

Original Research Paper

Designing Information System Architecture Based on Education 4.0 Case Study: Senior High School Institutions of Indonesia

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Abstract: The development of information technology that has occurred to date has made information technology necessary in an organization's business in various fields. Information technology support is very much needed in the current era of globalization because it can increase business effectiveness and efficiency. Utilization of technology optimally and in line with business processes is the main thing in developing the application of information technology. Senior High School (SHS) is one of the educational agencies in Indonesia that is developing following the development of technology. SHS institutions realize how important it is to apply technology in supporting their business processes. At present, the SHS institution has been helped with technology such as the use of Excel in all recording in schools, but the SHS institution itself has not implemented optimal and integrated information technology in every field of school activity which often occur in data loss, delivery of information both in terms of learning as well as school activities that require a long time, and not integrated the school system. The application of information technology that will be used by a school must be by the goals of the school so that the application can help the school well in achieving school business goals, the use of Enterprise Architecture (EA) in the application of information technology to help analyze information technology planning by SHS institutions. This study will use The Open Group Architecture Framework (TOGAF) to assist in application planning. The final results of this study proposed six application blueprints namely Academic System, Non-Academic System, Procurement Management, Financial Management, HR Management, and Data Management which are tailored to the business process and the needs of the SHS institution.

Keywords: Enterprise Architecture, TOGAF, Senior High School, School Information System

Introduction

Information technology has undergone continuous changes where so many innovative service offerings are provided by development of information technology (Kurnia *et al.*, 2021). Organizations or companies must be able to adapt to technological developments to be able to continue to survive and improve by utilizing information technology in their business (Norton *et al.*, 2020; Oliveira and de Souza, 2022) including in the world of education which is starting to adapt and innovate for standard school education (Razaque *et al.*, 2019; Abdul and Alajlan, 2020; Varvarigos, 2020). Information technology itself plays an important role as one of the

supports in the business processes of an organization. The role of information technology can provide guidelines in integrating systems among the financial divisions in an organization (Supriyadi and Amalia, 2019).

Senior High School (SHS) is one of the privately-owned educational institutions in Indonesia. The SHS institution is a "very good (A)" accredited school and has realized the importance of implementing information technology in supporting school activities, however, this SHS institution has not implemented the facilities offered by technology optimally in supporting their school activities. The consequences of not optimally applying information technology to school activities are carried out, with the following explanation:

1. School marketing. Dissemination of school information is still being done by word of mouth and with the help of social media. The SHS agency used to have a school website but now the website is no longer used
2. Admission of new students. New student registration is assisted by online forms and data recording using excel, as well as submission of information received by new students through chat media
3. Academic preparation. Preparation of material and class schedules using excel and takes approximately one week to check to teach history, teacher biographies, and delivery of academic information to teachers and school students
4. Learning process. The learning process is carried out conventionally without a special learning support system, as well as poor responses from students regarding the effectiveness of the current learning process which can be seen in Fig. 1 of the SHS Institutional Learning Effectiveness Level Chart. From Fig. 1 it can be seen that the current level of effectiveness of the learning process was taken from a survey of 397 students, 40% said it was effective, 53% said it was less effective, and 7% said it was not effective
5. Assessment of student learning. Assessment of student learning is assisted by the use of excel to store student score data and assist in the processing. It takes enough time to process all student grade data and enter it into student report cards
6. Assessment of student attitudes. Recording the value of student attitudes is still done conventionally where by using notes on a book. It will be difficult to find the attitude value of one student because the search must be carried out one by one in each student's attitude value book
7. Infrastructure and Operation. This conventional recording makes it often wrong to record data on infrastructure and operation facilities
8. Data collection is stored in one administrative computer, both data for new students/students, teachers, alumni, and other data needs. Likewise, drafts of similar documents are stored in the administrative computer. Because of this, there are often obstacles in the process of requesting the required data from either the teacher or the principal to the administration because the administration must know the data or draft required, and then they will send the data or draft to the teacher or principal. the school asked for it. This results in not the optimal time required in the process of submitting data or draft documents

Therefore it is necessary to plan the development of an information system at the SHS institution, but the design of the information system must be in line with the goals to be achieved by an organization so that it can have an impact on the SHS institution (OG, 2018) that operates

amid the development of education 4.0, because technological developments have had such a large impact on the quality of learning and the quality of education (Darmawan *et al.*, 2018), and in educational institutions, it can be said to be successful with one of them depending on efficient teaching, technological advances, student participation, and other factors (van der Merwe *et al.*, 2020).

Enterprise Architecture (EA) is one method that can be used as a guide in the development of information technology and is a technology practice in developing organizational performance by helping organizations see themselves in the context of a holistic and integrated view (Kotusev, 2019) of technology resources, information flows, business practices, and organizational strategic direction (Bernard, 2012), (Kotusev, 2018). Inside EA itself has a variety of frameworks that can be used such as The Open Group Architecture Framework (TOGAF), Zachman, Gartner Enterprise Architecture Method, Federal Enterprise Architecture (FEAF), Dept. of Defense Architecture Framework (DoDAF), and others.

In this study, the EA framework that will be used is TOGAF. TOGAF itself was chosen because this framework provides a comprehensive approach to planning, design, and implementation and provides detailed methods on how to build and implement an EA. (Hermawan and Sumitra, 2019; Rusli and Bandung, 2017). TOGAF itself also provides methods that organizations can use in developing and maintaining a company architecture within the organization so that it can be aligned with the organization's strategy. (Komyshova and Barrios, 2021).

Based on the explanation that has been described in the previous paragraph, this research was carried out to design information technology for SHS Institutions with EA using the TOGAF framework.

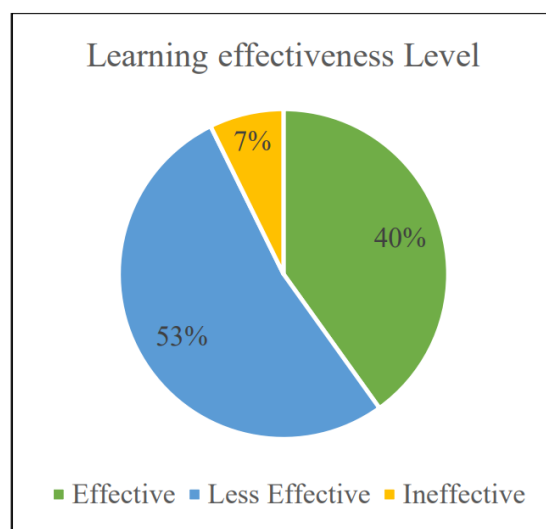


Fig. 1: SHS institutional learning effectiveness level chart

Literature Review

Education 4.0

Education 4.0 comes from the development of the Industrial revolution 4.0 which was brought into the realm of education to create what is called education 4.0. Education 4.0 revolution being able to combine the latest technology can increase the effectiveness of the learning process, and with Education 4.0 school students will have more interest in learning (Hashim, 2018). Education 4.0 seeks to equip students with the skills necessary for 21st-century learning and work and prepare them to act on relevant social challenges as sustainable development goals (Oliveira and de Souza, 2022). Seven aspects of the education 4.0 revolution can be applied in educational institutions, namely, personalization like interactive book and video, gamification, mobile connectivity to access and interact with the system, adaptability means there track according to background and behavior, learning analytics-method means there track and provide support programs, intelligent teletutor or the Chabot, and e-assessment and correction automatically. (Hendradi *et al.*, 2019; 2020).

Enterprise Architecture (EA)

Enterprise Architecture or EA is a methodology that can be used to assist companies with a framework for developing information, organizational structures, business processes, business strategies, and information technology infrastructure by proposing strategic alignment between business and information technology. Tannady *et al.* (2020). EA is a management practice that can maximize the contribution of organizational resources, IT investment, and system development activities to achieve organizational performance goals. EA will help design a system for an organization to support the needs and technology of the organization in achieving organizational goals and targets (Deny *et al.*, 2021). EA Will help to analyze any opportunities for integration of Information Communication Technology (ICT) data sources (Pańkowska, 2021).

EA can be regarded as the principles, methods, and models used in the design and realization of the organizational structure, business processes, information systems, and infrastructure of a company. Uysal and Mergen (2021). EA unites information and builds IT and business alignment consisting of information and technology services, processes, and infrastructure (Gorkhali and Xu, 2019).

The Open Group Architecture Framework (TOGAF)

The history of the development of The Open Group Architecture Framework (TOGAF) began before 1990. Created by the United States Department of Defense and

the manufacture of the net refers to The Technical Architecture Framework for Information Management (TAFIM). In 1990 TOGAF was adopted by the Open Group. In 1995 the first TOGAF specification was introduced. 9 years later in 2004 TOGAF 8 (Enterprise Edition) was released. To improve the previous version in 2009 was released TOGAF 9 (Josey, 2017).

TOGAF enables stakeholders to develop and implement enterprise architecture in information technology planning that is flexible and one that is quite often used both on a national and international scale (Wiranti *et al.*, 2020).

TOGAF is a framework architectural design that has several characteristics, namely (Amalia and Supriadi 2017):

1. Included in the third most used framework architectural design
2. A framework that is an open-source standard.
3. Focus on Architecture Development Method (ADM) implementation cycles and processes
4. Neutral
5. Accepted by the international community in general.
6. The approach is comprehensive (holistic)
7. Have the tools to complete the planning and design process

Based on Fig. 2, the TOGAF Framework shows the phases in the TOGAF framework, in this study we will only discuss the TOGAF phase from the preliminary phase to Phase E: Opportunities and Solutions, with the following explanation (Gunawan *et al.* 2019):

1. Preliminary Phase. The tool used in this phase is the Principles Catalog. The steps taken at this stage are to make the EA design principles a reference for architectural development
2. Architecture Vision: This phase aims to create a uniform view of the importance of designing an EA to achieve company goals. The steps that will be taken are the determination of the existing strategy in the current SHS institution
3. Business Architecture: The steps that will be carried out at this stage are to develop a description of the basic business architecture, and develop a description of the target business architecture
4. Information System Architecture: This stage will discuss the data architecture (data components used by the application to produce the required information) and application architecture (the required applications, create application modeling, and explain the usability of the designed application)

5. Technology Architecture: The steps for creating a technology architecture are modeling the target organization's network configuration
6. Opportunities and Solution: In this phase, more emphasis is placed on the priority of planning the initial implementation of the proposed application

Previous Research

There are several studies related to this research that also discusses enterprise architecture using the TOGAF framework so that it is used as a reference in this study which can be seen in Table 1 Previous Research.

Table 1: Previous research

No	Description	Explanation
1	Title Author Publisher Summary	Planning of Higher Education Information Technology Strategy Using TOGAF (A Case Study at AMN Cilacap) (Prayitno, 2019) O. T. Prayitno Indonesian Journal of Information Systems (IJIS) Discusses the design of information technology in high schools using the TOGAF framework and produces the architecture of new student admission, the academic registration process, postgraduate registration, and release, research and community service, financial processes, hr reporting, and procurement processes.
2	Title Author Publisher Summary	Modeling and Enterprise Architecture of Final Project Management Based on National Research Standards for Higher Education in Indonesia (Setiyani <i>et al.</i> , 2020) Lila Setiyani, Karya Suhada, Yahya Suherman Proceedings of the 1 st International Conference on Folklore, Language, Education and Exhibition (ICOFLEX) Discuss modeling a final project management enterprise architecture based on national research standards for higher education in Indonesia. The final result of this research is to produce an enterprise architecture that can be implemented and this design can describe the business architecture, information systems, and technology so that it can provide guidance or standardization to final project management students who can meet the National Research Standards in Higher Education
3	Title Author Publisher Summary	Enterprise Architecture Model for Vocational High School (Wikusna, 2018) Wawa Wikusna International Journal of Applied Information Technology Discuss modeling enterprise architecture in Vocational schools and producing data architecture, application architecture, technology architecture, and implementation plan directions for the school. The author designs an enterprise architecture for Senior High School that can build the achievement of school goals
No	Description	Explanation
4	Title Author Publisher Summary	Development of Enterprise Architecture in Senior High School Using TOGAF as Framework (Supriyadi and Amalia, 2019) Hari Supriyadi, Endang Amalia Universal Journal of Educational Research 7 Discusses the development of enterprise architecture at a high school located in Bandung using the TOGAF framework The final result of this research is to describe the results of the analysis of the data architecture design (converting excel files into database files), application architecture (adding applications that support data processing), and technology architecture (adding application servers and databases)
5	Title Author Publisher Summary	A hybrid infrastructure of enterprise architecture and business intelligence and analytics for knowledge management in education (Moscoso-Zea <i>et al.</i> , 2019) Oswaldo Moscoso-Zea, Jorge Castro, Joel Paredes-Gualtor, And Sergio Luján-Mora IEEE Discusses enterprise architecture with hybrid infrastructure (combined) with business intelligence and analytics for knowledge management in education The result is that the researcher proposes to combine the resulting EA model with the development of a model-driven software that can enable application development based on all the business processes, actors, roles, and objects required for a particular department. The The proposed application design is obtained through the modeling language provided by EA

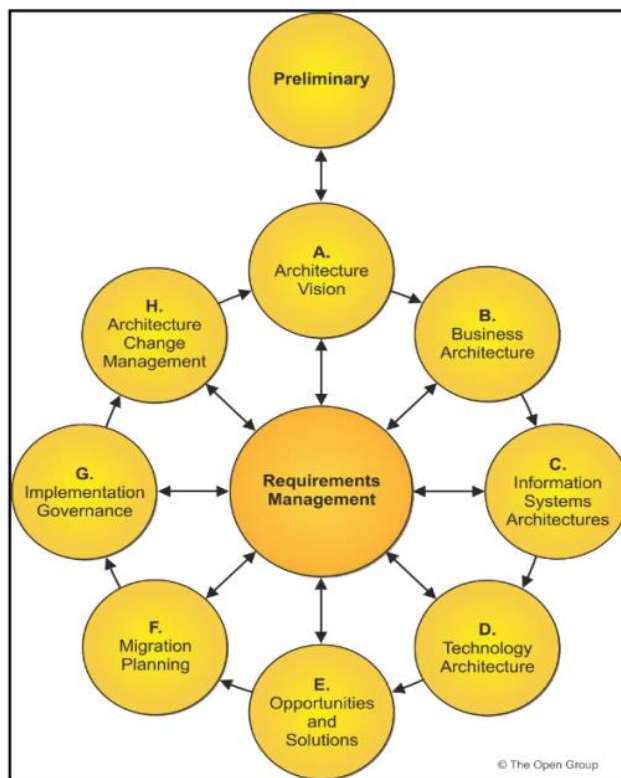


Fig. 2: TOGAF framework (Amalia and Supriadi, 2017)

Materials and Methods

This research will use qualitative methods and is a case study research with the object of research being the SHS institution, where an analysis of the activities of the SHS institutional school activities will be carried out and provide an information system design using the TOGAF framework.

Research Stages

The research stages that will be used in this study can be seen in Fig. 3 Research Stages with the following explanation:

1. Research Problem. In the formulation of the problem, it will be concluded that the problems that occur are to be investigated
2. Study of Literature. A search for references such as books, research, journals, or websites related to the TOGAF framework will be carried out and the collected reference data will be studied by researchers to solve problems that have been formulated previously
3. Data Collection. The data collection process that will be carried out by researchers is by doing observations, and conducting interviews at the SHS institution. In the observation process, the researcher also went down to the place of the case study, namely

the SHS institution. In the observation process, the researcher reviewed the operations, business support applications, and infrastructure implemented by the SHS institution. The interview process will be carried out with parties who know the current situation experienced by the SHS institution and understand the business processes that run at the SHS institution

4. Enterprise Architecture Analysis. In the process of analyzing the enterprise architecture design, the research will perform data processing and design using the TOGAF framework which refers to TOGAF 9.2 (OG, 2018). The Preliminary Phase will explain the catalog of architectural principles that will be used in this research. Architecture Vision will be explained using Value Chain. Business Architecture will describe the Driver/Goal/Objective, Actor Role Matrix, and SHS Institutional Architecture Business Targets. Information System
 The architecture will be divided into two, namely Data Architecture with conceptual data diagrams, and Application Architecture with an explanation of the Application Portfolio Catalog. Technology Architecture explains the Target Network Topology, and the last phase, Opportunities, and Solutions will explain the opportunities given by each proposed application design
5. Conclusion. At the end of the study, conclusions will be drawn from the final results of this study

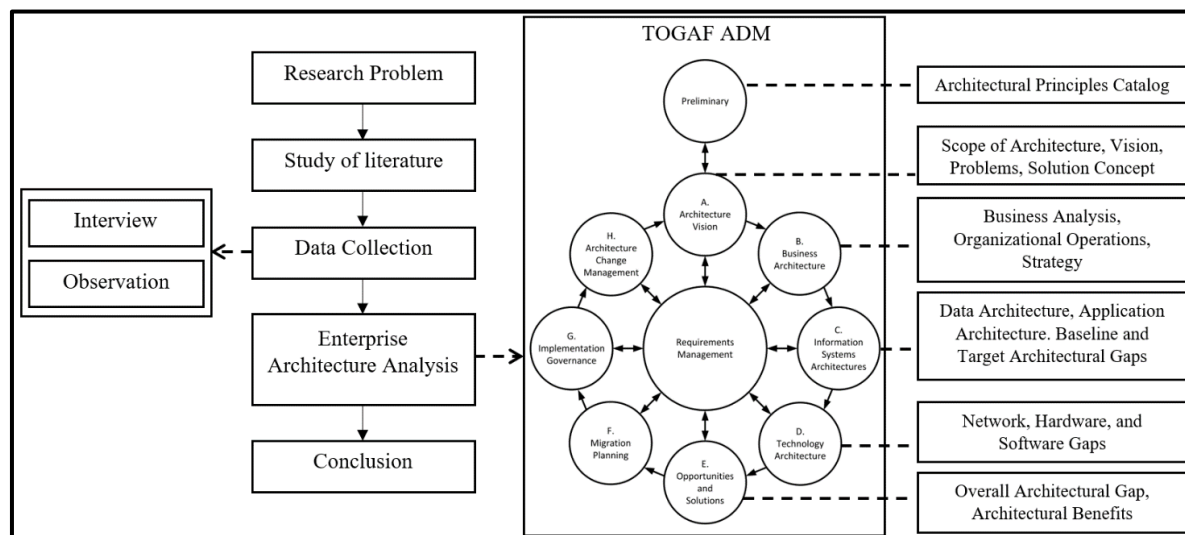


Fig. 3: Research stages

Results and Discussion

Preliminary Phase

Within the TOGAF ADM framework, there are several catalog principles consisting of business principles, data principles, application principles, and technology principles. The principles of this catalog will be used as a reference for information system design, maintenance, and infrastructure management, the principles of the catalog which can be seen in Table 2 Architectural Principles Catalog, are as follows.

Architecture Vision

At this stage, it will be explained related to the business value that will be conveyed as a result of the existing business at the SHS institution. Value Chain is a business analysis that can be used to determine the main activities and supporting activities within an organization. Analysis of the value chain of SHS institutions can be seen in Fig. 4 value chain of SHS institutions. The picture describes the elements of each activity in the value chain, the analysis is obtained from the results of collecting interview data and observations at SHS institutions.

SHS institutional value chain on primary activity with the following explanation:

1. Inbound Logistics. This element consists of the process of accepting new students every year, making a curriculum that follows the government's education policy, as well as setting the academic schedule referred to as setting the school teaching and learning schedule
2. Operation. This element consists of processes, especially in schools, namely teaching and learning activities, student character education, as well as

extracurricular activities, as well as development training for teachers

3. Outbound Logistic. The output of the process carried out by the SHS institution is to prepare for student exams, both midterm exams, final semester exams, or national exams, prepare graduation for students, and provide a quality learning process
4. Marketing and Sales. This element in the SHS institution consists of the promotion process through social media such as Instagram and Facebook, or by making promotional banners, collaborating with various partners such as universities in Indonesia, and conducting social services or social services
5. Service. SHS institutions provide academic information services for students or guardians of students, provide counseling sessions if needed to students, and provide services to alumni of SHS institutions if needed

SHS Institutional Value Chain on Support Activity with the following explanation:

1. Firm infrastructure. School budget and financial management are carried out to be able to meet all school needs, school facilities, and infrastructure needs, as well as needs in the school academic process
2. Human resource development. The existence of new teacher recruitment activities if required personnel adapted to their fields, internal training for teachers in improving the quality of human resources, as well as conducting school academic evaluations
3. Technology development. In carrying out business processes, SHS institutions are assisted by several technology applications such as Dapodik from the government, Microsoft Office which is used to help

record school data needs, as well as learning support applications such as Google, Zoom, and others

4. Procurement. The procurement process consists of providing school laboratory facilities, from computer labs, chemistry labs, and biology labs, providing library needs, and school health units, as well as all needs related to computer stationer

Business Architecture

This point will explain the relationship between drivers/goals/objectives in the SHS institution and the description of the actor role matrix in the SHS institution.

The following is an explanation related to drivers/goals/objectives which can be seen in Table 3 Drivers/Goals/Objectives of SHS institutions.

The following is an explanation regarding the analysis of the actor role matrix of the SHS institution to show which actors carry out their roles and functions, which can be seen in Table 4 Actor Role Matrix of the SHS institution. Table 4 illustrates the RACI relationship between actors and the existing roles in the activities that run in the SHS institution. Where R (Responsible) is the actor who is responsible for carrying out the answers for these activities. A (Accountable) is an actor who has the authority to approve answers for carrying out these activities. C (Consulted) is an actor whose opinion is sought after and is communicated in two directions with other departments. I (Informed) is an actor who gets information from an activity decision and then distributes it to other parts.

In the proposed target business architecture, most of the business processes of the SHS Institution will be assisted by an information system that can be integrated. The following is an explanation of Fig. 5 Target Business Architecture of SHS Institution:

1. Academic Function is the main business process in the SHS Institution, that's why this business process is essential. In this academic system, it will be divided into several sub-systems, namely new student registration, curriculum, and online learning
In the new student registration process, there will be a new website for students who will register themselves to the SHS Institution. On the website, there is an AI Chat Bot facility which is an adaptation of the development of Education 4.0 points of the Internet of Thinking. In addition to chatbots, registrants will also find it easier to find out the completeness of registration files and upload files. This system will also help registrants to find out what fees must be paid, the schedule for the entrance exam, the score for the entrance exam, and notification of whether or not the registrant has passed the entrance exam
2. The non-academic process is a process that is carried out after the learning activities are completed. This process can be useful for the development of student interest which consists of activities outside the

classroom, extracurricular activities, and improving the quality of students

Activities outside the classroom on the nonacademic system will provide information related to events, seminars, or competitions at the SHS Institution, as well as provide information if there is certified training for students. Extracurricular activities at the SHS Institution consist of extracurriculars and clubs, in this system students will get this information and can register for the extracurricular or club they are interested in and will be given information related to the implementation, and the person in charge of the extracurricular and club

3. The procurement function will be assisted with the Saprass management system and the maintenance Saprass which records all data collection on infrastructure facilities, incoming and damaged goods online, as well as recording the use of classrooms, labs, or the library, and borrowing library books
4. The school financial process is one of the processes that support the SHS Institution's business. In its development, a financial management system will be planned that regulates incoming and outgoing financial data collection, invoice printing, and routine financial reporting
5. The HR function was developed with the creation of a school website containing information related to all activities carried out at the SHS Institution and information about the SHS Institution, a system for data collection of outgoing and incoming letters, data collection for partners, and scheduling of activities from partners, either training, seminars, or others, as well as there is a performance evaluation for teachers
6. The data collection function was developed with the design of a data management system that stores all data for teachers, staff, students, and alumni. An e-document system that contains document template drafts such as cooperation letters, invitation letters, and other letters

Architecture Vision

In this phase, we will discuss the information system architecture at SHS institutions which are translated into two points, namely data architecture and application architecture. In the data architecture, the conceptual data diagram and its relationships will be explained, and in the application architecture, the description of the proposed application catalog will be explained.

Data Architecture

At this point, we will discuss conceptual data diagrams, which are conceptual ERD (Entity Relationship Diagram) model information obtained from collecting organizational business needs analysis. Entities and relationships modeled in this ERD are defined based on business needs. The conceptual diagram of the data is shown in Fig. 6 conceptual data diagram.

Figure 6 the conceptual data diagram describes the entire concept model of the target data system in the design of enterprise architecture at the SHS institution. The concept of the data is obtained from the results of the analysis. The figure describes the relationship between one data entity and another data entity.

The relation in the conceptual data diagram consists of one to one (1-1), one to many (1-N), and many to many (M-N). Account type data has M-N relation to account data and 1-N to chatbot/live chat. Account data has M-N relation to job type, account data has M-N relation to account type, has 1-N relation to chatbot/live chat, has 11 relations to extracurricular/club data, has 1-N relation to school information data, has M-N relation to event list data, has 1-N relation to e-doc data, has N-1 relation to performance evaluation data, has 1-1 relation to class data, and has 1-N relation to class schedule detail data.

New student data has a 1-1 relationship to student data, N-1 to new student fees data, and M-N to entrance examination data. Student data has a 1-1 relationship to new student data, N-1 to class data, 1-N to chatbot/live chat, 1-N to pay tuition data, M-N to extracurricular/club data, M-N to event list data, and 1-N to score data. Class schedule data has a 1-N relationship to class schedule detail data, 1-1 to room data, 1-1 to exam data, and 1-1 to class evaluation data. Facility data has an N-1 relation to room data. The subject data has an N-1 relationship to the subject detail data and 1-N to the class schedule detail data. Student attitude data has a 1-N relationship to student data and M-N to class data.

Financial data has a 1-1 relation to school event data, and 1-1 to pay tuition data. School event data has a 1-1 relationship to event details data, 1-N to event list data, 11 to partner data, and 1-N to account data.

Application Architecture

This point will discuss the proposed application for SHS institutions in the development of enterprise architecture using TOGAF which can be seen in Table 5 application portfolio catalog.

At this point, the importance of each of the previously proposed applications will also be explained. The determination of this will be based on the use of an application portfolio which will be divided into four quadrants consisting of strategic, high potential, key operational, and support. The explanation can be seen in Table 6 SHS institutional application portfolio.

In Table 5, a portfolio of proposed applications for SHS Institutions is described which consists of four quadrants, namely:

1. Strategic. A critical application to support future business strategies. Included in this quadrant are non-academic systems, procurement management, and HR management. The non-academic system is included in this quadrant because this system will assist the SHS Institution in supporting student

development outside the learning process so that it can increase the value of learning and student talents. Procurement Management is included in this quadrant because this system will assist in the process of procuring school facilities so that it can support school development. HR Management is included in this system because it will assist in the process of improving the quality of teachers and school staff as well as disseminating school information

2. High potential. These are applications that may be critical in achieving future organizational success. Included in this quadrant is Financial Management because this system will support the SHS Institution in recording school finances so that they are more organized
3. Key operational. Applications that an organization uses and functions to maintain the organization's operations. Included in this quadrant is the Academic System because this system is a system that supports the school's main business processes, namely the teaching and learning process
4. Support. These are applications that function to improve business efficiency and management effectiveness but do not function to increase competitive advantage. Included in this quadrant is Data Management because this system is a system that can assist in the process of collecting school information so that analysis can be carried out regarding data collection for new students, teachers, staff, students, and alumni

Technology Architecture

In this section, we will discuss the network topology proposed in the design of the SHS institutional technology architecture which can be seen in Fig. 7 SHS Institutional Target Network Topology. In Fig. 7 SHS Institution Target Network Topology can be seen the topology proposal for the SHS Institution, where there are additional switches to be able to interconnect networks within the school, there is a server for data storage, namely a database server and application storage server and there is a firewall to protect the school internet cycle process. Internet users and students can obtain school information through a network connected to the internet.

Opportunities and Solutions

In general, there will be several proposed applications for SHS institutions. It is proposed that the existing application design will provide solutions in the development of SHS institutional business processes, as follows:

1. Information System Academic that provides solutions for SHS institutions in assisting the new student registration process, assisting in the preparation of curriculum and subject matter, and

- assisting in the learning process which has various student assistant features such as displaying class schedules, discussion forums, AR learning, and so on
2. Non-Academic Information System application that provides a solution for SHS institutions in assisting the process outside of student academic activities, such as the extracurricular/club process which displays extracurricular/club lists and their registration, displaying a list of activities that can be followed by students, students, as well as providing a counseling system for teachers and students
 3. Procurement management application that provides a solution for SHS institutions in assisting the procurement process for school facilities/goods. This system also helps Operations Affairs in collecting data on incoming goods, destroyed goods, lists of space usage, as well as lists of goods submissions
 4. Financial management applications that provide a solution for SHS institutions in assisting the process of recording school finances. Where will help the school treasurer to record the funds owned by the school, incoming funds, outgoing funds, a list of fund applications, as well as the history of funding applications
 5. HR Management application that provides a solution for SHS institutions in assisting the Deputy Head of Public Relations in collecting incoming mail, and

6. Data Management applications that provide a solution for SHS institutions in helping to collect data for SHS institutions. The administrative section can recap new student data, student data, teacher data, teaching data, and alumni data, and can also upload document drafts that can be downloaded by teachers as needed
7. From the results of the proposed application design that has been given previously. At this point, it will also discuss the priority of the proposed application which is divided into three parts, namely short-term, medium-term, and long-term. The priorities of the application proposal can be seen in Fig. 8 Scheduling of SHS Institution's Proposed Application

In the short term, there will be proposed applications for the Academic System and Financial Management. In the medium term, there will be proposals for Procurement Management and HR Management applications in the long term, there will be proposals for Non-Academic System applications and Data Management.

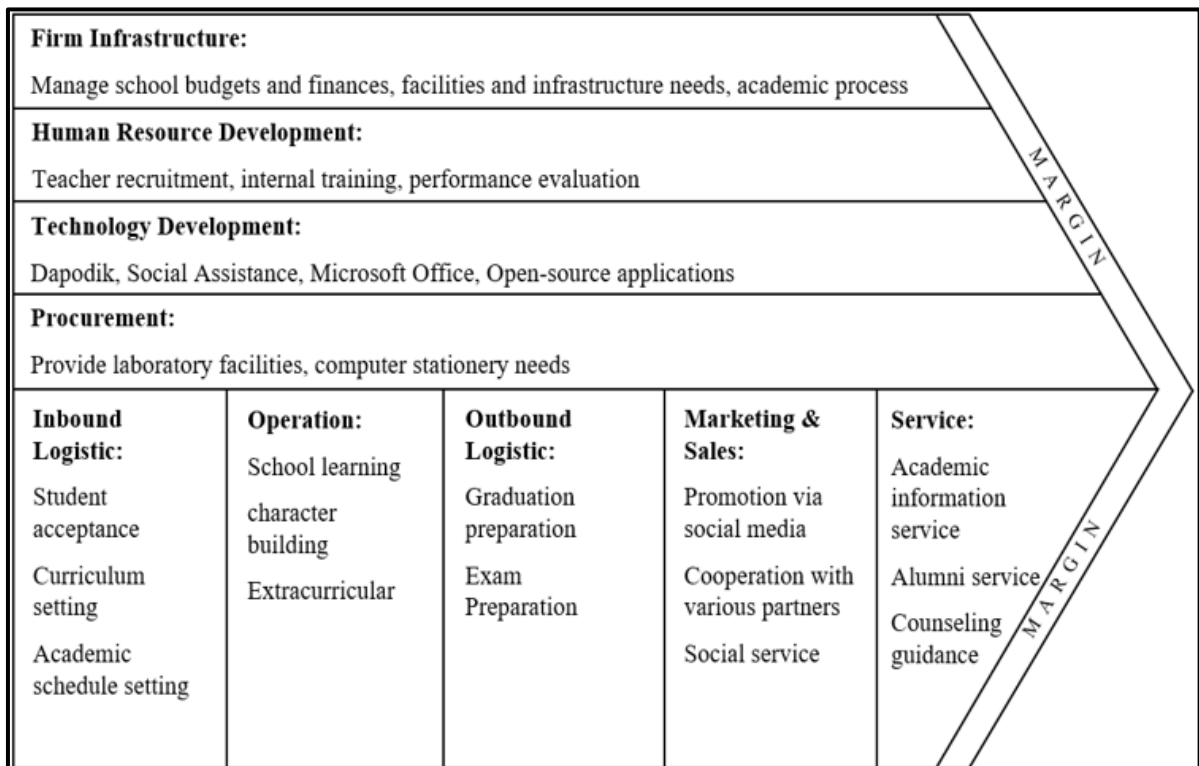


Fig. 4: Value Chain of SHS institutions

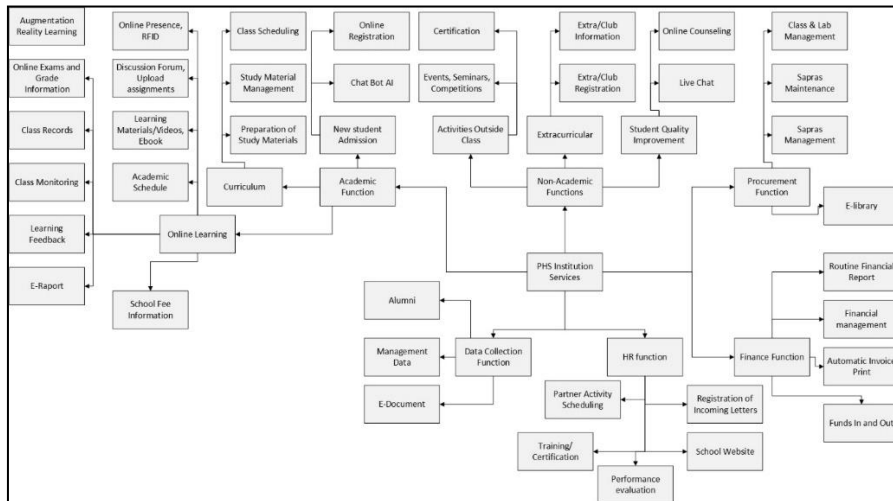


Fig. 5: Target business architecture of SHS institution

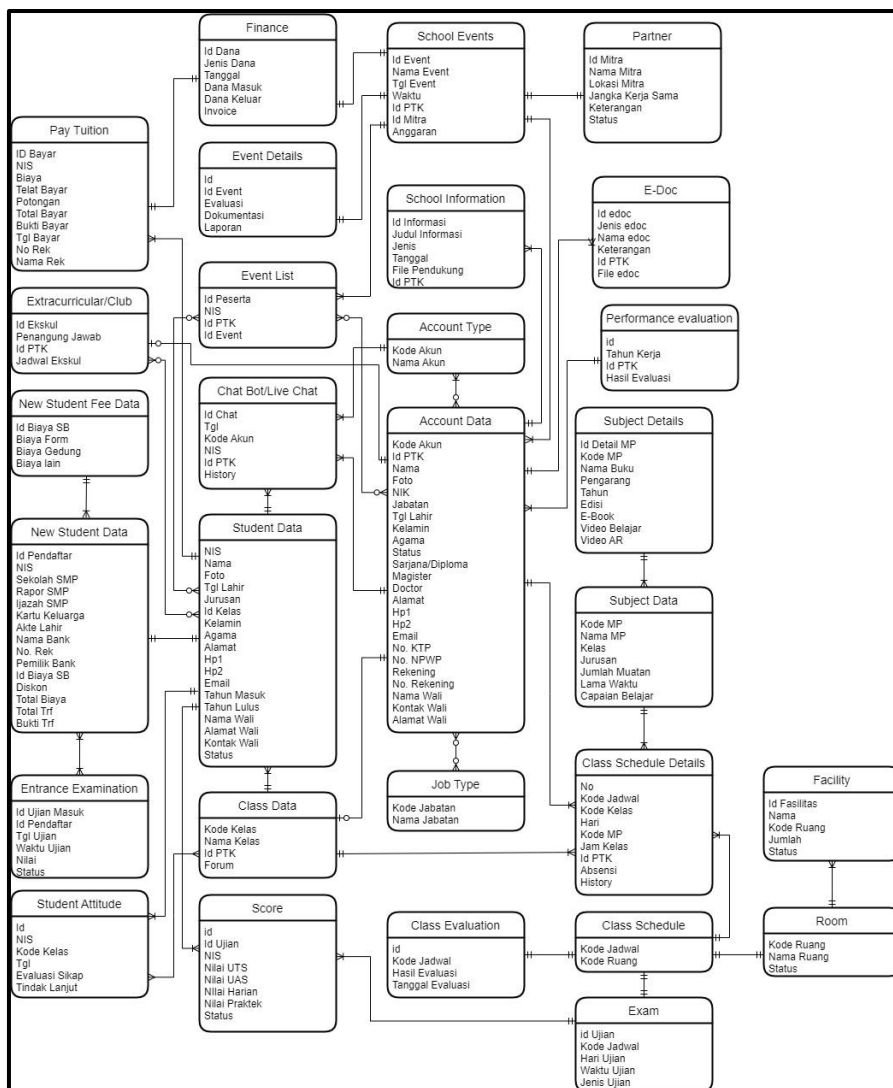


Fig. 6: Conceptual data diagram

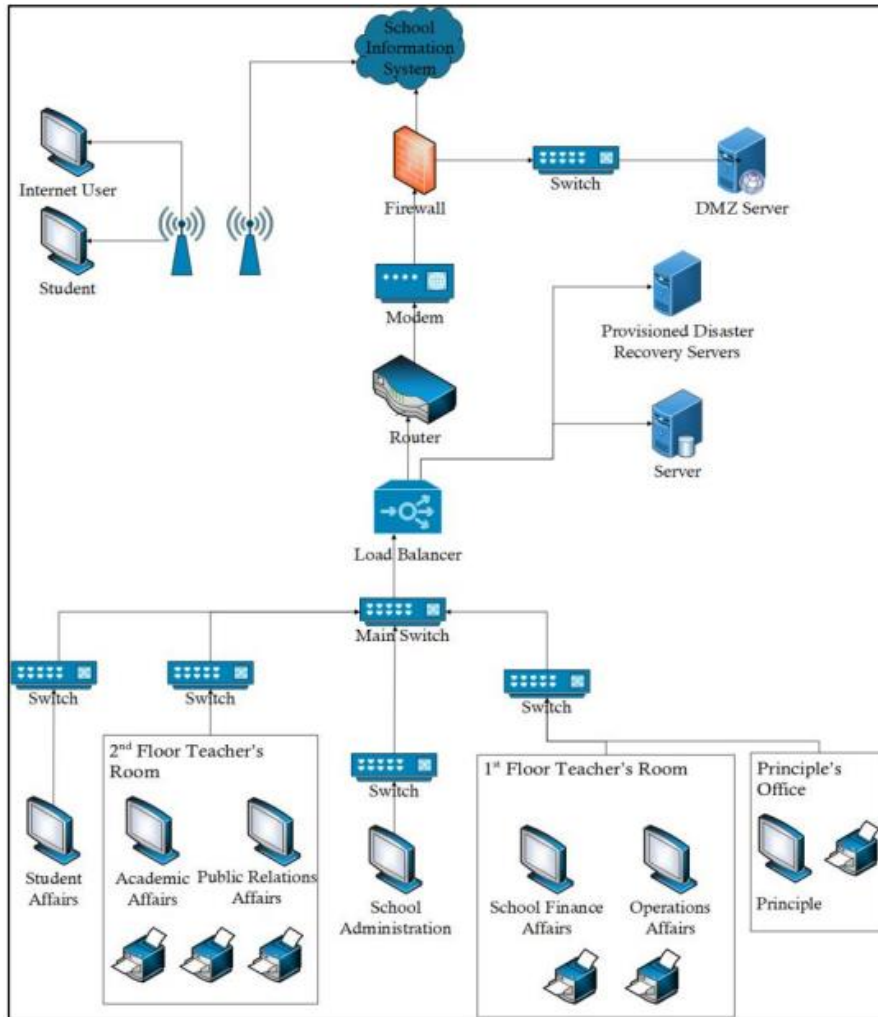


Fig. 7: SHS institutional target network topology

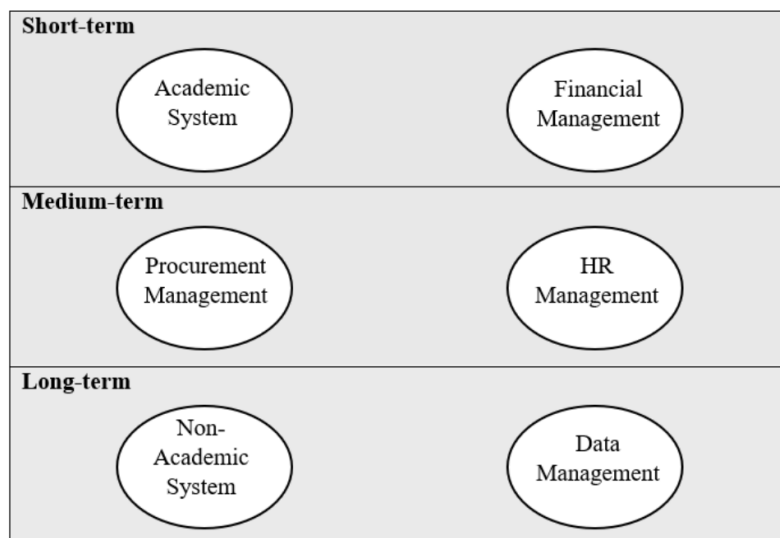


Fig. 8: Scheduling of SHS institution's proposed application

Table 2: Architectural principles catalog

Business Principles	
Principle 1:	Utilization of information systems for organizations
Statement:	The design of this information system is made to utilize the development of information systems for the organization as a whole
Rationale:	This principle is created from the perspective of the whole organization and has long-term value. With this principle, it will help the entire organization to complete its tasks with the help of the designed information system
Implications:	Achievement of the use of information systems throughout the organization will bring changes in business processes that occur
Principle 2:	Information management is the business of the whole organization
Statement:	All areas of the organization are included in the design of the developed information system
Rationale:	Users of information are organizational stakeholders, teachers, and students. To ensure that information management is aligned with the business, the entire organization will be included in the design of the information system created
Implications:	The design of information systems requires the responsibility of every part of the organization in its use
Data principle	
Principle 3:	Data can be shared
Statement:	The user has access to the data necessary to perform the task; therefore, data is shared across functions and organizations
Rationale:	Timely access to accurate data is critical to improving the quality and efficiency of organizational decision-making
Implications:	This principle is one of three principles closely related to data: Data is an asset; data is shared, and data is easily accessible
Principle 4:	Easily accessible data
Statement:	Data can be accessed by users to perform their functions
Rationale:	Broad access to data leads to efficiency and effectiveness in decision making, and provides timely response to requests for information and service delivery
Implications:	This principle is one of three principles closely related to data: Data is an asset; data is shared, and data is easily accessible
Application principle	
Principle 5:	Application is easy to use
Statement:	This principle is one of three principles closely related to data: Data is an asset; data is shared, and data is easily accessible
Rationale:	The more a user has to understand the underlying technology, the less productive that user will be. Ease of use is a positive incentive for app usage
Implications:	Applications must be user-friendly and can be easily accessed in terms of features, and information, and in accordance with the needs of the organization
Technology principle	
Principle 6:	Availability
Statement:	Systems and technology can always be made available to users
Relational:	As long as the organization's business processes are run, they need technical support that is always available in their use
Implications:	The technology that is built must always be monitored and always maintained

Table 3: Drivers/Goals/Objectives of SHS institutions

Catalog	Explanation
Driver	The need for system integration between parts of the school The need for better service in the school's academic process A more optimal process in school functions including non-academic functions, alumni, public relations, finance, data collection, and procurement of infrastructure suggestions
Goal	The school system becomes integrated There is a support system for school teaching and learning activities The function of the school becomes more optimal because of an integrated system
Objective	The design of an enterprise architecture that is interconnected with one another facilitates the running process Utilization of enterprise architecture design in school teaching and learning activities so that it can be more optimal The use of integrated data will help speed up school operations in various functions

Table 4: Actor Role Matrix of the SHS institution

Actor role	Principle	Administration	Student affairs	Academic affairs	PR affairs	Operations affairs
Academic						
Admission info	I	I		R/A		
New student registration	I	I		R/A		
New student	C	I	I		R/A	
Admission exam				I		
Study and exam scheduling	A/C		R/A			
Student grade management	A		R/C			
Report sharing	C		R/A		I	I
Graduation management	A/C	I	R/C			
Diploma making	C	I	R/A			I
Academic info	C			R/A		
Curriculum preparation	A/C			R/A		
Learning evaluation	A/C		I		R	
Non-academic						
Extracurricular	I	R/C			A/C	
Student quality improvement activities	A/C	I	I		R/A	I
alumni						
Alumni data management			C		R/A	
Administration						
Infrastructure data	I					R/A
Management						
Staffing data management					I	R/A
Teacher data management					I	R/A
Student data management			I			R/A
Classroom usage			I			R/A
Management						
Lab and library use management	I			R/A		
Book data management	I					R/A
Actor role	Principle	Administration	Student affairs	Academic affairs	PR affairs	Operations affairs
Book borrowing	I		I			R/A
Financial						
School financial management	C	R/A				
Academic fee management		R/A	I	I		
Non-academic fee		R/A			I	
Management employee/Teacher salary	C	R/A			I	
HR						
New teacher admission	C	I			R/A	
Employee admission	A/C	I			R/A	
Job vacancies info		I			R/A	
Mail management school	A/C	I			R/C	
Promotion management					R/A	C
Employee promotion	A/C	I			R/C	
Employee training	A/C	I			R/A	

Table 5: Application portfolio catalog

Application architecture	Explanation
Academic system	This proposed application will assist SHS institutions in carrying out the new student registration process from registration to the selection stage, curriculum preparation such as class scheduling, preparation of learning materials. The last function of this application is to assist in the online learning process such as in the distribution of class/exam schedules, the learning process, assessment, class evaluation, other information related to academics, and distribution of student report cards
Non-academic	This application proposal helps in the process of making school activities, both for students and teachers. System Assist in the extracurricular process and SHS institutional club and help recap the improvement of student attitudes
Application architecture	Explanation
Procurement management	Through the class, evaluations carried out by teachers and Student Affairs This proposed application assists in the process of procuring goods, SHS institutional infrastructure and assists in recording SHS institutional infrastructure
Financial management	In this proposed application helps in collecting financial data for SHS institutions starting from incoming funds and using outgoing funds
HR management	This application proposal helps in the process of disseminating information on SHS institutions, collecting performance evaluation data, and collecting partner data
Data management	This proposed application helps in recapitulating all existing data collections at SHS institutions such as alumni data, as well as providing e-docs containing drafts of documents that can be used by SHS teachers/institutional staff

Table 6: SHS institutional application portfolio

Strategic	High potential
Non-academic management procurement management HR management	Financial management
Academic system	Data management
Key operational	Support

Conclusion

From the results of the research analysis described in the previous chapter, the design target for SHS institutions so that there is an information system that is interconnected with one another and can be in accordance with the needs and vision of the school, namely creating learning that follows technological developments, can be drawn several conclusions, namely creating learning that follows technological developments with the conclusion of the study, namely the design of an information system architecture that consists of:

1. Data Architecture generates several data entities starting from academic function data, nonacademic function data, procurement function data, financial function data, HR function data, and data collection
2. Application Architecture produces six application designs, namely academic systems, non-academic systems, procurement management, financial management, HR management, and data management

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Author's Contributions

Yemima Monica Geasela: Contributions to conception and design, acquisition of data and/or Analysis and interpretation of data. Author participated in all

experiments, coordinated the data-analysis and contributed to the writing of the manuscript. Authors contribute in drafting the article.

Nilo Legowo: Contributions to conception and design, acquisition of data, and/or Analysis and interpretation of data. Authors contribute in reviewing article critically for significant intellectual content.

Ethics

This article is original and contains unpublished material. Participants are made to know that their feedback will be contributing to the research project. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

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