Strategic Planning of Digital Fabrication Laboratories in the Field of Information System Using Togaf 9.2

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ABSTRACT. This study aims to compile the architecture of digital fabrication laboratories in the field of information systems that are effective and efficient in the knowledge conversion process, which includes the socialization process (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit). This research includes design science research; researchers collect data by conducting semi-structured interviews with five sources, and the data obtain following the five steps in the TOGAF 9.2 framework. This research produces digital architecture fabrication laboratories in information systems that facilitate the conversion of knowledge from the SECI model. This architecture can be a reference for organizations in the field of information systems such as universities in supporting the learning process, especially activities that require a direct direction from experts or practitioners during the COVID 19 pandemic.

Keywords: *Digital labrication laboratories, TOGAF 9.2, Covid 19 pandemic.*

1. INTRODUCTION

The COVID 19 pandemic has an impact on teaching and learning activities that occur in universities. Online classes via video conferencing are a solution for lecturers and students. Application conferences such as google meet, zoom, and others become a medium of exchange or transfer of knowledge. When teaching and learning activities resolve through video conferences, what about learning activities that require expert assistance, in which there is a knowledge conversion process as revealed in the SECI model [1][2][3][4]. The digital fabrication laboratories that have been disclosed by [5][6][7] describe a knowledge exchange place used by experts and individuals who learn to share knowledge or get the learning resources needed. In digital fabrication laboratories, individuals who are learning get assistance and can experiment with projects. This method can help overcome the COVID 19 pandemic's problems to achieve effectiveness and efficiency in exchanging or converting knowledge. During the COVID period, 19 digital business units were very trendy because they really helped the community. The digital business unit is part of the information systems field [8]. Seeing the importance of the right media for knowledge exchange and trends in information systems, attracting researchers to make an IS / IT strategic plan from digital fabrication laboratories in information systems. IS / IT strategic planning made to identify mapping applications that can help organizations [9][10] in the field of information systems to achieve the right digital fabrication laboratories (effective and efficient in the knowledge conversion process). Many methods used to make IS / IT strategic planning, including Ward & Peppard's framework [10], Brumec & Vrček framework [11], James Martin framework [12], Steven H. Spewak's Enterprise Architecture Planning (EAP) Model [12], Zachman Framework [13], TOGAF 9.2 [14].

2. LITERATURE REVIEW

Several frameworks or models use to develop IS / IT strategic planning. The researcher chose TOGAF 9.2 because this model provides a detailed framework that can guide building, managing, and implementing enterprise architectures and information systems. Besides, TOGAF has the advantage of allowing organizations or companies to change their enterprise architecture to follow the needs of the company or organization [15]. Within the TOGAF framework, enterprise architecture artifacts creat to describe an enterprise system, solution, or state. So that organizations can more easily read the plans to be implemented. According to [16], TOGAF has a broader scope than the Ward & Peppard method. TOGAF use for holistic information system planning and technology. Some

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of the concepts underlying this research are as follows:

A. Digital fabrication laboratories

Digital fabrication laboratories first appeared in architectural schools and were initiated using science laboratories as learning media in architectural schools [17]. According to the Encyclopedia Britannica (2011) [17], science laboratories define as a place where scientific research and development are analyzed using many instruments and procedures to study, systematize or measure objects' concern. Procedures that often occur are sampling, pretreatment, treatment, measurement, calculation, and presentation results. [17] explains that science laboratories in architecture schools demonstrate the firik concept in architectural applications and scientific studies. [17] noted that since the late 1990s, several schools began to introduce rapid prototyping and computer-controlled machines, which were later called digital fabrication laboratories. This space makes it possible to use rapid prototyping tools for physical models of digital information. [18] defines three types of engineering laboratories with different objectives, namely research, development, and education. According to them, research laboratories seek broader generalizable and systemic knowledge, thereby contributing to the overall knowledge in a field. In research projects, digital fabrication laboratories combine with the use of science laboratory equipment. In comparison, the development laboratory aims to obtain experimental data as a professional guide in designing and developing products. This laboratory type can also collect specific performance measurements to determine if a design's performance make. At the same time, the purpose of an instructional laboratory defines through learning objectives. Looking at the three types of laboratories based on their purpose, digital fabrication laboratories can fulfill these three laboratories types.

B. Information System Theme

An information system is a set of interrelated elements or components that collect (input), manipulate (process), store and disseminate (output) data and information, and provide corrective reactions (feedback mechanisms) to meet objectives. Feedback mechanisms are components that help an organization achieve its goals, such as increasing profits or improving customer service [19]. According to [19], information systems field studies:

a. Value information is directly related to how information shapes decision-makers to achieve organizational goals.
b. The potential impact of information systems and the application of information systems that can support the achievement of personal, organizational goals and improve quality of life.
c. Use of systems, business managers and systems professionals, and teamwork to successfully implement information systems.
d. The use of information systems to add organizational value and competitive advantage to the organization.
e. Information systems personnel in order to unlock the potential for new systems or system modifications.

C. Strategic Planning SI/TI

Strategic planning is critical for organizations to formulate implementation and evaluation, which in particular determines the survival and progress of an organization in a dynamic environment due to changing environmental factors and uncertainties [20]. According to Hellriegel et al. (2005), in [21], the process of strategic planning is carried out by diagnosing the organization's external and internal environment, deciding the vision and mission, developing overall goals, creating and selecting strategies and allocating organizational goals. Whereas specifically [11] explained that strategic planning of information systems had become a very challenging topic for scientists and practitioners, as has been done by [22] showing that investment in IT provides a return of investment (ROI) much lower than expected. Therefore, planning and implementing modern IT cannot be done exclusively by IT experts but also becomes a fundamental problem for company management. [9] defines IS / IT strategic planning to identify application mapping, namely applications that can assist organizations in implementing and realizing business goals and planning. [9] reinforce by explaining that the result of IS / IT development is a portfolio of implemented applications to create a competitive advantage that is in line with organizational strategy.

D. TOGAF 9.2

The Open Group Architecture Framework is a collection of methods, techniques, and best practices in developing an enterprise architecture managed by TOGAF [14]. TOGAF Version 9.2, launched in 2018 in London, provides an approach to building and implementing the corporate architecture. The TOGAF architecture development

method describes a precise method for building, managing, and implementing corporate architecture and information systems [14]. According to the life cycle architecture, the TOGAF consists of phases described in the form of cycles that allow companies to change their corporate architecture according to the company's needs [15]. Architectural artifacts make to describe systems, solutions, or company conditions used as techniques for the architectural structure of information regularly to be processed to meet stakeholder needs [15]. Here are the phases and artifacts of TOGAF 9.2.

FIGURE 1. TOGAF Stages and Artifacts 9.2 Source: [15]

3. METHODS

This research is a type of design science research that produces artifacts in the form of models from digital fabrication laboratories in information systems. In the data collection process, the study involved 5 (five) respondents using semi-structured in-depth interviews. Respondents were selected using a non-probability sampling method with purposive sampling. The data collection results use as the basis for the preparation of IS / IT strategic planning for digital fabrication laboratories in information systems. The compilation process is carried out by following the TOGAF 9.2 framework, expressly limited in scope to only a few steps, namely preliminary, architecture vision, business architecture, information system architecture, and technology architecture. This limitation carried out considering the resources and time of the research. The preliminary stage will discuss the problems encountered, identify targets for improvement, and identify possible solutions. The architecture vision stage is carried out by identifying the occurring poses. The business architecture stage will identify the business process architecture that occurs. The information system architecture stage identifies the information system portfolio based on the previous stage's data collection results. The technology architecture stage will analyze the required technology.

4. RESULT AND DISCUSSION

A. Preliminary stages

This research's preliminary stage is to identify the problems faced, target improvements, and possible solutions. Based on the results of qualitative data collection, it identified as follows:

TABLE 1. Preliminary Research

PROBLEM FACED	TARGET IMPROVEMENT	POSSIBLE SOLUTION
The need for media brings together experts/practitioners with students who focus on information systems equipped with expert/practitioner repositories, discussion forums, and trial media that receive expert/practitioner assistance.	Developing the right digital media facilitates the experts in sharing and students in learning with expert assistance.	Provision of repository knowledge (explicit knowledge), Focus group discussions classified according to the theme in the field of information systems, virtual test laboratories accompanied by Experts /practitioners at Digital fabrication laboratories in the field of information systems.

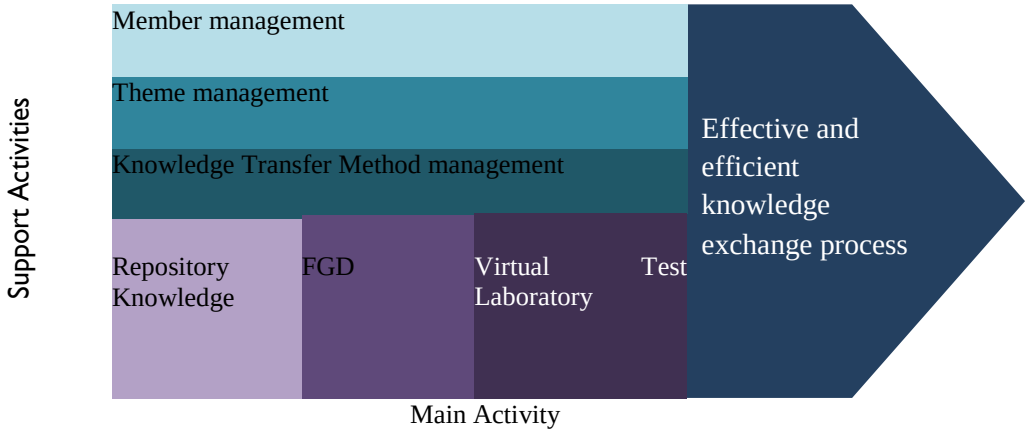

FIGURE 2. Value Chain for Digital Fabrication Laboratories in The Field of Information Systems

The main activity consists of a knowledge repository in the form of an externalization process (tacit knowledge expert to explicit knowledge) and a combination process (grouping or collecting explicit knowledge). The FGD (Focus group discussion) activity is in the form of a socialization process (tacit knowledge expert to tacit knowledge student). Virtual test laboratory in an internalization process (explicit knowledge expert to tacit knowledge student). The three main activities support by member management activities, technology management, theme management, and knowledge transfer management methods. At the same time, knowledge transfer method management is the management of the knowledge transfer method, which is the leading activity choice.

C. Architecture Vision Stage

Digital fabrication laboratories in information systems are knowledge exchange media that allow experts (practitioners) to share knowledge with individuals studying information systems and accompany them. Based on this understanding, to build Digital fabrication laboratories in information systems, a value chain can be described, which in general grouping into two, namely main activities and supporting activities.

B. Business Architecture Stage

Based on the value chain digital fabrication laboratories in information systems, each operational activity's processes and functions can be analyzed as follows:

1) Business process support activities

There are two sub-processes in the supporting activity business process: the presentation of member data and theme data presentation. The following is a table description of the support activity process.

TABLE 2. Description Of Support Activity Process

No of Process	Sub Process	Activity
1.1	Presentation of data member	Management of member Registration
1.2	Presentation of theme data	Management of theme data in Information system

Below is a detail of the business process of the supporting activities.

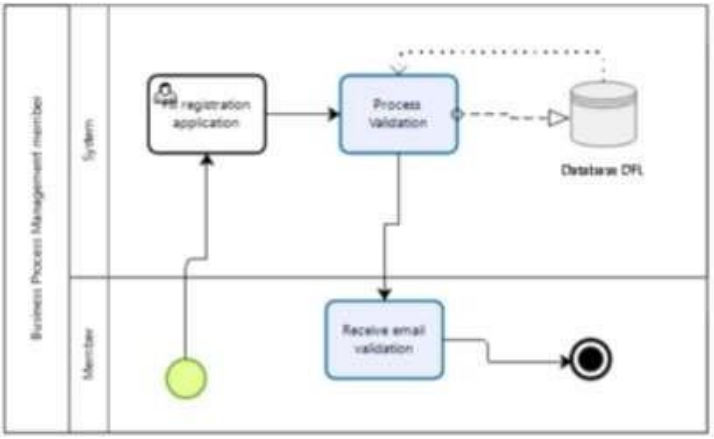

FIGURE 3. *Business Process Registration Member*

The business process for member registration begins with a student/expert/practitioner filling out a registration application, and then validated via email.

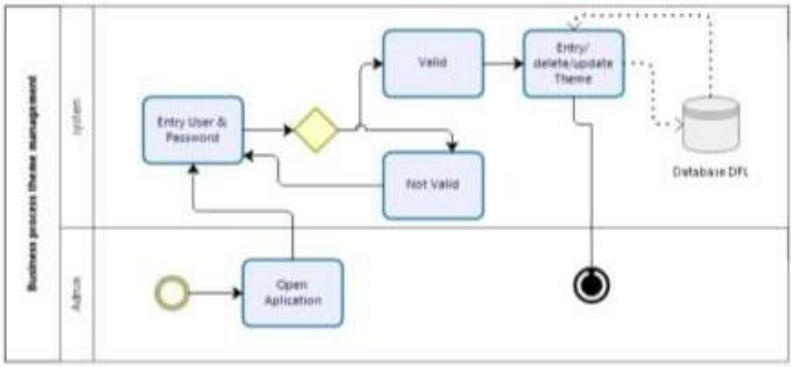

FIGURE 4. Business process theme management

2) Main Activity Business Process

The primary business activity process consists of three sub-processes, namely the presentation of the knowledge repository, the presentation of the focus group discussion, and the virtual laboratory test presentation, with details as presented in the following table.

TABLE 3. Description Of Main Activity Process

No of Process	Sub Proses	Activity
2.1	Presentation *repository knowledge*	Management data *explicit knowledge expert & student*
2.2	Presentation FGD	Discussion topic data management Comment data management
2.3	Presentation Virtual Test Laboratory	Management data test Expert assistance data management Management of trial results

Detail of Main Activity Business Process

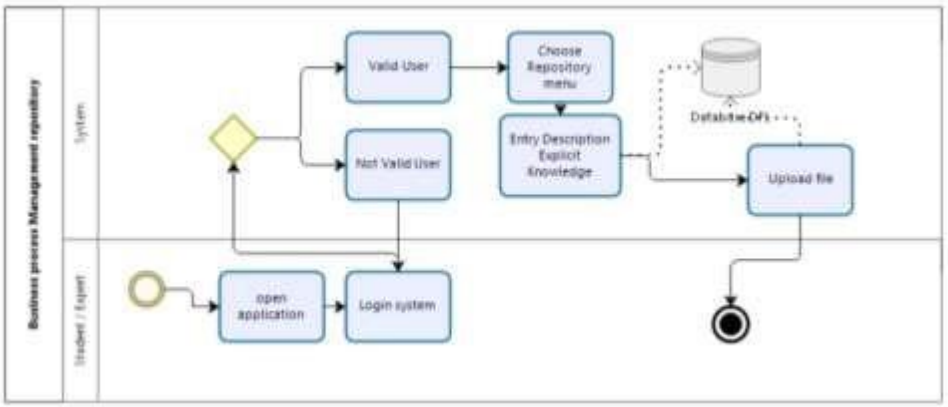

FIGURE 5. Business process entry repository explicit knowledge

The business process for the direct repository entry begins with both student and expert users logging in, then filling in the knowledge description and uploading the file as explicit knowledge.

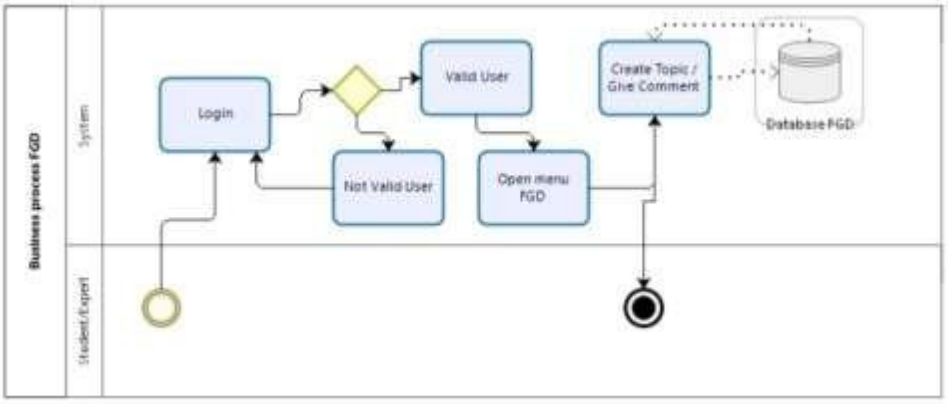

FIGURE 6. Business Process FGD

The business process in focus group discussion begins with the user opening an FGD and creating a discussion topic, from which other users can comment.

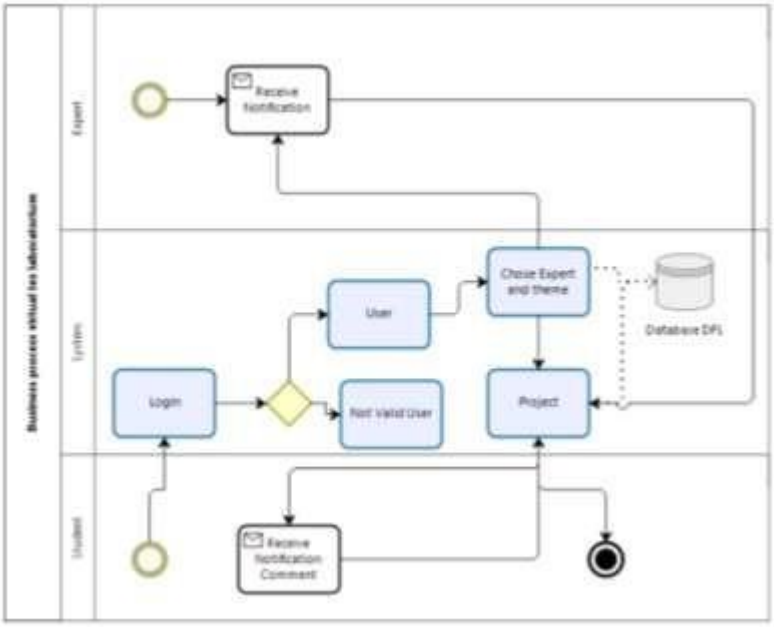

FIGURE 7. Business Process Virtual Tes Laboratory

The business process virtual test laboratory starts with the student logging in, then selecting the expert and theme in the application selection, then filling in the project data and uploading the supporting files. The expert who has been appointed by the student gets a message notification and then reviews and provides comments on solutions that can help the student.

3) Information System Architecture Stage

Based on the predetermined business processes, the following is the information system architecture from the digital fabrication laboratories in information systems:

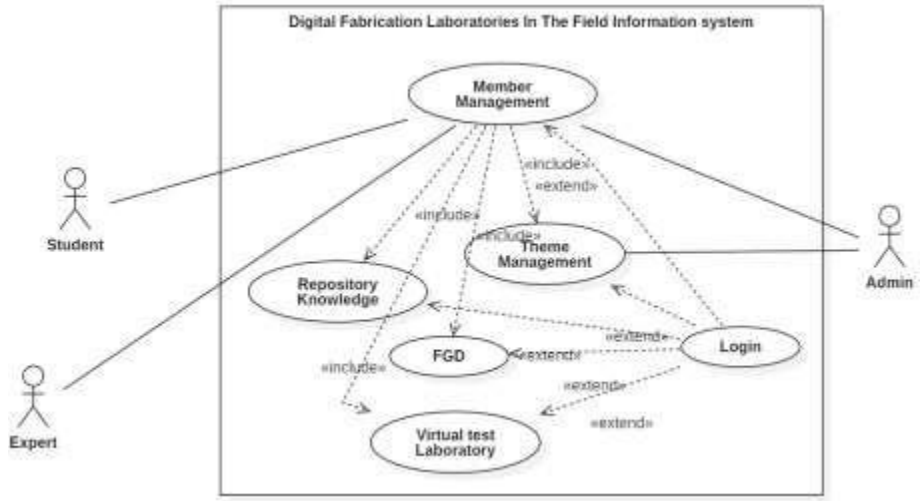

FIGURE 8. Usecase *Digital Fabrictaion Laboratories* in Information System

Based on digital fabrication laboratories in information systems, three actors identified: students, experts, and admins. Besides, there are four use-cases: member management, theme management, knowledge repository, focus group discussion, and virtual test laboratory.

4) Technology Architecture Stage

The next stage is the definition of the Digital Fabrication Laboratories' technology architecture in the Information Systems Field.

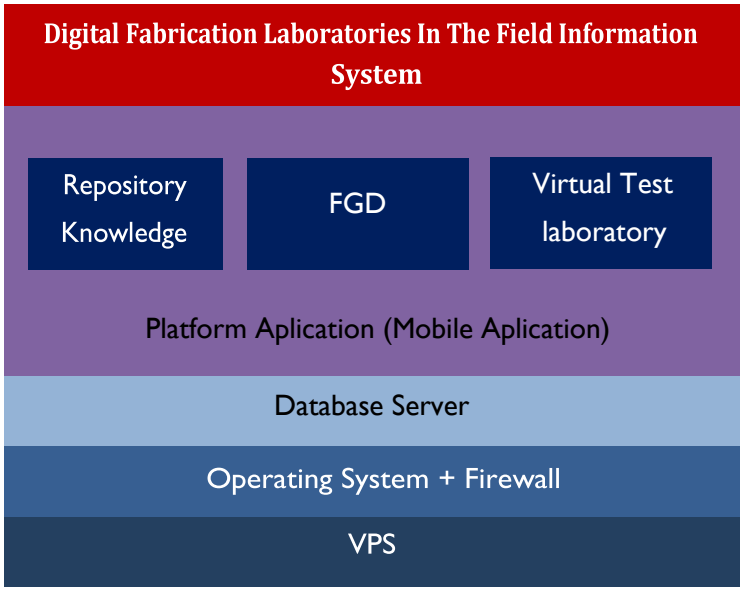

FIGURE 9. Technology Architecture of Digital Fabrication Laboratories in Information System

The technology architecture of the Digital Fabrication Laboratories in the Information System Sector consists of several layers. The lowest layer is physical hardware; researchers chose VPS (Virtual private server) because this is a suitable cloud computing technology that can support endless applications. The second layer is the operating system and firewall; at this second layer, organizations can choose the operating system's platform, namely Windows, Linux, and others. The third layer is the database server, which uses as data storage. The fourth layer is the application platform. The researcher proposes a mobile application platform because users find it easier to use social media on their cellphones from the data collection results. In the Digital Fabrication Laboratories application in the Information Systems Sector, the researcher proposes three features: the knowledge repository, FGD, and virtual test laboratory.

5. CONCLUSIONS AND FURTHER RESEARCH

Based on the description above, it can conclude that there are three features needed in the Digital Fabrication Laboratories architecture in the Information Systems Sector: a knowledge repository, FGD, and a virtual test laboratory. The knowledge repository facilitates the conversion process of knowledge externalization (tacit to explicit) and combination (grouping or collecting explicit knowledge). FGD facilitates the socialization (tacit to tacit) conversion process. Meanwhile, the virtual test laboratory facilitates the Internalization (explicit to tacit) conversion process. So that Digital Fabrication Laboratories in the Field of Information Systems strongly supports the SECI model. This architecture can be a reference for organizations in the field of information systems such as universities in supporting the learning process, especially activities that require a direct direction from experts or practitioners during the COVID 19 pandemic.

ACKNOWLEDGMENTS

Thank you to LPPM, Pamulang University, all fellow lecturers and students as well as the Directorate of Research and Community Service, Ministry of Research and Technology / National Research and Innovation Agency (Ristekbrin) as funders

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