

Design Air Conditioner Maintenance SOP based on ISO 9001:2015

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ABSTRACT

Indonesia is a country with a tropical climate. While the dry season comes, the temperatures become very high, which impacts the increase in air conditioner (AC) usage. With the increasing use of air conditioners, air conditioner facilities need to be maintained regularly to keep their functions and machines working well for a long period of time. The implementation of a quality management system, ISO 9001:2015, is the best decision for an organization to develop initiatives. The data required in this research is the quantity of air conditioner along with the description of its condition, the arrangement of the interview protocol, the results of interviews with Mr. Amin, the air conditioner technician, and the entire staff of majors at the Faculty of Engineering, Mulawarman University. Based on the analysis, there are 3 SOPs that are compiled, such as SOP of Air Conditioner Maintenance Requests, SOP of Air Conditioner Maintenance, and SOP of Air Conditioner Monitoring. The parties involved are the user/work unit, internal technician, external technician, general and financial sub-coordinator, and vice dean II as the person in charge. There are several stages in each SOP: SOP of Air Conditioner Maintenance Requests has 7 work steps, SOP of Air Conditioner Maintenance has 13 work steps, and SOP of Air Conditioner Monitoring has 5 work steps. In the entire range of air conditioner maintenance activities, several forms are required, such as the Air Conditioner Maintenance Request, Test, and Evaluation Form; the Air Conditioner Repair Report Form, Test, and Evaluation Form; and the Air Conditioner Monitoring Report Form.

Keywords:

Air conditioner; ISO 9001:2015; maintenance; operational standard procedures

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1. Introduction

Indonesia is a tropical country with two seasons that occur throughout the year. During the dry season, the room temperature is very high. The need for comfort is increasing needs for air conditioning machines. Currently the need for Air Conditioner (AC) is a basic requirement for both buildings with a high scale of use and buildings with a small scale. To maintain the function, age and health of those Air Conditioner, the reliability of the Air Conditioner function must get regular maintenance. Maintenance is all the activities performed to maintain the condition of an item or equipment and restore it to a certain condition. There are three types of Air Conditioners maintenance there is corrective, predictive and preventive maintenance.

Faculty of Engineering, Mulawarman University is one of many institutions that uses Air Conditioner as a tool to improve the comfort of all the people in it. Currently, Faculty of Engineering Mulawarman University has two buildings, namely the new building and the old building. In the old building, there are several rooms namely classrooms, meeting rooms, offices, laboratories and warehouses. The Air Conditioner facilities in the old building there are 52 ½ PK Air Conditioners distributed in several classrooms, 26 Air Conditioners in the Dean's building and several air conditioners in the study program room, hexagon building and laboratory.

Air Conditioner function is to stabilize the temperature and humidity in Faculty of Engineering building. Currently, the Air Conditioner conditions in Faculty of Engineering are in various conditions, such as good condition, reduced or decreased reliability, and damaged or unusable conditions. Therefore, one of the first ways or actions that can be done is to make Standard Operating Procedure (SOP) for air conditioner maintenance in Faculty of Engineering building. With the existence of SOP, the facilities in Faculty of Engineering building can run properly.

Based on the problems described, the formulation of the problem contained in this study is how to design a Standard Operating Procedure (SOP) for maintaining the air conditioner facilities in Faculty of Engineering based on [ISO 9001:2015](#). The purpose of the research is to design SOP for maintenance of air conditioner facilities in the faculty building. The boundary of this research is the object research is the maintenance of air conditioner facilities. This research did not use the implementation stage and the results of the research were in the form of checklists and flow charts or the process of maintaining air conditioner in the Faculty of Engineering, Mulawarman University building.

2. Literature Review

2.1 Maintenance

Based on [Kostas \(1981\)](#), maintenance is all activities related to maintaining a machine/equipment to remain in a condition that is suitable for operation, and if damage occurs, it is endeavored that the machine/equipment can be restored to a good condition. The role of maintenance will be felt when the system starts to experience interference or cannot be operated anymore. The main objectives of maintenance include extending the usability of assets, ensuring the operational readiness of all equipment needed in an emergency at any time, and ensuring the safety of people while using the equipment. There are several types of maintenance, namely Planned Maintenance and Unplanned Maintenance. Planned maintenance is maintenance carried out in an organized manner and in accordance with a previously made maintenance plan. This maintenance is divided into two namely Preventive Maintenance and Predictive Maintenance. Preventive maintenance is a maintenance program that serves to eliminate or take precautions against corrective and breakdown maintenance programs. A good preventive maintenance program can detect and prevent the decline in the function of a machine, equipment, and system. The preventive maintenance program also includes the creation of a maintenance schedule. And predictive maintenance is a condition-based of preventive maintenance program. Instead of relying on industry or plant average lifetime statistics to schedule maintenance activities, predictive maintenance uses direct monitoring of mechanical condition, system efficiency, and other indicators to determine actual averages. Time-to-Failure or loss of efficiency for each machine - train and system in the plant

Unplanned Maintenance is a form of emergency maintenance that can be defined as maintenance that needs to be done immediately to prevent more serious consequences, such as loss of time to produce, major damage to equipment and more expensive repair costs. This maintenance can be divided into 2 namely Corrective Maintenance and Breakdown.

2.2 Standard Operating Procedures (SOP)

In previous research of [Setiaji \(2010\)](#), explained about air conditioning maintenance that must be carried out on a split Air Conditioner with a special review of maintenance schedules, costs incurred to finance routine repairs, costs for electricity consumption used each month for Air Conditioners with routine maintenance and not. In this study, the scheduling used is an average scheduling system that can be applied in the use of small-scale air conditioners. The maintenance scheduling system does not reveal the influence of factors related to Air Conditioning.

[Sanoto \(2020\)](#) explains that Standard Operating Procedures (SOP) are references or guidelines used to evaluate the implementation of an institution's performance based on administrative indicators, technical and procedural indicators in accordance with the work relations in the organization concerned. The Standard Operating Procedures (SOP) purpose to create a commitment that is carried out by each work unit. Standard Operating Procedures (SOP) can be used in all work units, both government work units and work units in the forms of educational institutions. In addition, Standard Operating Procedures (SOP) can also be used to assess the quality of performance of a particular organization.

Four factors that can be used as a basis in determining the format of SOP preparation that will be used by an organization based on the [Minister of Administrative Reform and Bureaucratic Reform of the Republic of Indonesia number 35 of 2012](#), are how many decisions will be made in a procedure; how many steps and sub-steps are needed in a procedure; who is targeted as the SOP implementer; and what objectives are to be achieved in making this SOP. What are the objectives to be achieved in making this SOP. The best SOP format is one that is simple and can convey the required information appropriately and facilitate consistent implementation of the SOP in accordance with the purpose of the SOP.

2.3 Type of Standard Operating Procedures (SOP)

According to [Permenpan \(2008\)](#), based on the characteristics of the activities, SOPs can be categorized into two types, namely Technical Standard Operating Procedures (SOP) and Administrative Standard Operating Procedures (SOP). Technical Standard Operating Procedures (SOP) is a very detailed standard procedure of activities carried out by one apparatus or implementer with one role or position. Each procedure is described very carefully so that there are no other possible variations. This technical Standard Operating Procedures (SOP) is generally characterized by the executor of the activity being one person or one work team unit or one position even with more than one stakeholder and contains detailed steps or how to do the job or detailed steps for implementing the activity. Technical Standard Operating Procedures (SOP) are widely used in fields involving a single implementer who has relatively the same characteristics and with the same role. Administrative Standard Operating Procedures (SOP) are standardized procedures that are general in nature and not detailed from activities carried out by more than one apparatus or implementer with more than one role or position. This administrative Standard Operating Procedures (SOP) is generally characterized by a large number of activity implementers or more than one apparatus or more than one position and not a single unit and contains stages of implementing activities or steps for implementing activities that are macro or micro in nature that do not describe how to carry out activities. Administrative Standard Operating Procedures (SOP) include macro-scope activities with a large scope and do not reflect the implementer of the activity in detail and micro-scope activities with a small scope and reflect the actual implementer of the activities carried out. In the administration of macro-scope government administration, administrative Standard Operating Procedures (SOP) can be used for planning, budgeting, and other processes, or broadly speaking, processes in the government administration cycle.

2.4 Standard Operating Procedures (SOP) of Air Conditioner Maintenance

According to [Adhiatma \(2016\)](#), the preparation of the Air Conditioners maintenance SOP has several stages starting from the checking process. The checking process consists of 2 types of checks, namely flow checks and Air Conditioners output temperatures. Check flow aims to determine the speed of air flow generated by the indoor fan. The tool for checking uses a flowmeter. Check the Air Conditioners output temperature aims to determine the temperature of the air coming out of the Air Conditioners. The checking tool uses a firing thermometer which then immediately knows the measurement results. The next stage is cleaning. Cleaning that is done is cleaning the filter and the entire indoor Air Conditioners unit. How to clean the filter is by removing the filter and then washed clean to remove dirt and dust that sticks. How to clean the indoor unit as a whole is before the electrical circuit (PCB) is closed by a trashbag or other cover so that water does not hit the circuit. The next step is to spray water into the indoor air conditioner until all the dirt is clean and does not stick. The tool used is a katcher, which is a high-pressure water sprayer.

The preventive maintenance steps for outdoor air conditioners have some differences. One of them is that the outdoor Air Conditioners has an evaporator that must be cleaned but does not have a filter like the indoor Air Conditioners. The obstacles or problems that arise after checking are then taken to troubleshooting handling. This troubleshooting is divided into several major problems, namely, among others, the air conditioner does not cool, the indoor AC unit does not turn on and the outdoor Air Conditioners unit does not turn on.

2.5 ISO 9001:2015

The implementation of a quality management system is a strategic decision for an organization that can help the organization to improve its overall performance and provide a solid foundation for sustainable development initiatives. The potential benefits of an organization implementing a quality management system based on international standards are the ability to consistently provide products and services that meet customer needs and applicable legal and regulatory requirements; Facilitate opportunities to improve customer satisfaction;

Addressing risks and opportunities associated with its context and purpose; and Ability to demonstrate conformity to specified quality management system requirements.

This International Standard is based on the quality management principles described in [ISO 9000](#). The description includes a statement of each principle, a rationale for why the principle is important to an organization, some examples of benefits associated with the principle and examples of typical actions to improve organizational performance when applying the principle. The quality management principles are Customer focus; Leadership; Involvement of people; Process approach; Improvement; Evidence-based decision making; and Relationship management.

2.6 Previous Research

[Adhiatma \(2016\)](#) explains that, it focuses on designing SOP and checklists for preventive maintenance programs. The background of the error occurs of multitasking and number of staff who have not been properly trained, so that standards are needed in carrying out preventive maintenance. The observation results are compiled into SOP in tabular form and divided into 4 major activities namely Checking, Cleaning, Lubrication and Troubleshooting. Based on the existing SOP then leads to check sheet as a monitoring tool. Monitoring is carried out with the aim of overseeing the implementation of preventive maintenance and alignment with existing SOP.

According to [Ragilya \(2017\)](#), the process of maintaining a Management Information Systems (DPTSI) ITS Surabaya as a provider of technology and information system services to the academic community of the Sepuluh Nopember Institute of Technology (ITS) Surabaya. Maintenance activities are carried out to ensure that the SIM that has been developed and managed is in accordance with its function and objectives. The SOP document that will be produced from this final project research is an SOP document created based on the gap analysis method to measure the level of gap between the current conditions of the SIM maintenance process at DPTSI ITS Surabaya and ideal conditions according to ISO/IEC 14764 standards:2006 concerning software maintenance and the ITIL v3 framework regarding backup and monitoring activities in the IT Operation Management Function at the Service Operation level. The entire SOP document can later become a reference for the ITS Surabaya PSI DPTSI Sub-Directorate in carrying out the maintenance process for the SIM that has been developed.

According to [Gultom \(2020\)](#), in maintaining the campus environment, special monitoring and evaluation SOP are needed so that fatal errors do not occur as a result of incorrectly determining maintenance actions in the existing environment and the Head of Section can easily monitor, measure, analyze and evaluate every maintenance activity carried out. The purpose of this research is to redesign business processes so that they are better in terms of efficiency and bureaucracy, they do not occur simultaneously, but gradually and do not take a long time so that business processes do not swell and become effective, efficient and flexible business processes. The design of the process of monitoring and evaluating the maintenance of the campus environment is carried out by considering the actual condition analysis and gap analysis with the requirements of [ISO 14001:2015](#) clause 9.1. the process is made into an SOP that can be used as a company guide in monitoring and evaluating environmental maintenance. Through this SOP, it is expected that Telkom University can monitor, measure, analyze and evaluate the results of activities to maintain the campus environment more effectively and efficiently.

3. Methodology

The research method is carried out by extracting information from the parties involved in the information system.

3.1 Preparation of Interview Protocol

The activity of compiling the interview protocol is intended as reference for a list of questions in exploring the current conditions and expectations of the Air Conditioner maintenance process for the administration of the Faculty of Engineering, Universitas Mulawarman.

3.2 Interview

For the process of relevant informants, data and information extraction was carried out using an interview protocol document that had prepared previously. This interview method is carried out to collect information directly from the source. The interview technique itself consists of 3 types, namely structured interviews (in accordance with research guidelines / instruments), semi-structured interviews (interviews runs more flexible and

open, developing research guidelines / instruments), and unstructured interviews (interviews without guidelines / instruments, very free and open). In this final project, the researcher used the semi-structured interview technique.

During the interview process, several clauses from [ISO 9001:2015](#) were used, such as operations, performance evaluation, planning, and other clauses which became the main points and then could be used as material for consideration in making SOP in accordance with [ISO 9001:2015](#) standards.

3.3 Observation

The direct observation method, or this observation is carried out to observe object of research directly in order to find out the conditions that occur. This method aims to obtain information about the real conditions that occur in air conditioner maintenance activities. In other words, researcher can also find out the flow of each Air Conditioners maintenance process at the Faculty of Engineering, Mulawarman University at this time. As well as knowing whether the methods used are effective and efficient.

3.4 Analysis Stage

The data obtained from the interview process and direct observation will then be processed. The data processing method used in this final project research is a descriptive analysis of current conditions, expectations and ideal conditions that refer to and meet predetermined reference standards. The purpose of this data processing method is to be able to provide information in accordance with the needs of the final project research.

The analysis with the [ISO 9001:2015](#) approach focuses on the current condition of the Air Conditioners maintenance process and the ideal condition, namely the flow and control of Air Conditioners maintenance used, starting from the maintenance submission stage, the implementation process to the acceptance and maintenance process. The activity of identifying and analyzing current conditions, expectations and ideal conditions based on the references used aims to map the current conditions and expectations of the Air Conditioners maintenance process.

3.5 Standard Operating Procedures (SOP) Design Stage

The form of designing the structure and content of the Standard Operating Procedures (SOP) made will refer to government regulations which is [Minister of Administrative Reform and Bureaucratic Reform of the Republic of Indonesia number 35 of 2012](#), related to guidelines for the preparation of standard operating procedures for government administration. The drafting of the structure and content of the SOP is carried out as a basic concept in making the SOP. The preparation of the structure and content of the SOP that will be made refers to [ISO 9001: 2015](#). After drafting the SOP, verification activities are performed with the aim of confirming that the creation of the Air Conditioners maintenance SOP document is in accordance with the needs of the Faculty of Engineering, Mulawarman University community.

4. Results

4.1 Data Collection Stage

At the data collection stage, it was found that the total air conditioner in Faculty of Engineering building was 326. With total 281 in good condition, 10 in decreased reliability, and 35 failures. Interviews were aimed at informants who carried out, or found out in more detail about the air conditioner maintenance process carried out by the Faculty of Engineering. Meanwhile, in order to find out the expected conditions related to the air conditioner maintenance process in the future, apart from the staff of the Sub-Coordinating General and Finance, interviews were also conducted with all major staff of Faculty of Engineering, and air conditioner technician.

Observations were carried out at the same time as the interview. From the results of data mining several facts or findings were obtained which generally describe the current condition of air conditioner maintenance which is briefly described in the following points:

1. Visually, the physical condition of the air conditioner, there are air conditioners whose are not intact.
2. Some air conditioner conditions have decreased reliability, which is not in accordance with the set temperature.
3. There is an air conditioner that does not or is not turned on, the reason is unknown due to damage or electricity savings.

4.2 Analysis Stage

Based on current conditions from interviews that have been determined as well as expectations that refer to [ISO 9001:2015](#) such as the implementation of an ideal system with the operations of an organization. There are results from interviews that have been conducted at the previous data collection stage, the results of the interviews can be seen in Table 1 as follows.

Table 1. Percentage of Interview Results.

User	Position	Unschedule Maintenance	Maintenance Flow	1 Day Maintenance	AC Conditions
1	General and Finance Sub-Coordinator	100 %	100 %	100 %	-
2	Technician	100 %	-	-	-
3	Staff of Civil Engineering Study Program	100 %	40%	20%	60%
4	Staff of Environmental Engineering Study Program	100 %	100 %	80%	100%
5	Staff of Information System Study Program	100 %	-	-	100 %
6	Staff of Informaics Study Program	100 %	-	-	100 %
7	Staff of Geology Engineering Study Program	100 %	100 %	80%	80%
8	Staff of Industrial Engineering Study Program	100 %	40%	20%	100 %
9	Staff of Mining Engineering Study Program	100 %	100 %	80%	80%
10	Staff of Architecture Study Program	100 %	-	-	100 %
11	Staff of Electrical Engineering Study Program	100 %	-	-	100 %

After that, analyzed the Current Conditions, Expectations and Ideal Conditions based on the reference used, namely [ISO 9001: 2015](#). The result of the analysis is in Tabel 2.

Table 2. Analysis of current conditions, expectation, and ideal conditions.

No.	Criteria	Condition		
		Current	Expectations	Ideal
1.	Maintenance of AC Facilities	Unscheduled	There is a maintenance schedule	Routine maintenance every 3 months.
2.	Technicians	External	Internal	Having 2 internal and external technicians. In-house technician for light work.
3.	Estimated repair time	2 weeks	3 working days	3 working days. One day for reporting, the 2nd day for repairs and the 3rd day for monitoring.
4.	Workflow	Complicated	Easy and fast	SOP for workflow.

4.3 Standard Operating Procedures (SOP) Design Stage

In handling the air conditioner maintenance process, based on [ISO 9001:2015](#) which includes planning, operations and performance evaluation, there are several SOP proposed, such as SOP for Requesting Air Conditioner Maintenance, SOP of Air Conditioner Repair, and SOP of Air Conditioner Monitoring. The proposed Standard Operating Procedure (SOP) are in Tabel 3.

Table 3. Proposed SOP.

Proposed SOP	Explanatory
Submission / Request for Air Conditioner Maintenance	The procedure for submitting/requesting Air Conditioner maintenance is made with the aim of serving as a reference/guide in carrying out the Air Conditioner maintenance process at an early stage, namely processing requests for Air Conditioner maintenance by Air Conditioner users (both individual customers/units) to recording receipt of requests before maintenance activities are carried out on the Air Conditioner. The reason for making this SOP is because so far the Faculty of Engineering's General and Finance Sub-Coordinator has not had written procedures for the activity of submitting Air Conditioner maintenance request reports, where the maintenance request referred to in this SOP is maintenance that is only related to the work scope of the FT General and Finance Sub-Coordinator.
Air Conditioner repair	This Air Conditioner repair procedure is made with the aim of being a reference/guide in carrying out Air Conditioner repair/maintenance activities. The reason for making this procedure is because so far there is no written procedural document in carrying out Air Conditioner maintenance.
Air conditioning monitoring	This Air Conditioner monitoring procedure contains guidelines that can be used as a reference/guidance in carrying out Air Conditioner monitoring. The purpose of this procedure is to provide a reference/guidance in carrying out the process of monitoring Air Conditioner maintenance related to one of the tasks of the General and Finance Sub-Coordinating staff, namely identifying and checking that electronic facilities in the Faculty of Engineering are running well. With this procedure, it can facilitate and speed up the process of identification and checking, as well as being able to carry out documentation.

The design of the structure and content of this SOP refers to government regulations with the aim of making it easier for researchers to prepare the content structure of the AC maintenance SOP document, as well as making it easier for the General and Financial Sub-Coordinator Staff in the future to carry out the procedures that have been prepared. Researchers did not use the entire content structure of the reference but adjusted it as needed. The structure of the SOP document that will be prepared is then submitted as a product book that will be given to the General and Financial Sub-Coordinator. The structure or content that will be included in the AC maintenance SOP document framework is described in Table 4.

Table 4. Draft SOP Structure and Content.

Chapter	Sub-Chapter	Content
Document Details	Endorsement Column	
	Document Description	
	Revision History	
Introduction	Purpose	
	Scope	
	SOP Content	
	Organizational Structure	Roles and Responsibilities
AC Maintenance Request Procedure	Definition	Maintenance Request Definition
		Main Objective
	AC Maintenance Request Performance Measurement Indicator	
	AC Maintenance Request SOP	SOP Description and Information
		Flow of AC Maintenance Request Procedure Stages
AC Repair Procedure Definition of Repair	Definition	Repair Definition
		Main Objective
	AC Repair Performance Measurement Indicators	
	AC Repair SOP Description and Information	Description and Information SOP
		Flow of AC Repair Procedure Stages
AC Maintenance Monitoring Procedure	Definition	Definition of Request
		Main Objective
	AC Monitoring Performance Measurement Indicators	
	AC Maintenance Monitoring SOP	SOP Description and Information
		Flow of AC Maintenance Monitoring Procedure Stages

The following is an explanation of each procedure and form along with the equipment and requirements needed for the activities in it, described in Table 5.

Table 5. Draft SOP Structure and Content.

No SOP	Name of SOP	No Form	Name of Form
SOP – SubkooorUK - 001	Air Conditioner Maintenance Request Standard Operating Procedure (SOP)	FRM – SubkooorUK - 001	Air Conditioner Maintenance Request Form
SOP – SubkooorUK - 002	Air Conditioner Repair/Maintenance Standard Operating Procedure (SOP)	FRM – SubkooorUK - 002	Air Conditioner Repair Report Form
SOP – SubkooorUK - 003	Air Conditioner Maintenance Monitoring Standard Operating Procedure (SOP)	FRM – SubkooorUK - 003	Air Conditioner Monitoring Inspection Form

The following are the key performance indicators that exist in each SOP, which are described in Table 6.

Table 6. Draft SOP Scope and Content Based on Key Performance Indicator.

AC Maintenance Request Performance Measurement Indicator Procedure (SOP – SubkooorUK – 001)	-	Number of AC maintenance requests reported by documented customers/units.
	-	Number of requests related to AC maintenance that can be completed (e-tickets with closed status).
AC repair (SOP – SubkooorUK – 002)	-	Number of documented AC repair/maintenance activities.
	-	Number of AC repair/maintenance activities from customer/unit requests that can be completed.
	-	Number of documented testing and evaluation of repair/maintenance activities. Performance Measurement Indicator Procedure
	-	Average time taken to perform repair/maintenance activities.
AC monitoring (SOP – SubkooorUK – 003)	-	Time period to perform AC monitoring activities.
	-	Number of air conditioners that are managed to be down/damaged after repair.
	-	Number of documented monitoring issues.

The guidelines for making the SOP itself, researchers use references from the regulation of the Minister of Administrative Reform and Bureaucratic Reform of the Republic of Indonesia regarding guidelines for the preparation of standard operating procedures number 35 of 2012. For the model or format that will be used by researchers for making this SOP is to use a flowchart form, this is because of the many work steps and decisions that exist. For the making of the SOP document itself, it was carried out offline, in accordance with the agreement between the researcher and the General and Financial Sub-Coordinator of the Faculty of Engineering, Mulawarman University. Documents made offline are all forms made in the SOP. In addition to forms, the creation of reports and checklists is also done offline. In this section, an explanation of each procedure and form will be presented along with the equipment and requirements needed for the activities in it.

The AP SOP format required in the Bureaucratic Reform Policy has a standardized format unlike the SOP format in general. The AP SOP format used in the Bureaucratic Reform Policy is the Branched Flowchart Format, Using only Five Flowcharts Symbols, and the Executor is separated from the activity. The format used in the AP SOP is a branched flowchart format and no other formats are used. Using only Five Flowcharts Symbols, the symbols used in SOP AP only consist of 5 (five) symbols, namely 4 (four) Basic Symbols of Flowcharts and 1 (one) Off-Page Connector symbol. Therefore, to avoid unnecessary repetition and inefficient overlapping, the writing of activities is not accompanied by implementers (actors) and is separated in a separate implementer column.

Accordingly, the writing of activities uses active verbs followed by objects and descriptions such as writing reports; documenting complaint letters; compiling meeting materials; sending invitation letters to participants; examining files, signing draft net letters, archiving documents. The writing of the implementers (actors) is not sorted hierarchically but is based on the sequence of activities so that activities always start from the left side and no activities start from the center or right side of the flowchart matrix.

4.4 Standard Operating Procedures (SOP) Verification Stage

Verification is carried out with the aim of ensuring the correctness of data and information, especially the activities and flows contained in the air conditioner maintenance SOP document that has been made. Certification of SOP for air conditioner maintenance is carried out by conducting interviews with the head and sub-coordinator of General and Finance, Faculty of Engineering, Mulawarman University. From the verification result obtained, changes/improvements were made to flows, activities and other information in the SOP that were not in accordance with the wishes of the General and Finance Sub-Coordinator. Using [ISO 9001:2015](#) as reference of the SOP might be create the expectation so it can have a positive impact on the existing system. However, the biggest challenge in implementing it is the consistency of the stakeholders who run the system.

4.5 Final Stage

The final stage in designing Air Conditioner Maintenance SOP is as follows:

The SOP for Requesting Air Conditioner Maintenance is a guide used by the General and Finance Sub-Coordinator in carrying out the Air Conditioner Maintenance process at an early stage, such as processing requests

dor air conditioner maintenance by the working unit to recording receipt of requests before maintenance activities are carried out on the air conditioner.

Air conditioner repair or maintenance SOP is a guide used by the General and Finance Sub-Coordinator in carrying out the air conditioner maintenance process at an advanced stage, namely carrying out air conditioner repair or maintenance activities based on requests for repairs by the working unit or from the internal wishes of the General and Finance Sub-Coordinator.

The SOP for monitoring air conditioner maintenance is a guide used by the General and Finance Sub-Coordinator in carrying out the air conditioner maintenance process at the final stage, such as providing guidance in carrying out air conditioner monitoring activities. In carrying out air conditioner monitoring, an air conditioner monitoring inspection form will be required. The inspection form will be used to monitor air conditioner maintenance carried out by building staff within 2 weeks.

5. Discussions

The data needed in this study are the quantity of air conditioners along with a description of the condition of the air conditioners, compiling an interview protocol to facilities the interview process, interviews with the General and Finance Sub-Coordinator of the Faculty of Engineering, Mulawarman University, interviews with air conditioner technicians and a few of the interview result of all major staff of Faculty of Engineering, Mulawarman University.

The data collection process started from compiling an interview protocol, making observations by counting the number of air conditioners, so the quantity of air conditioners could be known, conducting interviews with the major staff of Faculty of Engineering to find out the quantity of air conditioners in the study program rooms as well as to find out the stages in submit an application for air conditioner maintenance at Faculty of Engineering. Conduct interviews with the General and Finance Sub-Coordinator of the Faculty of Engineering to find out the flow of applying for air conditioner maintenance in Faculty of Engineering building, conduct interviews with air conditioner technicians to find out the stages of the Faculty of Engineering is calling air conditioner technician.

The result of data collection are processed and used as a reference in designing air conditioner maintenance SOP. In designing air conditioner maintenance SOP, there are two steps, such as designing SOP documents and designing SOP structure and content.

In making the air conditioners maintenance SOP document, there are three stages, such as creating the SOP structure and content, creating the SOP document and verifying the SOP. The SOP document that has been made will be verified, the submitted to the General and Finance Sub-Coordinator, Faculty of Engineering, Mulawarman University.

There are 3 (Three) SOP that prepared, namely SOP Requesting/Submitting Air Conditioner Maintenance, SOP Repairing Air Conditioner and SOP Monitoring Air Conditioner. The parties involved in the SOP are the user/working unit, internal technicians, external technicians, General and Finance Sub-Coordinator, then the PIC (Person in Charge). There are several staged in each SOP, namely the SOP Requesting/Submitting Air Conditioner Maintenance has 7 steps, then SOP Repairing Air Conditioner have 13 steps and SOP Monitoring Air Conditioner have 5 steps. In the entire process of Air Conditioner maintenance activities, several forms are required, namely the Air Conditioner Maintenance Request, Test, and Evaluation Form, Air Conditioner Repair Report, Test, and Evaluation Form, and Air Conditioner Monitoring Report Form.

6. Conclusion

The conclusion made are the answers to the formulation of the problems that have been previously defined and based on the results of the research that has been done. The conclusions obtained from the analysis stage to the design and validation of product documents are:

1. The SOP document consist of a flow of procedures, with the use of a form that makes it easier for the General and Finance Sub-Coordinator to document air conditioner maintenance activities.
2. In preparing the Standard Operating Procedure (SOP) for air conditioner maintenance, it was proposed to make 3 procedures, namely SOP Requesting/Submitting Air Conditioner Maintenance, SOP Repairing Air Conditioner and SOP Monitoring Air Conditioner. The entire contents of the SOP document are recorded

separately from this final project book and become a product document entitled Standard Operating Procedure (SOP) document for Air Conditioning Maintenance at the Faculty of Engineering, Mulawarman University.

3. SOP document testing is carried out by interviewing to verify documents. After the verification is complete, the document is in accordance with the requirements and the planned to implemented. With the creation of the air conditioner maintenance SOP document, it is hoped that it can help improve staff performance within the Faculty of Engineering, Mulawarman University.

The suggestion that the author can give is divided into 2 types suggestion, there is suggestions to the implementer of the Air Conditioner Maintenance SOP, namely the General and Financial Sub-Coordination of the Faculty of Engineering, Mulawarman University, and other suggestions to researchers who will conduct further research. Suggestions that can be given to parties related to the Air Conditioner Maintenance flow at the Faculty of Engineering, Mulawarman University, namely the author suggests that the SOP document that has been tested can be really implemented properly; Internal Technicians are needed at the Faculty of Engineering, Mulawarman University; and There needs to be an evaluation every 6 months of the implementation of the Air Conditioner Maintenance SOP so that it is known whether the staff has carried out the Air Conditioner maintenance process in accordance with the SOP, and whether there are obstacles or other problems that cause the need to change the procedure in Air Conditioner maintenance in the SOP.

And suggestion that the author can give for further research is that this research only limited to making SOP documents without monitoring the implementation of the SOP. For further research, testing and evaluation of the effectiveness of this SOP document on the Air Conditioner maintenance process carried out by the General and Financial Sub-Coordination of the Faculty of Engineering, Mulawarman University; The media used at this time is still manual. For further research, it can be developed to the results of SOP or administration online; and For further research, it can create work instructions as a form of refinement of the Air Conditioner Maintenance SOP document.

This purposed SOP can be applied to institutions that have a less structured maintenance system, such as other buildings around the Mulawarman University, public services offices, and so on.

Acknowledgments. None.

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Appendix

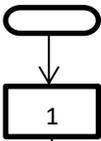
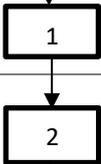
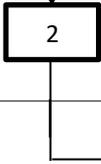
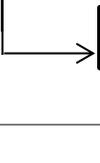
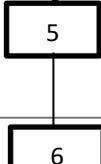
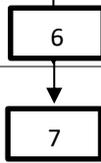
Appendix 1

Description of SOP for Submitting/Requesting of Air Conditioner Maintenance.

AIR CONDITIONER MAINTENANCE REQUESTS		
 <p>Faculty of Engineering Mulawarman University</p>	SOP Number	SOP – SubkooorUK - 001
	SOP Title	SOP of AC Maintenance Request
	Published Date	
	Revision Date	
	Applies Date	
	Confirmed by	Vice-Dean II Faculty of Engineering,
		Ir. Budi Nining Widarti, S.T., M.Eng. NIP. 198107032006042002
SOP Description	Qualification and List of Implementers	
The SOP for submitting/requesting AC maintenance is a guide used by the General and Finance Sub-Coordinator in carrying out the AC maintenance process at the initial stage, namely carrying out the AC maintenance request process by the work unit to recording the receipt of the request before carrying out maintenance activities on the AC.	List of Implementers: <ul style="list-style-type: none"> - Building Staff - Sub General and Finance Coordinators - Working Unit Qualification of Implementers <ul style="list-style-type: none"> - Have good technical skills - Having good interpersonal ability - Have knowledge of the flow of AC maintenance requests 	
Context		
SOP Air Conditioner Maintenance		
REFERENCES	EQUIPMENT/REQUIREMENTS	
ISO 9001:2015	<ul style="list-style-type: none"> - Media: telephone/SMS/e-mail/WhatsApp - Air Conditioner maintenance request form (FRM – SubkooorUK – 001) 	
Reminder	DATA COLLECTION	
If this SOP is not implemented, then handling related to AC maintenance is delayed or cannot be carried out.	<ul style="list-style-type: none"> - Record the identity of the work unit - Record detailed information related to Air Conditioner maintenance requests obtained directly from the working unit 	

Appendix 2

Submitting/Requesting of Air Conditioner Maintenance Flow

Submitting Requests of Air Conditioner Maintenance Flow						
Procedure Activities of Air Conditioner Maintenance Request	Implementers			Requirements	Time	
	Working Unit	PIC (WD II)	Sub General and Finance Coordinators			
1. There is a problem with the Air Conditioner				Maintenance is approved for problems such as the AC leaking, the AC not cooling, the AC making noises and other damage.	2 minutes	
2. Submitting the Request to Maintenance the Air Conditioner				Fill out the AC maintenance request form and reports directly via telephone/SMS/e-mail/WhatsApp	3 minutes	
3. Accept the Air Conditioner Maintenance request				General and Finance Sub Coordinators standby during working hours	5 minutes	
4. Report the Request				Announcement of maintenance submission reports is submitted via telephone/SMS/e-mail/social media (WhatsApp/Line)	5 minutes	
5. Receive maintenance request report for carrying out repair activities.				Receive announcement of maintenance submission reports submitted via online form or via telephone/SMS/e-mail/social media (WhatsApp/Line)	2 minutes	
6. Collecting the requests				Fill out the form	5 minutes	
7. Run the maintenance activities				Maintenance activities refer to SOP that valid (SOP – SubkoorUK – 002)	Depends of the activites.	

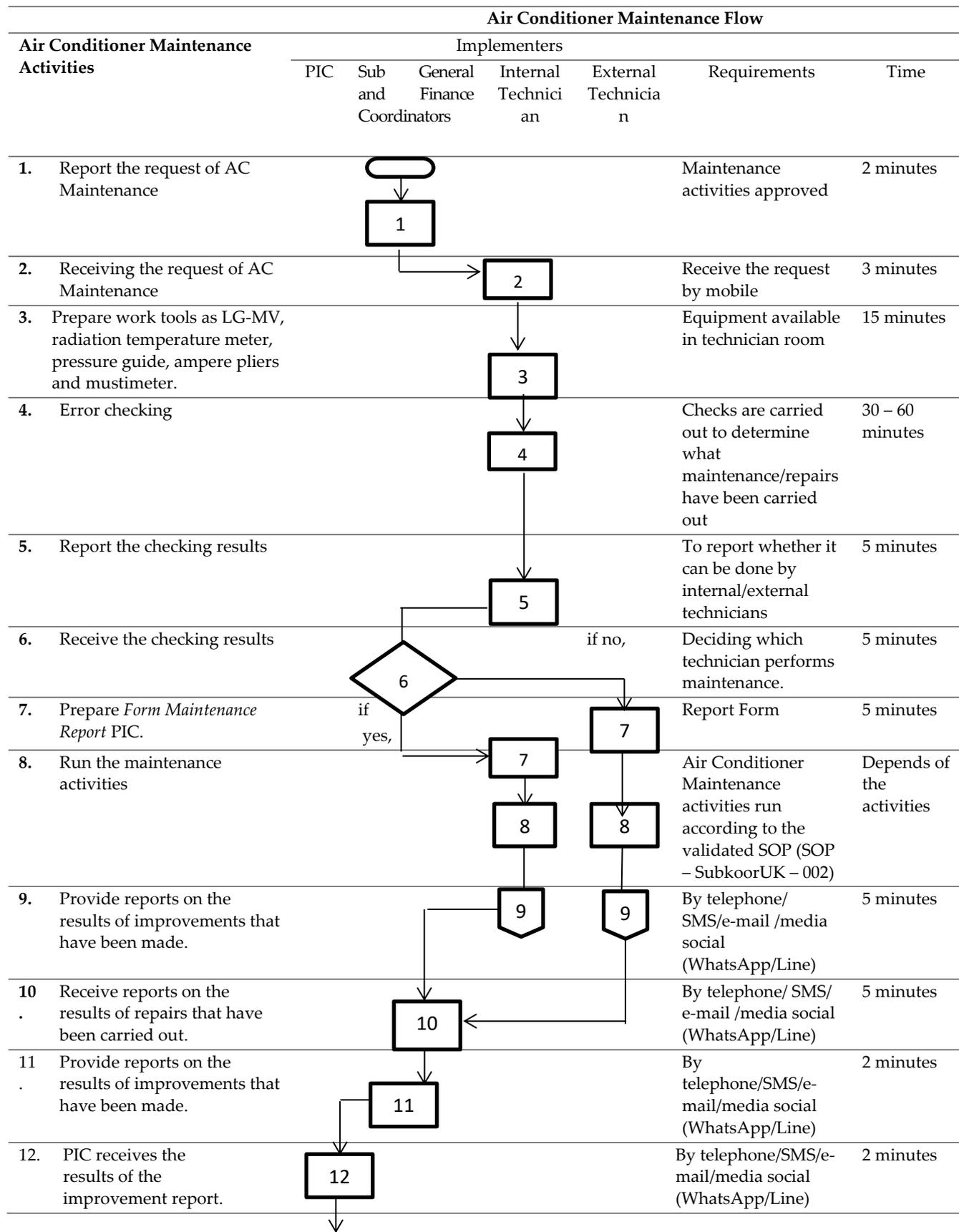
Appendix 3

Description of Air Conditioner Maintenance SOP

AIR CONDITIONER MAINTENANCE		
	SOP Number	SOP – SubkooorUK - 002
	SOP Title	SOP of AC Repair/Maintenance
	Published Date	
	Revision Date	
	Applies Date	
	Confirmed by	Vice-Dean II Faculty of Engineering,
<p>Faculty of Engineering Mulawarman University</p> <p style="text-align: right;">Ir. Budi Nining Widarti, S.T., M.Eng. NIP. 198107032006042002</p>		
Description of SOP	Qualification and List of Implementers	
The SOP for AC repair or maintenance is a guide used by the General and Finance Sub-Coordinator in carrying out the AC maintenance process at an advanced stage, namely carrying out AC repair or maintenance activities based on requests for repairs by work units or internal wishes of the General and Financial Sub-Coordinator.	<p>List of Implementers:</p> <ul style="list-style-type: none"> - PIC (Vice-Dean II) - Sub General and Finance Coordinators - Internal Technician - External Technician <p>Qualification of Implementers</p> <ul style="list-style-type: none"> - Have good technical skills - Having good interpersonal ability - Have knowledge of the flow of AC maintenance requests 	
Context	-	
REFERENCES	EQUIPMENT/REQUIREMENTS	
ISO 9001:2015	<ul style="list-style-type: none"> - Media: telephone/SMS/e-mail/WhatsApp - Air Conditioner maintenance request form (FRM – SubkooorUK – 001) 	
REMINDERS	DATA COLLECTION	
If this SOP is not implemented then there are several repair/maintenance processes on the AC that cannot be carried out and are not properly documented.	<ul style="list-style-type: none"> - Record identification and monitoring results to verify AC repair/maintenance requests. - Record detailed information on AC repair/maintenance activities carried out. - Record detailed plans and test results as well as evaluation of AC repair/maintenance activities carried out. 	

Appendix 4

Air Conditioner Maintenance Flow



Appendix 5

Description of Air Conditioner Maintenance Monitoring SOP



Faculty of Engineering
Mulawarman University

Air Conditioner Monitoring

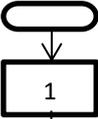
SOP Number	SOP – SubkooorUK - 003
SOP Title	SOP of AC Maintenance Monitoring
Published Date	
Revision Date	
Applies Date	
Confirmed by	Vice-Dean II Faculty of Engineering,

Ir. Budi Nining Widarti, S.T., M.Eng.
NIP. 198107032006042002

Description of SOP	Qualification and List of Implementers
The AC maintenance monitoring SOP is a guide used by the General and Finance Sub-Coordinator in carrying out the AC maintenance process at the final stage, namely providing guidance in carrying out AC monitoring activities.	<p>List of Implementers:</p> <ul style="list-style-type: none"> - Sub General and Finance Coordinators - PIC (<i>Person-In-Charge</i>) <p>Qualification of Implementers</p> <ul style="list-style-type: none"> - Have good technical skills - Having good interpersonal ability - Have knowledge of the flow of AC maintenance requests
Context	
Air Conditioner Maintenance SOP	
REFERENCES	EQUIPMENT/REQUIREMENTS
ISO 9001:2015	<ul style="list-style-type: none"> - Media: telephone/SMS/e-mail/WhatsApp - AC Monitoring Report Form (FRM – SubkooorUK – 003) - Unit Inspection Report Form (FRM – SubkooorUK - 004)
REMINDERS	DATA COLLECTION
If this SOP is not implemented then there are several repair/maintenance processes on the AC that cannot be carried out and are not properly documented.	<ul style="list-style-type: none"> - Record details of AC monitoring activities carried out. - Record detailed plans and test results as well as evaluation of AC monitoring activities carried out.

Appendix 6

Air Conditioner Maintenance Monitoring Flow

Air Conditioner Monitoring Flow					
Air Conditioner Monitoring Activities	Implementers			Requirements	Time
	PIC	Sub and General Finance Coordinators			
1. Monitoring AC maintenance activities that have been carried out				Improvement activities have been carried out	2 minutes
2. Checking				In the form of a checklist and several questions to users/work units regarding the condition of the AC after repairs.	15-20 minutes
3. Provide reports on the results of monitoring that has been carried out.				Via telephone/SMS/e-mail/social media (WhatsApp/Line)	2 minutes
4. Receive monitoring report results.				Via telephone/SMS/e-mail/social media (WhatsApp/Line)	2 minutes
5. Close/end the AC maintenance monitoring report.				The report is declared complete	1 minute
					

References

Adhitama, W, Christoforus, and Panjaitan, T.W.S. (2016). Standard Operating Procedure Design for Preventive Maintenance in the Engineering Department. *Journal of Tirta*, 4(2), 13-20.

Candy, C. (2008). Guidelines for the Preparation of Standard Operating Procedures. *PERMENPAN Number 21 of 2008 Concerning Guidelines for Preparation Standard Operating Procedures for Government Administration*, 6(11), 51-52.

Gabriele, G. (2018). Analisis Penerapan Standar Operasional Prosedur (SOP) di Departemen Marketing dan HRD PT Cahaya Indo Persada. *Artikel Ilmiah Jurnal Agora*, 6(1).

Clements, R.C. (1993). *Quality Manager's complete guide to ISO 9000: interpretation, application, implemetion, registration, nd benefits of the ISO 9000 standard*. Prentice Hall.

Gultom, J., Widyaningrum, S., & Wiyono. (2020). Redesign of Monitoring and Evaluation SOP of Telkom University Environment Maintenance Based on ISO 14001:2015 Clausul 9.1 Using Business Process Improvement Method. *E-Proceeding of Engineering*, 7(2).

ISO 9001:2015. (2015). *Quality Management System Requirements*. London: BSI Standards Limited.

Kementerian Pendayagunaan Aparatur Negara dan Reformasi Birokrasi. (2012). Peraturan Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi Nomor 35 Tahun 2012 tentang Pedoman Penyusunan Standar Operasional Prosedur Administrasi Pemerintahan. *Jakarta: Permen PANRB*.

- Kementerian Pendayagunaan Aparatur Negara dan Reformasi Birokrasi. (2008). Peraturan Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi Nomor PER/21/M.PAN/11/2008 Tahun 2008 tentang Pedoman Penyusunan Standar Operasional Prosedur Administrasi Pemerintahan. *Jakarta: Permen PANRB*.
- Kostas, Dervitsiotis. (1981). *Operation Managemenet. New York: Mc Graw Hill International BookCompany*.
- Larson, S. (2015). ISO 14001:2015 1, (December).
- Ngadiyono, Y. (2010). *Industrial Mechanical Maintenance. Yogyakarta: Ministry of National Education, Yogyakarta State University*.
- Permana, I.I. & Aryanto, A. (2019). Analisis Preventive dan Corrective Maintenance Loading Arm pada PT. Pertamina Tbbn Semarang Group. *Industrial Engineering Online Journal, 7(4)*.
- Rachmi, A., Susanto, T.D., & Herdiyanti, A. (2014). Development of Standard Operating Procedure (SOP) Service Desk Based on ITIL V3 Framework Using Service GAP Analysis Method (Study Case: pt. xyz, Tangerang). *Journal of Engineering ITS, 3(2)*.
- Ragilya, A.N. (2017). Pembuatan Standard Operating Procedure (SOP) Perawatan Sistem Informasi Manajemen (SIM) Berdasarkan Metode GAP Analysis yang Memenuhi Standar ISO/IEC 14764:2006 dan Kontrol Kerangka Kerja ITIL V3. *Undergraduated Thesis. Institut Teknologi Sepuluh Nopember*.
- Sanoto, H. (2020). Compilation of Standard Operating Procedure (SOP) at Bengkayang Regency Education Office in the Context of Improving the Quality of Organizational Management. *Scholaria: Journal of Education and Culture, 10(3), 63-68*.
- Setiaji, B. (2010). Pengaruh Suhu dan Lama Pemanggangan Terhadap Karakteristik Soyflakes, Skripsi Program Studi Teknologi Pangan, Fakultas Teknik, Universitas Pasundan. *Bandung*.
- Soemohadiwidjojo, A.T. (2014). Easy to Prepare SOP. *Jakarta: Spreader Self-Help Group*.
- Sumito, C., Amilia, F.R.C., Rochadi, M.T., & Martono. (2014). Scheduling Analysis of Split AC Preventive Maintenance Activities in the Central Building of PDAM Tirta Moedal Semarang. *Civil Engineering Space, 19(2), 63-70*.
- Yuono, L.D. & Budiyanto, E. (2021). Basic Air Conditioner (AC) Maintenance Techniques. *Lampung: CV. Lady Alifatama*.

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