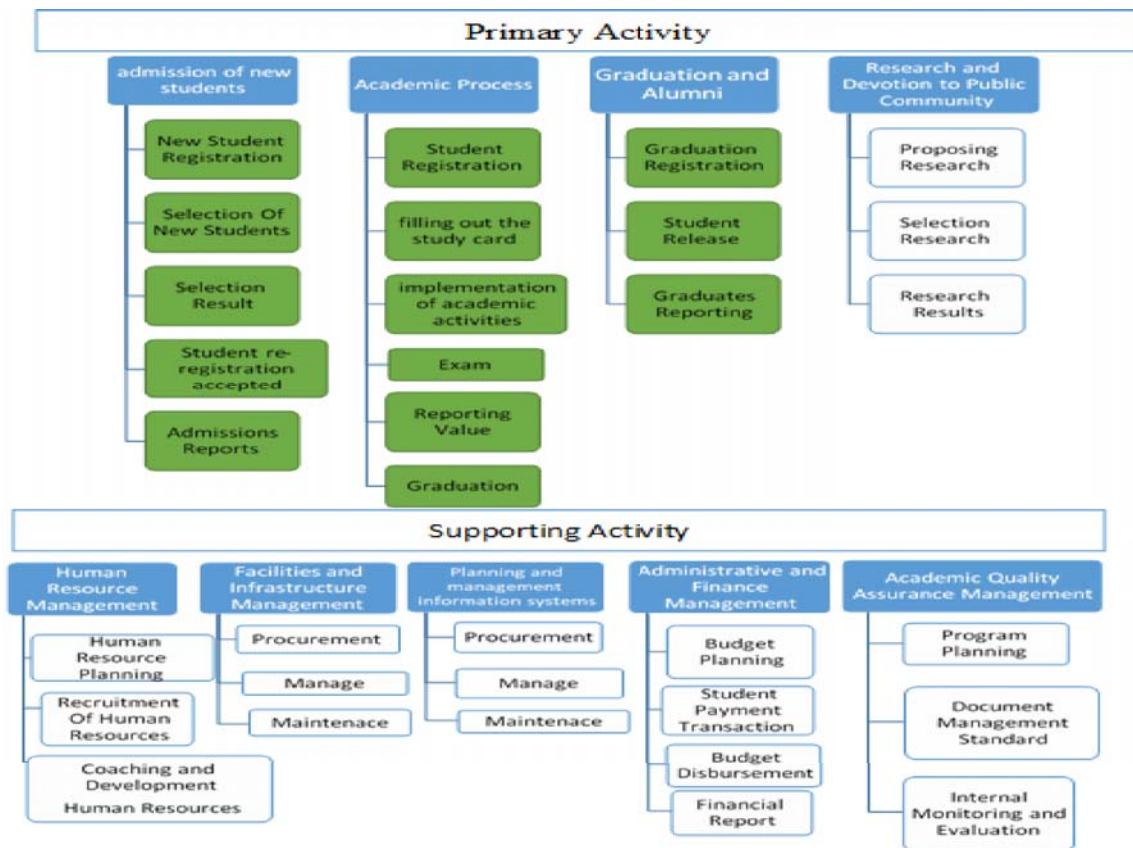
Figure 3. Functional Decomposition Diagram

3.4. Phase C: Information System Architecture

In the TOGAF framework, architectural data serve to determine the needs of the data to be used in architectural applications, as for the application architecture can be used for data processing. Data Architecture: Entity data retrieved from an existing business function as explained in details using FDD.

Identification data that has been done indicates that there are 82 entities retrieved from 8 business functions as shown in Tables 2 and Table 3.

Table 2. List Data Entity-Primary Activities

ANS	The Organizing Committee, Budget ANS, ANS schedule, marketing and promotion, Q&A Study Program and ANS, Candidate Registration, Exam Materials Selection, selection admission test, the results of the selection of new students, registration, custody, and reports of new students.
AP	Academic Calendar, curriculum, schedule of lectures, Lecture Hall, students, attendance, Exam Grades, statistics on leave, the Status of the mutation, Resignation, Drop Out, accreditation, evaluation reports, reports EPSBED
GA	The Committee of students, graduation, graduation registration budget, payment, proof of graduation payment, transcript of grades, and the alumni report.
RDPC	Budget Research, Research Proposals, Research Reporting Students, Lecturers, Research, Testing, Research Results.

Table 3. List Data Entity-Support Activities

HRM	Recruitment of HUMAN RESOURCES, the results of the selection of procurement Clerks, employees entering, Exiting Employees, Employee Development, benefits, Attendance, Payroll, Listing Awards & Pieces, Career Development, Recruitment, Performance Evaluation, The dismissal of the employees, employee evaluation report
FIM	Procurement, inventory, assessment, elimination of asset inventory, evaluation and inventory reports.
PSI	Completeness, The Technical Guidelines, The Report ESPBED, Applications, Data Security, Academic Administration Service, The IT LAB Supplies, Schedule IT Laboratory, Schedule IT Practices, Report, and Evaluation Lab IT
AFM	Budget, financial accounting, management of payment and education costs, payroll, financial reporting, and management.
AQM	Program Planning, document management, Monitoring and evaluation of the quality of Academic.

To define data, entities of the group need to describe a conceptual model that uses a matrix of relationships of entities and business functions. The purpose of this matrix is to know the data are made, update the data, the data is only read as a reference only. Green color (create, update, read), while the yellow just to read only "in any business functions together with the data entity to form clusters of cells on the diagonal of the matrix called "basic data subject ". Relationships between data entities and business functions in the matrix can be used both to expand the scope of applications for the next stage and shows some of the data in the business functions. Figure 4 shows the relationship between data entities and business functions of registration of new students and the teaching-learning process diagonally.

3.5 Application Architecture:

An application used for processing data from existing problems identified in each business function. Application of mapping results shown in Table 4.

Table 4. Application Modules

No	Business Function	Primary Activity Applications	Applications Code
1	Admission New Students (ANS)	Promotion and marketing	ANS1.1
		Faqs	ANS1.2
		New Student Registration	ANS1.3
		Registration Payment System	ANS1.4
		Scheduling & Testing	ANS1.5
		Entrance Exams	ANS1.6
		Student Registration	ANS1.7
		New Student Reporting	ANS1.8
2	Academic Process (AP)	Management Of The Administrative Class	AP2.1
		Management Schedule	AP2.2
		The Management Value	AP2.3
		Presence Management	AP2.4
		Curriculum Management	AP2.5
		Academic Calendar	AP2.6
		Evaluation Of Teaching And Learning	AP2.7
		Activities	AP2.8
		Reporting Of Accreditation	
3	Graduation and Alumni (GA)	Administration Of Graduation	GA3.1
		Scheduling Graduation	GA3.2
		Graduation Registration	GA3.3
		Payout Graduation	GA3.4
		Transcript Value	GA3.5
		Ijasah Publishing	GA3.6
		Management Alumni	GA3.7
		Reporting Wisudawan & Alumni	GA3.8
4	Research and Devotion to Public Community (RDPC).	Schedule Management Research Proposals	RDCP4.1
		Research	RDCP4.2
		Research Report	RDCP4.3
	Supporting Activity		
5	Human Resource Management (HRM)	HR Recruitment Management	HRM5.1
		Employee Management	HRM5.2
		Employee Administration	HRM5.3
		The presence of the	HRM5.4
		Employee Performance	HRM5.5
		Employee Assessment	HRM5.6
		Employee Training	HRM5.7
		Promotion Salaries	HRM5.8
		Piece Salaries	HRM5.9
		Evaluation Reports	HRM5.10
6	Facilities and Infrastructure Management (FIM)	Procurement	FIM6.1
		Vendors	FIM6.2
		Order Items	FIM6.3
		Inventory	FIM6.4
		Inventory Valuation	FIM6.5
		Removal Supplies	FIM6.6
		Reports and evaluation of Assets	FIM6.7
7	Planning and management information systems (PSI)	Managing Laboratory	PSI7.1
		Lab Scheduling	PSI7.2
		Development Of Information System	PSI7.3
		Network Control	PSI7.4
		Management of Databases and the Web	PSI7.5
		Evaluation reports	PSI7.6

No	Business Function	Primary Activity Applications	Applications Code
8	Administrative and Finance Management (AFM)	EPSBED Reports	PSI7.7
		The Management Of The Budget	AFM8.1
		Employee Administration Finance	AFM8.2
		Administration Management Education	AFM8.3
		Cost Of Management Faculty	AFM8.4
		Salary management	AFM8.5
		financial reporting	AFM8.6
9	Academic Quality Assurance Management (AQM)	Program Planning	AQM9.1
		Document Management Standard	AQM9.2
		Academic Quality Evaluation Report	AQM9.3

In the next step, the activity that must be done is to provide infrastructure components for candidate applications. Technical architecture design should consider the standard interface application platform and technology refer to the TOGAF Technical Reference Model (TRM) [12]. Infrastructure component specification required by the application system to support business process UNIGAL applied TRM indicated in Table 5.

Table 5. TOGAF Technical Reference Model

NO	TOGAF TRM Component	Component Description
1	Infrastructure Applications: Image data management, Interchange site user interface, and manage transaction processing systems, directories, networks, and security.	OpenGL GUI, MySQL, PHP, Web portals, Apache Web server, users of the classification, record transaction data for managing the authentication Account data.
2	Business Applications:	Business Apps
3	Operating System Service	Server Linux, Ms. Win XP, 10
4	Network Service	SMTP/POP3/IMAP/Telkom
5	Communication Infrastructure	LAN, Internet

3.6. Phase D: Technology Architecture

Technology architecture that is designed to determine the necessary technology to an environmental system for application in data processing. An early stage in designing the architecture of the technology is to identify the basic principles of the technology platform is required to support the sharing of the data type. Technology platforms described refers to the TOGAF TRM, a conceptual model can be seen in Figure 4.
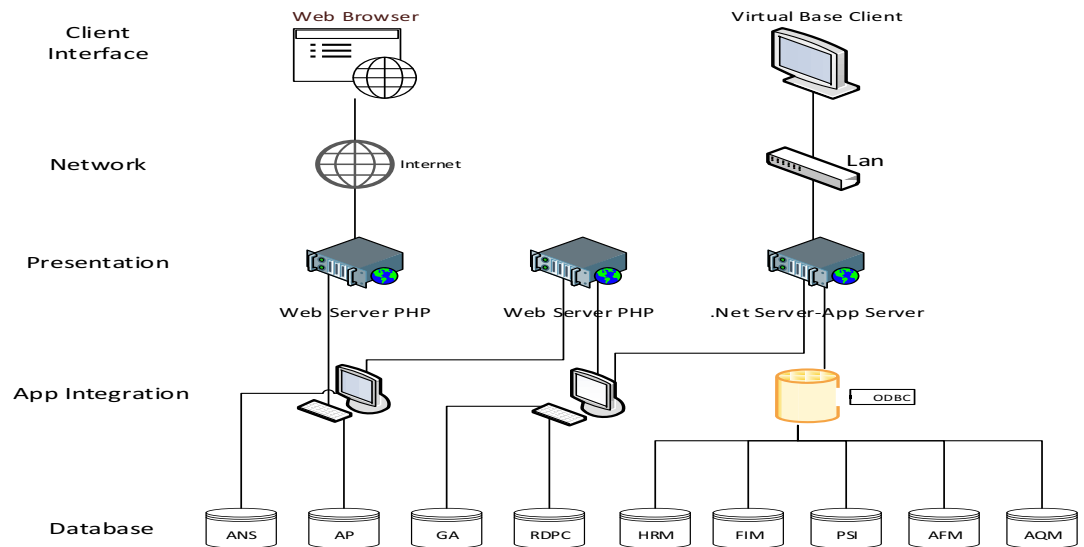
Figure 4. The proposed technology platforms

3.7. Phase E: Opportunities and Solutions

Opportunities and Solutions phase aims to evaluate and choose the way of the implementation of the architecture as well as consolidated analysis of the gap between the previous phases. This is the phase of the input from the output of each phase before.   Analysis of information system gap:Analysis of information system Gap addressed see a comparison between the information systems architecture that exists today and that has been designed. This showed that not all information systems are built to support required business processes UNIGAL. Figure 7 shows that the system changes required to support the business processes and the achievement of the objectives of the organization (See Figure 5).

Figure 5. Analysis of information system gap

The results of such an analysis the evaluation gap will be the basis of the development of information systems. A comparison of present and proposed technology platform suggests that there are an increase and the addition of hardware, software, and equipment for communications networks [13]. A comparison of the existing technology platform and the proposed shown in Table 6.

Table 6. Analysis of technology platform

		To Be									
		Network Topology	*Router*	*Firewall*	*Server*	*Switch*	*ISP*	*Storage*	*VPN*	*IDS/ISP*	*Management access*	*Monitoring Tools*
As Is	*Network Topology*	U										
	Router		U									
	Firewall			U								
	Server				R							
	Switch					U						
	ISP						U					
	Storage							U				
	VPN								U			
	IDS/ISP									U		
	New										Add	Add

U: Update   R: Retain   Add: Add

Opportunities and solutions from modelling architecture that has been designed before having the purpose to generate the appropriate information system with the target in the design [10]. Proposed solutions at this stage are to conduct design and development applications and provide the required infrastructure indicated in Table 7 below.

Table 7. Application Development Solutions

No	Infrastructure	Development Plan	Development	Principle Of Architecture
1	Security, Hardware, and network topology	Physically separating or logic data paths transactional and non-transactional	The process of segmenting the network cable or Wireless for a transactional process Academic data, involving basic elements used for building design the network is a Router, Firewall, IDS, IPS, Switch and Access Point	Data Security
		Doing restrictions on either the physical, as well as in logic. Applying the authentication credentials, authorizes and accountability	Services used to support the administration of access rights related information and monitoring in the form of: a. identity management, authorization, authentication credentials, and access control Management	Data Security

No	Infrastructure	Development Plan	Development	Principle Of Architecture
			b. Control Logging and log management c. the Auditing Capabilities d. Control Monitoring and event management. Control Data encryption/decryption and key management control f. Physical Access, intrusion detection, and surveillance controls	
2	Security, Hardware, and network topology	Doing the separation of the core server application with an internet direct use technology Demilitarized Zone Using a secure path using a Virtual Private Network Creating a layered firewalls to protect data from attacks or threats coming from outside	Perform segmentation of network topology, to improve modularity and infrastructure reliability with segmentation as follows: a. WAN aggregation layer combine network connection LAN Office, and health facilities to the Core b. Core layer-high Service Availability.	Data Security
3	Data Network	Adding a service provider as a backup in case of failure on the connection of UNIGAL	1. Cooperation with internet service providers to keep the reliability of the system. 2. Providing service monitoring	Service availability and follow the changes.
4	Software Development	Changing the software development of In-house became outsource development.	Make a cooperation with vendors to submit some or complete business process activities in order to more quickly in achieving the vision, mission, and goals of the Organization	Service availability and follow the changes.

A similar study was carried out by [14], a study using the TOGAF framework method was conducted to plan University strategies but only reached the architecture technology phase. Another study conducted by [15], where research was conducted using the TOGAF framework to create information systems for universities. In this study, only discussing in describing existing Technology Architecture without providing opportunities and solutions in the future.

Therefore, the stages carried out in this study can produce a blueprint that can align IT infrastructure and business processes and provide opportunities and solutions for technology that must be built for the future. However, to increase the success factor of implementation must be calculated the risks and costs that must be appropriate. Risks and costs are an important factor in this enterprise architecture implementation.

4. Conclusion

Business modelling or business process of the University of Galuh Ciammis has 2 main functions such as Core Activities and Supporting Activities. Core Activities is Academic Process which we focus on, has 4 processes, Admission, Academic or Learning Process, Graduation, and Research and Devotion to Public Community. Supporting Activities consist of Financial, Logistic Procurement, Public Relation, Building Infra Structure, Human Resources, and Students Activities. From Data Architecture in Academic Process we have 41 entities, and from Application Architecture, we have 20 application and 3 among this application are new such as students complain, e-learning and final project supervision and at the moment we run this 3 application for test. Proposed Enterprise Architecture can be used as a guide for the University of Galuh Ciamis to govern its Information System. Technology architecture helps in integrating the systems of information and data from all the activity that is in the University of Galuh Ciamis. For opportunities and solution, providing analysis for application development architecture and technology architecture the University of Galuh Ciamis in the future.

References

[1] Syynimaa, N. 2015. *Enterprise architecture adoption method for higher education institutions* (Doctoral dissertation, University of Reading).

[2] Simon, D., Fischbach, K., & Schoder, D. 2014. Enterprise architecture management and its role in corporate strategic management. *Information Systems and e-Business Management*, **12**(1),pp. 5-42.

[3] Oktavia, L., & Gaol, F. L. 2013. Information Technology Strategic Planning At PT. Venturium System. *Journal of Computer Science*, **9**(12),pp. 1847.

[4] Seethamraju, R. 2015. Adoption of software as a service (SaaS) enterprise resource planning (ERP) systems in small and medium sized enterprises (SMEs). *Information systems frontiers*, **17**(3), pp. 475-492.

[5] Goethals, F. 2005. An overview of enterprise architecture framework deliverables. *Available at SSRN 870207*.

[6] Desfray, P., & Raymond, G. 2014. *Modeling enterprise architecture with TOGAF: A practical guide using UML and BPMN*. Morgan Kaufmann. **8**(1), pp.3-10

[7] Anggara Wijaya, I., & Setyohadi, D. B. 2017. Analysis Business Architecture Study Case: Medical Colleges in Purwokerto. *Advanced Science Letters*, **23**(3), pp. 2401-2403.

[8] Katuu, S. 2018. The Utility of Enterprise Architecture to Records and Archives Specialists. In *2018 IEEE International Conference on Big Data (Big Data)* (pp. 2702-2710). IEEE.

[9] Armstrong, C., Cerenzia, J., Harrington, E., Rivett, P., & Waskiewicz, F. 2007. TOGAF/MDA/IC Synergy Project: Integration Proof-of-concept Results. *Object Management Group*.

[10] Dinh, H. T., Lee, C., Niyato, D., & Wang, P. 2013. A survey of mobile cloud computing: architecture, applications, and approaches. *Wireless communications and mobile computing*, **13**(18), pp. 1587-1611.

[11] Porter, M. E., & Advantage, C. 1985. Creating and sustaining superior performance. *Competitive advantage*, *167*.

[12] Rochwerger, B., Breitgand, D., Levy, E., Galis, A., Nagin, K., Llorente, I. M., ... & Ben-Yehuda, M. 2009. The reservoir model and architecture for open federated cloud computing. *IBM Journal of Research and Development*, **53**(4), pp. 4-1.

[13] Sudeikat, J., Braubach, L., Pokahr, A., & Lamersdorf, W. 2004. Evaluation of agent–oriented software methodologies–examination of the gap between modeling and platform. In *International Workshop on Agent-Oriented Software Engineering* pp. 126-141. Springer, Berlin, Heidelberg.

[14] Ramadhan, A., & Arman, A. A. 2014. Enterprise Architecture in University analyzing of implementation using business process management. In *2014 International Conference on ICT For Smart Society (ICISS)*, pp. 250-255. IEEE.

[15] Soares, S., & Setyohady, D. B. 2017. Enterprise architecture modeling for oriental university in Timor Leste to support the strategic plan of integrated information system. In *2017 5th International Conference on Cyber and IT Service Management (CITSM)*, pp. 1-6. IEEE.