

Designing Business Process Model and Standard Operating Procedures (SOP) of Integrated Laboratory Management At XYZ University

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ABSTRACT

Business processes and Standard Operating Procedures (SOP) are an integral part of organizations as a guideline to do activities to achieve their objectives. However, the integrated laboratory, established in 2020 as one of XYZ University's facilities to support learning and research activities, does not have an SOP yet. Thus, this study aims to design and develop business process models and SOP documents of integrated laboratory management as instructed in the Regulation of Minister of Research, Technology, and Higher Education Number 71 of 2017. The information regarding the business process was gathered by analyzing other laboratories' SOP and interviewing stakeholders. The interviewees were the Head of Integrated Laboratory Center of XYZ and the Head and Secretary of LPPM. After being developed, the business process models and SOP were presented to and approved by the process owner. These study outcomes are 25 business process models and 25 SOP documents of integrated laboratory management that have been verified by the Head of the Integrated Laboratory Center of University XYZ. The SOP documents have been handed over to the Quality Assurance Center of University XYZ to be formalized.

1. INTRODUCTION

An organization is a group of people who work together to achieve their goals. Every organization must provide an excellent service to all the stakeholders (Hamidi & Raflah, 2019). In achieving their goals, organizations certainly have several or groups of activities that they have to perform called business processes (Atrinawati & Pratikta, 2019). A business process is a group of activities in an organization, and the technical team works together to achieve the business goal (Weske, 2007). A business process is a series of tasks in an organization's interconnected relationships that utilize organization resources to get the expected results supporting the organization's process (Harrington, 1991). Organizations should have business process models and standard operating procedures Developed as guidelines for their activities. SOP is a guideline that consists of an organization's sequential tasks to ensure their step, decision, action, the use of resources consistently, effectively, systematically, and standards (Sitorus & Nasution, 2017).

University XYZ has recently established its integrated laboratory, which will support the

learning and research activities in 20 study programs and four research centers. Thus, university XYZ needs to develop SOPs for laboratory management to ensure all research activities can be supported. Furthermore, the Regulation of Minister of Research, Technology, and Higher Education Number 71 of 2017 stated that universities have to develop, organize, and evaluate business process maps and SOP in each unit (Permenristekdikti, 2017). A few studies regarding SOPs for laboratories in universities have been conducted. The SOPs should comply with the Minister of Education and Culture Regulation Number 3 of 2020 about the National Standard of Higher Education. It states that the laboratory is one of the education and research standard facilities and infrastructures that should have quality standards, work safety, health, convenience, users, and environment safety (Permendikbud, 2020). Zuliati (2017) explained that the SOP of equipment operation in the Faculty of Art and Design laboratory at the Indonesia Institute of Art could support learning activities and reduce the risk of error in using laboratory equipment (Zuliati, 2017). Nurhadi (2012) explained that the SOP solved several complex problems: overlapping laboratory usage schedules, unscheduled maintenance, unmonitored equipment usage, and the untraceable loan from the outside laboratory, missing or damaged equipment. This study produced eight SOPs that improve Mechanical Engineering laboratory management (Nurhadi, 2012). Thus, this study aims to answer how to manage research and learning activity in ITK's Integrated laboratory. The activities will be portrayed in business process models and SOP documents of integrated laboratory management using the principles of Business Process Management (BPM) and Business Process Model and Notation (BPMN).

2. METHODS

The research methodology is based on the Regulation of the Minister of Research and Technology. Higher Education Number 71 of 2017 involves several steps, i.e., Analyze Requirements, Design Business Process Model, Verify Business Process, Develop SOP Documents, Validate the SOP Documents, conclusion, and recommendations as shown in Figure 1 (Permenristekdikti, 2017).

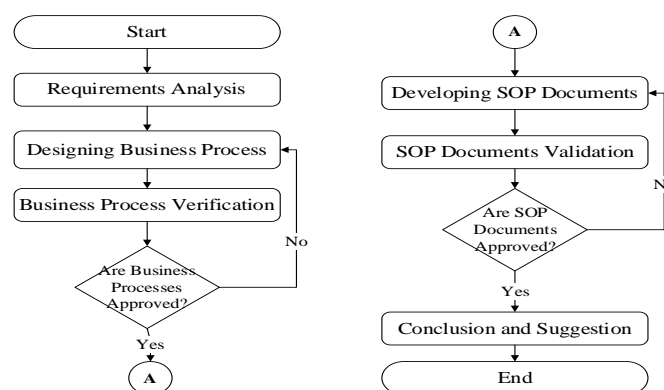


Figure 1. Methodology

2.1. Requirement Analysis

Requirement analysis is a step to identify the Integrated Laboratory management operations (Dumas et al., 2018). Three approaches: goal-based, function-based, and reference model-based. The goal-based approach is identifying processes and goals. The function-based is identifying process based on the task and function. The reference model identifies processes based on other laboratories' best practices and SOP documents. The information-gathering in this step uses two methods: document study and interview (Dumas et al., 2018). Document study is done by reading XYZ's documents and best practices of other laboratory's SOP documents. The interview is conducted with the Head and Secretary of the Research Department and Community Service of XYZ (LPPM), Head of Integrated Laboratory Center. The interview is to obtain a general description of the management process in the Integrated Laboratory Center.

2.2. Designing Business Process Model

Designing the business process model of integrated laboratory management produces flowcharts using the Business Process Model and Notation (BPMN) based on the requirement analysis result. The information-gathering in this step uses two methods: evidence-based discovery and interview-based discovery. Evidence-based discovery is a method that studies the documents owned by XYZ and other university laboratory SOP documents. Interview-based discovery is a method that acquires information through interviews with the Secretary of LPPM of XYZ and the Head of Integrated Laboratory Center. The business process design starts with identifying the resource, identifying process boundaries, identifying activity and events, identifying the control flows, and identifying additional elements (Dumas et al., 2013). The output of this step is the business process model of integrated laboratory management (Dumas et al., 2013).

2.3. Business Process Verification

This step ensures that the business process model has been designed following the integrated laboratory management process requirements. The Head of the Integrated Laboratory Center should verify all business process models. If the business process model is not approved yet, then redesign the model until it is approved. Business process verification also uses the process model quality method that is syntactic quality checking conforms to the rules of notation (Reijers et al., 2015). The output is the business process models that the process owner has approved.

2.4. Developing SOP Documents

After the process owner approves the business process models, the next step is developing SOP documents following the process models. The format of the SOP documents refers to the SOP preparation guidelines of XYZ and the Regulation of Minister of Research, Technology, and Higher Education Number 71 of 2017. The output is SOP documents of integrated laboratory management.

2.5. SOP Documents Validation

After developing SOP documents, the next step is validating and revising the SOP documents as needed. This step uses two methods of validation (semantic quality checking) such as simulation and paraphrastic (Reijers et al., 2015). Simulation is a validation method that refers to presenting the proper behavior of the model to the user in an intuitive way (Reijers et al., 2015). While this is a technique to make a process model understandable to somebody who is not familiar with modeling, this can be easily discussed by the business process owner (Reijers et al., 2015). The output is SOP documents that the Head of the Integrated Laboratory Center has approved.

2.6. Conclusion and Suggestion

The last step of the research is to conclude and provide recommendations for the laboratory SOPs in the University XYZ integrated laboratory.

3. RESULTS AND DISCUSSION

REQUIREMENT ANALYSIS

This step aims to identify the process requirement of Integrated Laboratory Center management. Using two methods of gathering information and three approaches to identify the process, explained the below:

3.1 Document Study

This step uses three approaches to gather data and identify the requirement process. Process identification in the Goal-Based approach is based on the target and objectives of XYZ that are located in the 2020-2024 strategic plan document of XYZ and based on the critical performance indicators document of the university. Process identification in the Function-Based approach is based on tasks and functions of the Integrated Laboratory of XYZ located in XYZ's organization and working procedure document and the duty of the Integrated Laboratory Center based on meeting results on November 30, 2020. Task and function of the integrated laboratory center can be seen in Table 1.

Table 1. Task and Function of Integrated Laboratory Center

Task	Center Task	Function
Carry out activities in a branch of science and technology to support the implementation of education, research, and community service tasks in the environment of XYZ	<p>Arranging the business plan, budget and work program, and procedure of the Integrated Laboratory Center</p> <p>Organizing and controlling the implementation, monitoring, and evaluation of all work programs following the business plan and budget</p> <p>Controlling service quality standard and implementation of practical activities and their development with the coordinator's</p>	-Resource development and empowering all elements of laboratory equipment effectively and efficiently in supporting the science and technology needs to support the implementation of education, research,

<p>department and lecturer</p> <p>Controlling service quality standard and implementation & development of research according to research focus roadmap, i.e., energy, food, maritime, smart city, and community service</p> <p>Responsible for all the laboratory activities and continuity of integrated laboratory management</p> <p>Facilitate the development of lecturer, educational staff, and student competency in conducting the practicum and research</p> <p>Arranging the development plan of laboratory equipment for learning development needs together with the coordinator's department and lecturer, also for research development that focused on energy, food, maritime, smart city, and community service</p> <p>Ratify the implementation procedure of practicum activities, schedule the practicum, facilitate the equipment and material for practicum activities</p> <p>Coordinating the cooperation between integrated laboratory and other parties to improve the quality of the laboratory and its development</p> <p>Proposing standard service rate of training, laboratory analysis, and the other similar services</p> <p>Arranging and preparing the role performance report, being responsible, and reporting the finances following the applicable rules</p> <p>Organizing a laboratory facilitates infrastructures such as treating the laboratory equipment, managing the laboratory utilization, and equipment and supplies</p>	<p>community service, and cooperation.</p> <ul style="list-style-type: none"> -Provide any service and utilization of laboratory equipment and material -Arranging the requirement plan and provision of laboratory equipment and material -Laboratory Equipment Maintenance -Management of laboratory equipment and material
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The last approach is Reference Model-Based is to identify processes based on existing standards. In this case, they were learning the laboratory SOP references from other universities available online the internet, intending to know their laboratory management process. There are several references to the SOP document, as shown in Table 2.

Table 2. The SOP Reference

Num	Process	Mechanical Engineering Lab of Udayana University	Chemical Lab of Tanjung Pura University	Mathematics Lab of Surabaya Institute of Technology	Lampung University Lab
1	Scheduling for practical lecture	v	v	v	v
2	Laboratory utilization	v	v	v	v
3	Laboratory utilization for external				v
4	Equipment & supplies loan	v	v		v
5	Laboratory utilization for research	v	v		v

3.2. Interview

The second method is interviewing parties related to the laboratory management process. The purpose is to ensure that the integrated laboratory center's business process has been identified. The result from the interview showed in Table 3.

Table 3. The Interview Result

Num	Role	Result
1	Vice-Chancellor of Academic	Integrated Laboratory needs.
2	Head of LPPM XYZ	<ul style="list-style-type: none"> • Integrated laboratory management concept
3	Secretary of LPPM XYZ	<ul style="list-style-type: none"> • General description of integrated laboratory center management process • Integrated laboratory management process mapping
4	Head of Student Center	General description of integrated laboratory
5	Head of Integrated Laboratory Center	<ul style="list-style-type: none"> • Identification of business process of integrated laboratory management • Integrated laboratory management process mapping

The data gathered in this step will be processed and analyzed until it generates a candidate for the business process. After that, It obtained a general description of the laboratory management process and a map of the business process integrated laboratory management. Figure 2 shows the process architecture of the integrated laboratory management process that has been modeled by the Business Process Model and Notation (BPMN). Business Process Mapping is shown in Table 4. The business process that has been identified in this step are 25 laboratory management business processes.

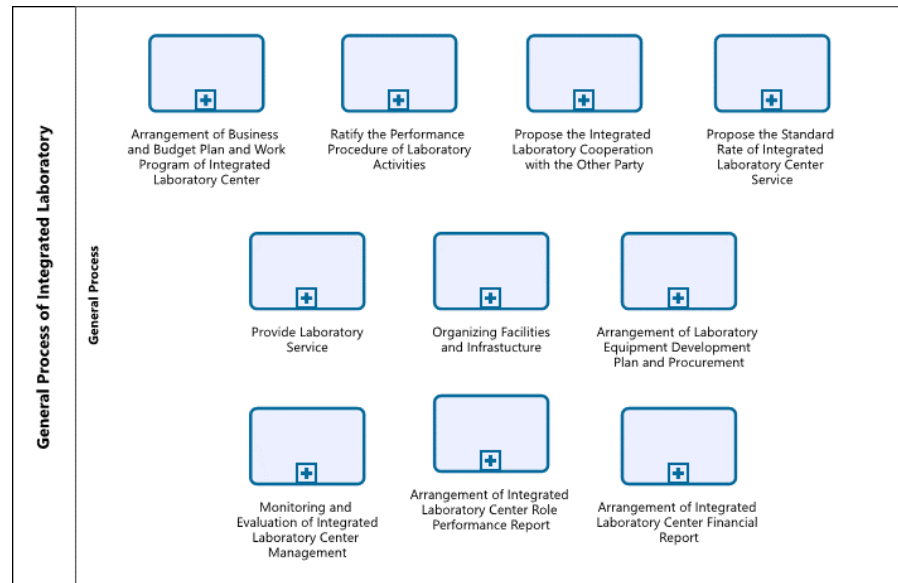


Figure 2. General Process of Integrated Laboratory Management

Table 4. The Business Process Mapping

Business Process Name¹	Safety Lab Induction	Room Utilization for Internal	Laboratory Analysis Service
Business Process Type	Core Process	Core Process	Core Process
Users	User, Laboratory Assistant	User, Laboratory Assistant, Educational Staff, Head of Integrated Lab Center	User, Laboratory Assistant, Educational Staff, Head of Integrated Lab Center
Main Activities	Provide video/work procedure of lab equipment and safety	Provide room utilization service for internal	Provide laboratory sample analysis service
Main Input	Video/work procedure of lab equipment and safety	Room utilization form	Sample analysis request
Main Output	Test result and statement approval have watched/read the induction	Room utilization evidence and service feedback	Analysis report and service feedback
Business Process Owner	Integrated Laboratory Center	Integrated Laboratory Center	Integrated Laboratory Center
Information Source	Organization and working procedure, meeting PowerPoint, and interview of Vice-Chancellor of	Organization and working procedure, meeting PowerPoint, and interview of LPPM secretary	Interview with Head of Integrated Lab Center

Business Process Name ¹	Safety Lab Induction	Room Utilization for Internal	Laboratory Analysis Service
Academic			

1. only shows 3 of 25 business process

DESIGNING BUSINESS PROCESS

After the requirement analysis step, the next step is to design business processes that refer to standard and popular systems that as Business Process Model and Notation (BPMN) with Bizagi. This step uses two methods of gathering evidence-based discovery and interview-based discovery. The result is shown in Table 5 for the evidence-based discovery result and Table VI for the Interview-based discovery result.

Table 5. Evidence-Based Discovery

Num	Document	Information
1	Draft Internal Quality Assurance System Standard of Laboratory Service 2021	<ul style="list-style-type: none"> • Definition of Integrated Laboratory • Definition of Head, Laboratory Assistant, Technician of Integrated Laboratory Center • Definition of Occupational Safety and Health
2	Powerpoint Document of Integrated Laboratory Meeting (November 30, 2020)	Concept proposal of an integrated laboratory of XYZ
3	SOP Document Belong to Other university	Activity flows of laboratory management in other university

Table 6. Interview-Based Discovery

Num	Role	Result
1	Vice-Chancellor of Academic	General description of the practical lecture scheduling process
2	Secretary of LPPM XYZ	Process flow of integrated laboratory management
3	Head of Integrated Laboratory Center	<ul style="list-style-type: none"> • Roles and responsibilities of Integrated Laboratory Center in the laboratory management process • Process flow of integrated laboratory management

The interview aims to ensure the process model has been designed following the requirements and execution of the integrated laboratory management process. The business process model at this step and its relationship with the stakeholder is shown in Table 7. This mapping is to show which stakeholder that responsible for running the business process.

Table 7. Business Process and Stakeholder Mapping

Num	Business Process ²	User	Laboratory Assistant	Educational Staff	Head of Integrated Lab Center
1	Safety Lab Induction	√	√		
2	Room Utilization for Internal	√	√	√	√
3	Room Utilization for External	√	√	√	√
4	Equipment Loan for Internal	√	√	√	√
5	Laboratory Analysis Service	√	√	√	√
6	Material Management		√	√	√

2. Only showed 6 of 25 business process

After that, design the business process with the flow as follows:

a. Identify the Resources

The purpose of this step is to define the resource responsible for the activities of the process. The information on the resource is shown by pool and lane (Dumas et al., 2013). The pool is the diagram area that shows activities carried out by the organization unit or implementer. The line is the diagram area that shows the responsible implementer of the carried-out activities in the Business Plan, Budget, and Work Program arrangement process, such as the Educational Staff, the Head of the Integrated Laboratory Center, and the Laboratory Assistants & Technicians shown in Figure 3.

b. Identify the Process Boundaries

This step aims to discover the scope of the process (Dumas et al., 2013). The first step is to identify the event, a sign that shows an event or incident. First, determine the start event, which indicates where a particular process will start. After that, determine the end event, which indicates where the process will end. For example, in the Arrangement process of the Business Plan, Budget, and Work Program, the process starts with proposing the business plan, budget, and work program and then ends with the Head's approval, as shown in Figure 3.

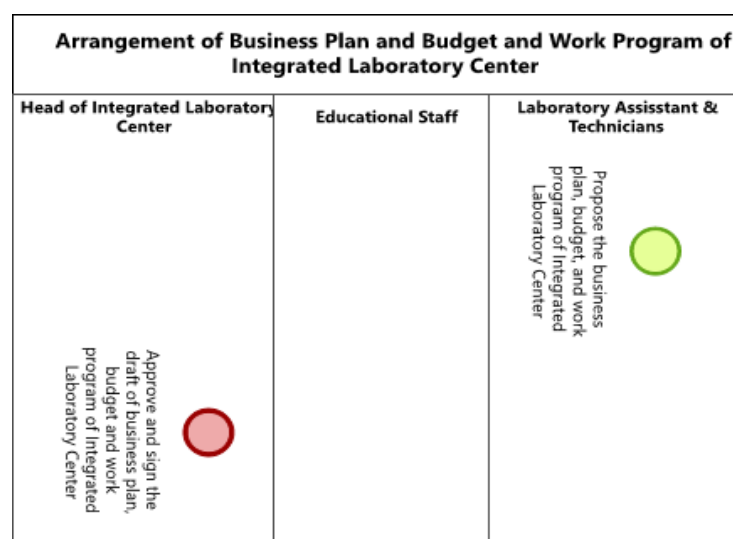


Figure 3. Identify the Resources and Boundaries

c. Identify the Activity and Events

After identifying the scope of the process, the next step is to identify the activity and the events. This step aims to identify the main activity (Dumas et al., 2013). This stage describes the activities with task notation. In Figure 4, the part marked with red boxes shows related and sequential seven activities in the Arrangement process of the Business Plan, Budget, and Work Program.

d. Identify the Control Flows

This step needs to identify the order dependencies, decision points, concurrent execution of activities and events, and potential rework and repetition. Decision points demand the addition of (X)OR splits (Dumas et al., 2013). Structure loops could model rework and repetition. Concurrent execution of activities can be connected with AND gateway. Figure 4 shows that in the Arrangement process of the Business Plan, Budget and Work Program uses (X)OR splits to describe the decision points that occur in the process are marked with yellow boxes.

e. Identify Additional Elements

This step is to identify additional elements in the form of business objects involved in the process, such as data objects, data storage, and annotation (Dumas et al., 2018). Figure 4 shows that the Arrangement process of the Business Plan, Budget, and Work Program has 2 data objects marked with green boxes.

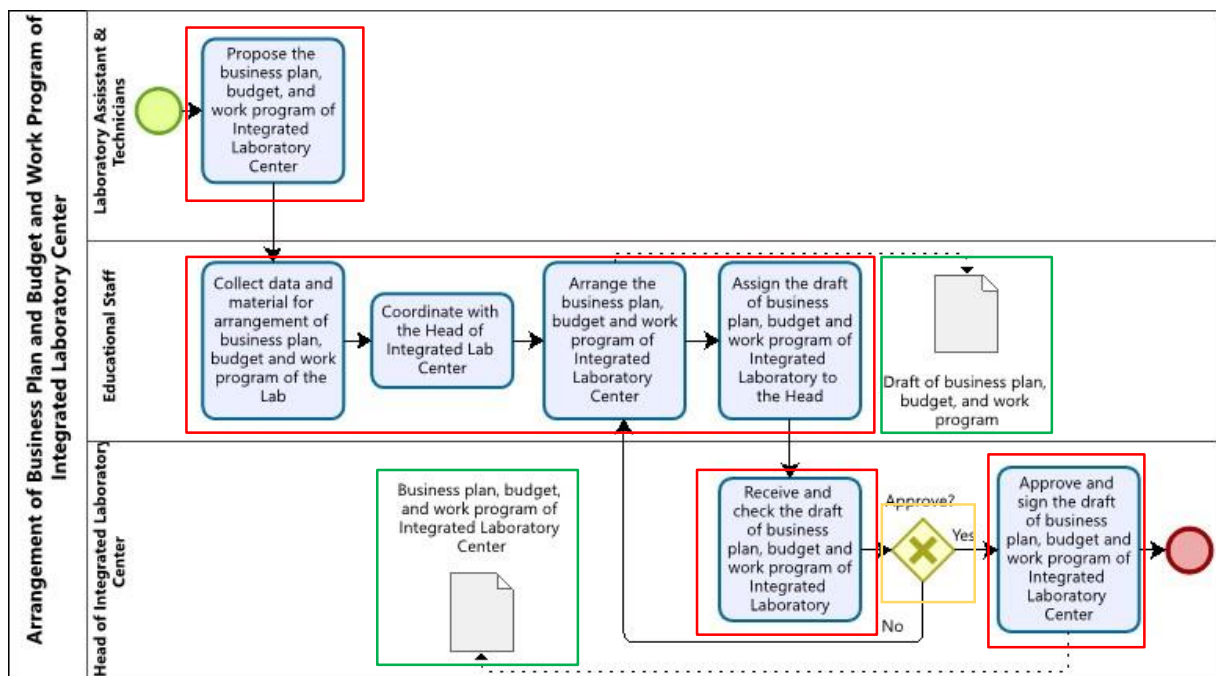


Figure 4. Arrangement Process of Business Plan, Budget, & Work Program

BUSINESS PROCESS VERIFICATION

The business process that has been modeled in the previous step is presented to the

process owner, the Head of the Integrated Laboratory Center, to verify the process model. If the process model is not suitable yet, so redesign the model until the process owner approves it. The evidence of the process model approval is by process model minutes.

DEVELOPING SOP DOCUMENTS

There are 25 developed SOPs using the guidelines from the Minister of Research, Technology, and Higher Education regulation and SOP guidelines of XYZ, as shown in Table 8.

Table 8. List of SOP

Num	Number of SOPs	SOP Title³
1	IT10.II.14/SOP/PPM.04.001	Arrangement of business and budget plan and work program of Integrated Laboratory Center
2	IT10.II.14/SOP/PPM.04.002	Ratify the performance procedure of research and development also a laboratory service
3	IT10.II.14/SOP/PPM.04.003	Propose the Integrated Laboratory Center cooperation with the other party
4	IT10.II.14/SOP/PPM.04.004	Propose the standard rate of Integrated Laboratory Center service
5	IT10.II.14/SOP/PPM.04.005	Arrangement of Integrated Laboratory Center role performance report
6	IT10.II.14/SOP/PPM.04.006	Arrangement of Integrated Laboratory Center financial report
7	IT10.II.14/SOP/AK.01.001	Practical lecture scheduling
8	IT10.II.14/SOP/AK.01.002	Execution of practical lecture
9	IT10.II.14/SOP/AK.01.003	Monitoring and evaluation of execution and practical activities service
10	IT10.II.14/SOP/PPM.01.001	Safety lab induction
11	IT10.II.14/SOP/PPM.01.002	Room Utilization for Internal
12	IT10.II.14/SOP/PPM.01.003	Room Utilization for External
13	IT10.II.14/SOP/PPM.01.004	Laboratory equipment and supplies loaning and return for internal
14	IT10.II.14/SOP/PPM.01.005	Laboratory equipment and supplies loaning and return for external

3. Only showed 14 of 25 SOPs

SOP consists of 2 elements: the SOP documentation element and the SOP element.

a. SOP Documentation Element

This element contains things related to SOP documentation as a document, such as cover, leadership decisions, revision list, table of contents, and a brief explanation about SOP. A brief explanation consists of the purpose, scope, and definition/general term related to the standard procedures.

b. SOP Element

This element is the main element of the SOP document that consists of the SOP identity and procedure section. SOP identity consists of logo and institution name; SOP number; SOP creation, revision, and implementation date; the title of the SOP; SOP approval by the compilers, unit's chair, authorized officials; institutes; linkages; warning; executive qualification;

equipment and supplies; notes and data collection. The procedure section consists of a flowchart that describes a sequence of steps or systematic and sequential activity procedures. This section includes the activities number, steps or procedures; implementer; standard quality, requirement, time, output, and description/notes. The procedure section of the SOP is shown in Figure 5 by taking an example from the Arrangement of the Business Plan, Budget, and Work Program of the Integrated Laboratory.

Arrangement of Business Plan, Budget and Work Program of Integrated Laboratory Center SOP								
Num	Activity	Implementer			Quality Standard			Notes
		Laboratory Assistant & Technician	Educational Staff	Head of Integrated Lab Center	Requirement	Time	Output	
1	Propose the business plan, budget and work program of Integrated Laboratory Center	<pre> graph TD Start([Start]) --> Step1[Propose] Step1 --> Step2[Collect data] Step2 --> Step3[Coordinate] Step3 --> Step4[Arrange] Step4 --> Step5[Assign] Step5 --> Step6{Check} Step6 -- No --> Step4 Step6 -- Yes --> Step7[Approve] Step7 --> End([End]) </pre>			Proposed business plan, budget, and work program	2 days	Proposed business plan, budget, and work program	
2	Collect data and material for arrangement of business plan, budget and work program of Integrated Laboratory Center				Data and supporting material for the arrangement	1 day	Data and supporting material for the arrangement	
3	Coordinate with the Head of Integrated Lab Center				Data and supporting material for the arrangement	1 day	Data and supporting material for the arrangement	
4	Arrange the business plan, budget and work program of Integrated Laboratory Center				Data and supporting material for the arrangement	1 week	Draft of business plan, budget, and work program	
5	Assign the draft of business plan, budget and work program of Integrated Laboratory Center to the Head of Integrated Lab Center				Draft of business plan, budget, and work program	1 day	Draft of business plan, budget, and work program	
6	Receive and check the draft of business plan, budget and work program of Integrated Laboratory Center				Draft of business plan, budget, and work program	2 days	Draft of business plan, budget, and work program	
7	Approve and sign the draft of business plan, budget and work program of Integrated Laboratory Center				Business plan, budget, and work program	1 day	Business plan, budget, and work program	

Figure 5. Procedure Section of SOP

SOP DOCUMENTS VALIDATION

After SOP is developed, the SOP is presented to the process owner, the Head of the Integrated Laboratory Center, to validate the SOP documents. As explained earlier in this step, using two validation methods (semantic quality checking), the simulation has been done in business process model verification and paraphrased conducted by discussing with the process owner, the Head of Integrated Laboratory Center. If the process owner approves the SOPs, the process owner will sign the SOP documents specified in the SOP identity section. The validation in this research is only until the Head approves it of the Integrated Laboratory Center, which is then submitted to the Quality Assurance Center of XYZ to be legalized simultaneously with other work units in XYZ. Validation and verification complement each other (Reijers et al., 2015).

4. CONCLUSION

The result of this research: (1) It has been generated 25 business process models using BPMN with Bizagi software that successfully verified by the Head of Integrated Laboratory Center; (2) The Laboratory has standard operational reference in the form of an SOP document, which is arranged according to the National regulation and SOP guidelines of XYZ. The SOP development produces 25 SOP documents that have been approved by the process owner, the Head of the Integrated Laboratory Center.

The suggestion for further research are (1) Business process that has been modeled, require to research monitoring and evaluation to determine the value of the effectiveness and reliability of the business process.; (2) SOP of integrated laboratory management that has been developed, can be continued with the implementation of the SOP, then conduct the monitoring and evaluation of management activities of XYZ integrated laboratory.

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