

COMPARISON STUDY OF MEASUREMENT RESULTS BETWEEN RAIN GAUGE 7052.0100 AND OPTICAL RAIN GAUGE 815 AT LAPAN KOTOTABANG

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ABSTRACT

In general, the population in Indonesia is a farmer. This causes farmers to need information about the weather to carry out agricultural activities. One way to obtain information about the weather is to use the Rain Gauge instrument. In this study, the Rain Gauge instrument at LAPAN Kototabang from 2020 to 2021 was compared with the Optical Rain Gauge instrument. This research uses descriptive research with secondary data in the form of rainfall intensity data that has been measured on the Rain Gauge and Optical Rain Gauge from LAPAN Kototabang. This research was conducted to analyze the output data from the Rain Gauge and Optical Rain Gauge in the form of rainfall intensity, rainfall accumulation, and time. From the data analysis, two results can be stated from this research. First, the analysis of the rainfall parameter data that has been processed shows that the rainfall in Kototabang in January - October 2020 and 2021 has a high rainfall value. This causes the intensity of rainfall in Kototabang to be categorized as heavy rain. The two accumulations of rainfall in 2020 and 2021 in the Kototabang area are 497.031 mm and 0.602 mm using the Rain Gauge. While the measurement using Optical Rain Gauge rainfall intensity is 0.207 mm and 0.221 mm. This proves that the intensity of rainfall in 2020 is greater than the intensity of rainfall in 2021.

Keywords : *Weather; Rainfall; Rain gauge; Optical rain gauge; Kototabang.*



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I. INTRODUCTION

Weather is a condition in a certain area and time that is influenced by various atmospheric phenomena [1]. Knowledge of the weather is very important because Indonesia is one of the countries in the tropics so it often experiences extreme weather changes, which results in hampering human activities [2]. Factors that affect extreme weather include humidity, temperature, wind speed, air pressure, and rainfall [3]. Indonesia's maritime islands, which are located in the tropics, have high annual rainfall. Rainfall will be higher in mountainous areas [4]. One of the stations that serve to measure atmospheric phenomena such as rainfall in mountainous areas is LAPAN Kototabang.

LAPAN Kototabang is a station located in the equatorial region, precisely in Kototabang, Palupuh District, Kototabang Regency, West Sumatra. This station is located at coordinates 100° 32" East Longitude and 0° 23" South Latitude. LAPAN Kototabang is a mountainous area with an altitude of 865 m above sea level. The influence of the topography of an area can be the main cause of weather changes in a wide-scale pattern of a climate and variations in rainfall in an area [5].

Research on rainfall in LAPAN Kototabang has been carried out, but this research is more focused on the distribution, movement, and changes of clouds that occur [6]. The characteristics of rainfall in this study can be

seen through the conditions of the clouds that are formed, not based on the existing rainfall data. In 2009 also researched the analysis of rainfall behavior. This study also focuses on the distribution of clouds which will later be obtained from rainfall analysis [7]. This study also uses data that is quite short, which is only 4 months. In 2014, research results for variations in rainfall are still difficult to obtain. This is caused by fluctuations or data that changes from year to year [8].

Rain Gauge is a tool that functions to measure rainfall and its measurement in millimeters (mm). a researcher named Agyei also explained that the Rain Gauge is a rain gauge where rainfall measurements are carried out for a long time. [9]. Rainfall measurements are carried out for 24 hours so that the daily, monthly, and annual rainfall can be used as a reference for residents around LAPAN Kototabang. Weather refers to the state of the atmosphere at a particular place and time. Weather is a natural phenomenon that consists of several elements of weather. If one of these elements changes, then one or more weather elements will also change. This overall change is called weather change [10].

Rain is a form of liquid that falls to the earth [11]. Rain is a natural phenomenon contained in the hydrological cycle [12]. Rain is also a process of falling water droplets from the atmosphere to the earth's surface [13]. Rainfall is a phenomenon characterized by high variability both in space and time [14]. The process and formation of rain consist of two parts, namely rain micro-physics and rain macro-physics. Rain micro-physics examines the characteristics of precipitation particles such as raindrop size, Raindrop Size Distribution or DSD, falling speed of raindrops, and others. While rain macro-physics examines cloud formation and precipitation formation [9]. The amount of rain that falls at a certain time in a certain area is called rainfall [15]. The state of rainfall and rainfall intensity can be seen in Table 1.

Table 1. Rainfall conditions and rainfall intensity

Rainfall Conditions	Rainfall Intensity (mm)		
	1 minute	1 hour	24 hour
Very light rain	< 0,02	< 1	<5
Light rain	0,02 – 0,05	1-5	5-20
Moderate/normal rain	0,05 – 0,25	5-10	20-50
Heavy rain	0,25 – 1	10-20	50-100
It's raining very hard	>1	>20	>100

(Source: Ref [16])

Based on Table 1, it can be explained that heavy rain conditions are worth more than 1 mm/min, while very light rain conditions are less than 0.02 mm/m. Two processes support the growth of raindrops that become resistant to the atmosphere and finally fall like rain to the earth. The two processes are the ice crystal process and the coalescence process. The coalescence process, states that small raindrops will increase in size by colliding with other grains. Another tool that can measure the intensity of rainfall is the Optical Rain Gauge.

Optical Rain Gauge (ORG) is one of the instruments in LAPAN Kototabang which is used to measure rainfall in minutes without having to collect rainwater. ORG is an automatic rain gauge that measures rainfall without having to collect rainwater [17]. ORG uses a photo-diode as a receiving sensor to detect changes in light due to rain. ORG can work normally in any condition of rain intensity, and its readings are not affected by wind, dust, and can work on buoys [18]. This study aims to describe the block diagram of the Rain Gauge instrument type 7052.0100 and the Optical Rain Gauge instrument type 815, to analyze the rain parameter data from the measurements of the Rain Gauge instrument type 7052.0100 and the Optical Rain Gauge 815 instrument from January to October 2020 and January to October 2021. The final objective is to determine the accumulation of rainfall in 2020 and 2021 using the Rain Gauge type 7052.0100 instrument and the Optical Rain Gauge 815 instrument.

II. METHOD

This study uses a descriptive type of research with secondary data in the form of rainfall intensity data that has been measured on the Rain Gauge obtained from LAPAN Kototabang. The purpose of this research is to obtain information about the Rain Gauge instrument and analysis of rain parameter data at LAPAN Kototabang. The Rain Gauge instrument was analyzed starting from the physical form, block diagram, working principle, and existing data processing. The processed data is the original data without any data manipulation.

Research variables several values that have variations. In this study, there are two types of variables, namely the independent variable and the dependent variable. The independent variables consist of date, month, year, and time. The dependent variable in this study is the value of rainfall intensity.

In this study, the researchers conducted a direct analysis of the spaciousness of the tool to be studied and studied manually as well as a literature review of the instrument, be it the physical form of the tool, a series of

systems, working principles, and steps to obtain data. The data obtained is in the form of secondary data that has been recorded by software that has been programmed on the Rain Gauge and Optical Rain Gauge.

The descriptive statistical analysis technique is a method used to present quantitative data in descriptive form. In this study, analysis of the output data from the Rain Gauge and Optical Rain Gauge in the form of rainfall intensity, rainfall accumulation, and time was carried out. There are several ways to analyze rain parameter data, namely by processing rain intensity data so that daily rainfall accumulation and monthly rainfall accumulation in the Kototabang area are obtained from 2020 to 2021.

Secondary data from the Rain Gauge and Optical Rain Gauge is obtained through several processes, where the rain that falls will enter the measuring tube. Furthermore, the falling rainwater will fall past the Reed Switch sensor. After that, the rainwater will be accommodated by the Tipping Bucket. Rainwater that hits the Tipping Bucket will be recorded directly by the Rain Gauge default application, namely Tinytag Explorer. The output of this application is displayed in tabular form. To get the intensity of rainfall from the Rain Gauge used the equation:

$$R = \text{data logging} \times 0.01 \text{ mm} \quad (1)$$

Data analysis was conducted to determine the classification of rainfall in Kototabang. The data analysis technique that will be carried out is descriptive statistics in the form of tables and graphs. Graphs are useful for providing results visually in describing the relationship between two variables obtained through measurement or calculation.

III. RESULTS AND DISCUSSION

This research focuses on the systematic explanation of the block diagram work of the Rain Gauge and Optical Rain Gauge instruments as well as the results of the analysis of rainfall measurement data. Rainfall measurement data to be analyzed is output data that has been monitored using Rain Gauge and Optical Rain Gauge instruments. Based on the results of data analysis, the relationship between the duration of rain monitoring and the accumulation of rainfall will be obtained.

If there is a magnetic field between the two plates, the plates will be attracted to produce an electric current. After the magnetic field moves away from the reed switch, the reed switch contacts will return to their initial position. The up and down movement of the tipping bucket will cause a magnetic field that passes through the front of the reed switch sensor to work so that it connects the contacts. In simple terms the operating principle of a tipping bucket is that the rain that falls will be collected into a fixed size bucket that is tilted and will drain when it is full [19],[20]. The working principle of the tool in detecting rainfall intensity can be seen through the block diagram in Figure 1.

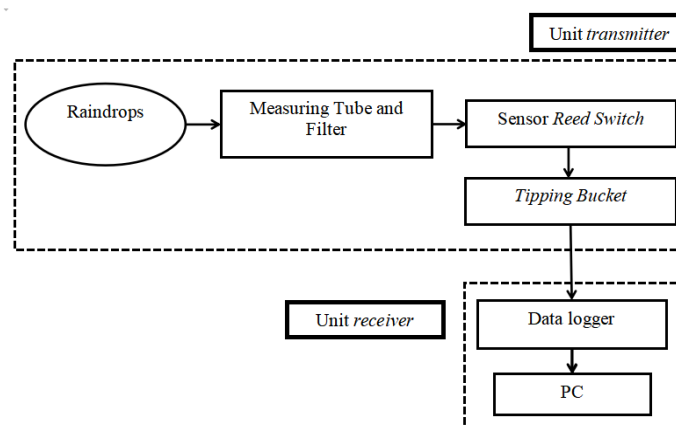


Fig 1. Rain Gauge Block Diagram

The working principle of the rainfall intensity detection hardware system consists of a transmitter unit equipped with a Tipping Bucket, a reed switch sensor, and a receiver unit. Where the rain that falls will enter the measuring tube. Furthermore, the falling rainwater will fall past the Reed Switch sensor. The reed switch sensor will detect the amount of rainfall that has fallen. After that, the rainwater will be accommodated by the Tipping Bucket. Rainwater that hits the Tipping Bucket will be recorded directly by the Rain Gauge default application, Tinytag Explorer. The resulting data is transmitted telematically using a transmitter to the receiver unit.

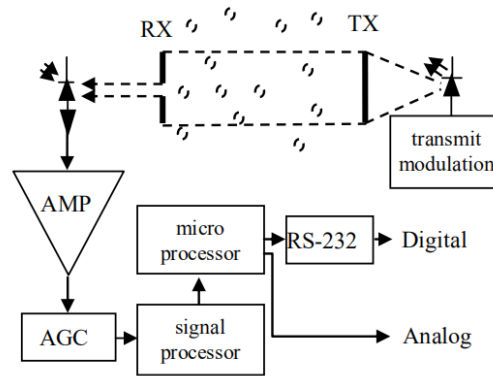


Fig 2. Optical Rain Gauge Block Diagram

Another rainfall detection instrument is the Optical Rain Gauge. The working principle of this tool in detecting rain is the instrument transmitter block consisting of transmit modulation, Infrared Light Emitting Diode (IRED), and a TX lens which functions as a rectifier of the IRED output light. The receiver box consists of a protective lens, a light detector pin in the form of a photodiode and an amplifier block, signal processor and conditioner. The IRED output light is received by the photodiode. The photodiode output will be amplified by the initial gain amplifier and connected to the Automatic Gain Controlled (AGC) normalization circuit and proceed to signal to condition. The output of the signal conditioner is connected to the microprocessor. In the AGC block, the disturbance caused by variations in the light intensity received by the photodiode will be filtered, processed, and averaged. The average statistical measurement of the flickering light signal due to raindrops will be conditioned to be within the working area of the processor signal.

Rainfall measurement results using the Rain Gauge and Optical Rain Gauge instruments are accumulated in the form of a graph. The analyzed monthly rainfall accumulation data were taken for ten months, from January to October 2020 and 2021. The accumulated monthly rainfall data for 2020 is shown in Figure 3.

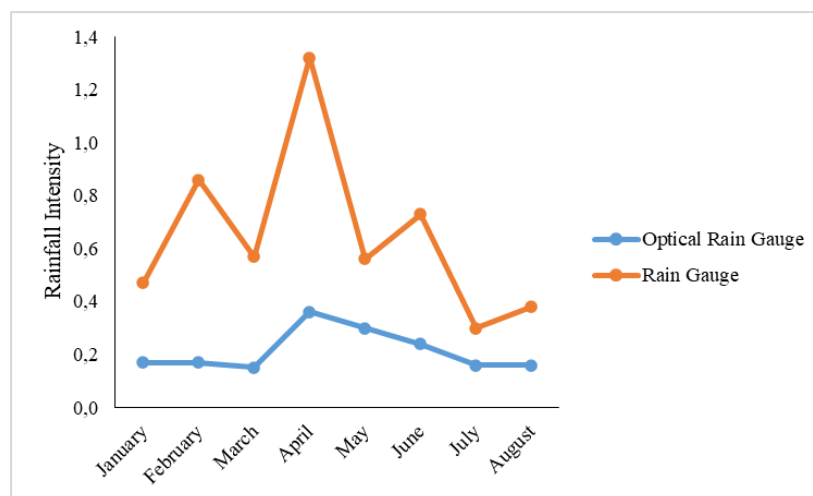


Fig 3. Monthly Rainfall Intensity in 2020

Based on measurements made using the Rain Gauge instrument, the highest monthly rainfall for 2020 occurred in September as shown in Figure 3. The accumulated rainfall in September was 2,577.98 mm. The minimum rainfall accumulation occurred in July, which was 0.30 mm. Measurements made using the Optical Rain Gauge showed that the highest rainfall occurred in April with a value of 0.36 mm. While the minimum rainfall occurs in October with a value of 0.14 mm. Rainfall accumulation data in 2020 changes drastically every month. The accumulation of monthly rainfall data is also carried out for 2021. The accumulation of monthly rainfall data for 2021 is shown in Figure 4.

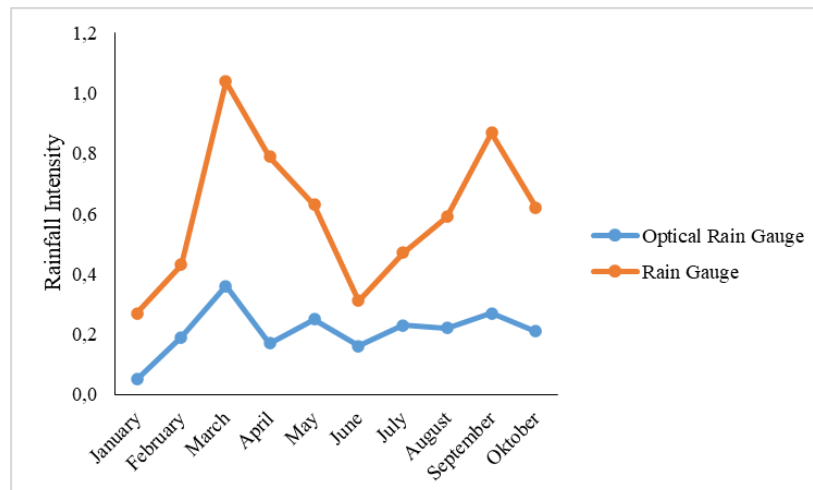


Fig 4. Monthly Rainfall Intensity in 2021

The data for the accumulation of rainfall in 2021 undergoes drastic changes every month. In Figure 4 based on measurements made using the Rain Gauge instrument, the highest monthly rainfall for 2021 occurs in March. The accumulated rainfall in September is 1.04 mm. The minimum rainfall accumulation occurred in January, which was 0.27 mm. Measurements made using the Optical Rain Gauge instrument showed that the highest rainfall occurred in March with a value of 0.36 mm. While the minimum rainfall occurs in January, with a value of 0.05 mm. The data for the accumulation of rainfall in 2021 undergoes drastic changes every month.

The rainfall data from the research at LAPAN Kototabang that the researchers did was compared with rainfall data from the Optical Rain Gauge instrument. The Rain Gauge's rainfall data has a slightly similar pattern to the Optical Rain Gauge. The comparison of the measurement results using the Rain Gauge and Optical Rain Gauge can be seen in Figure 5.

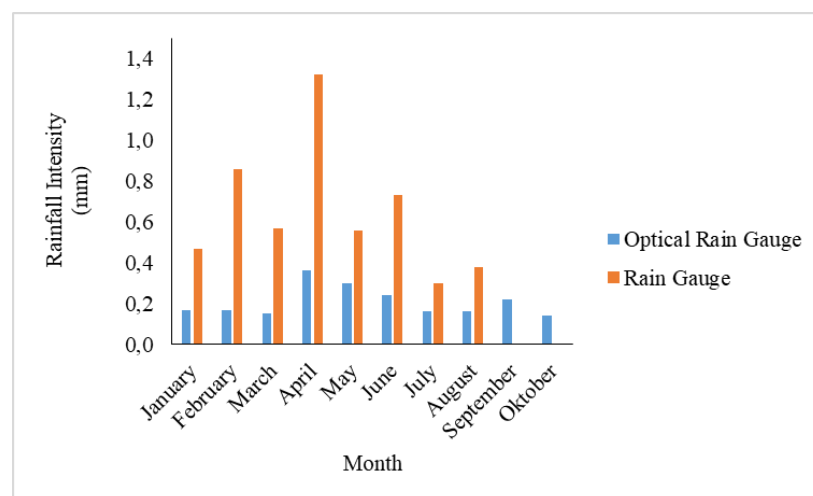


Fig 5. Accumulation of Rainfall in 2020

From the data in Figure 5, it can be explained that the rainfall data belonging to the Optical Rain Gauge and the rainfall data from the Rain Gauge have almost the same rainfall trend. This difference in rainfall is caused by an error in the rainfall data due to human error. Another error is caused by the presence of insects that enter. As a result, the measurement of rainfall has been disrupted.

The accumulation of monthly rainfall is also carried out in 2021. The data is obtained from the Rain Gauge instrument and the Optical Rain Gauge instrument which has extreme values for several months. The extreme difference from the accumulation of rainfall in 2021 is shown in Figure 6.

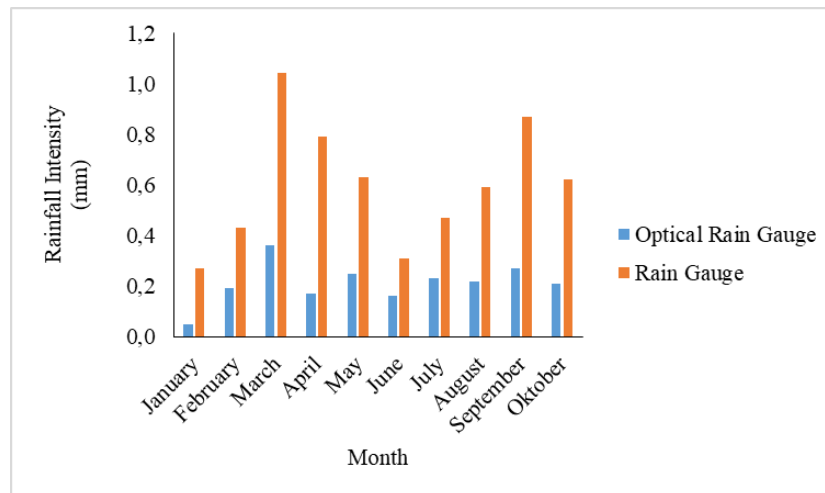


Fig 6. Accumulation of Rainfall in 2021

From the data in Figure 6, it is explained that the rainfall data belonging to the ORG and the rainfall data from the Rain Gauge have almost the same rainfall trend. Based on the accumulated rainfall in 2020 and 2021, it can be concluded that the average monthly rainfall in the Kototabang area is 497,031 mm and 0.602 mm, respectively. While measurements using Optical Rain Gauge in 2020 and 2021 can be seen the rainfall intensity values are 0.207 mm and 0.221 mm. This proves that the intensity of rainfall in 2020 is greater than the intensity of rainfall in 2021.

The results of the first study include a block diagram description of the Rain Gauge instrument type 7052.0100 with the Optical Rain Gauge type 815 instrument. stranger in the wind. The measuring tube is also equipped with a reed switch sensor which will detect the movement of the tipping bucket for 1 minute per count. The signal captured by the sensor will be forwarded to the data logger. Furthermore, the data logger will be sent to the PC for processing. The block diagram of the Optical Rain Gauge type 815 instrument starts with the incoming raindrops being captured by the TX lens, then the output from the TX lens will be received by the photodiode. The output of the photodiode will be amplified by the initial gain connected to the AGC circuit. From AGC will proceed to the signal conditioning stage. The output will be connected to the microprocessor. The results from the microprocessor will be forwarded to the monitor to display the results.

The results of the second study obtained are analysis of parameter data from the Rain Gauge type 7052.0100 instrument with Optical Rain Gauge type 815 instrument from January to October 2020 and January to October 2021. The results obtained indicate the intensity of rainfall in Kototabang includes heavy rainfall. This is due to the topography of Kototabang which is at an altitude of 865 m above sea level. The higher the area, the higher the rainfall. Based on the opinion of a scientific expert [4], rainfall will be higher in mountainous areas.

The results of the study also include analysis of rainfall data, where this rainfall data is in the form of monthly rainfall accumulation. The highest peaks of rainfall in 2014 were in October-November and March-May [19]. While in this study, the highest peak of rainfall was in September-October using the Rain Gauge instrument and April-May using the Optical Rain Gauge instrument for 2020. In 2021 the highest peak of rainfall will be in March. However, the annual variation of rainfall in Kototabang is still difficult to observe. This is due to fluctuations or data that changes from year to year.

In September and October 2020 there was an extreme difference in rainfall intensity between the Rain Gauge instrument and the Optical Rain Gauge instrument. Measurement of rainfall intensity using the Rain Gauge ranges from 0 mm - 2300 mm. While the measurements using the Optical Rain Gauge instrument ranged from 0 mm - 0.5 mm. Based on a study conducted by a researcher [8] shows that the value of normal rainfall intensity ranges from 0 mm - 3 mm in the Kototabang area. The measurement results obtained indicate that the measured value on the Optical Rain Gauge instrument is more accurate than the Rain Gauge instrument. This is caused by several factors in the measurement using the Rain Gauge, such as human error. At the time of measurement, the remaining rainwater contained in the tipping bucket is not wasted so that when it rains again the water left in the tipping bucket is also measured again. Then the intensity of rainfall becomes less efficient. This also occurs in months that have extreme differences in rainfall intensity.

In this study, several obstacles had quite an influence on the results of the study. These obstacles, among others, occur in the limited access to instruments and the lack of data that is processed to be able to draw more accurate conclusions. Testing of manual data processing experienced problems due to a large number of data files. A lot of rainfall data that researchers process is as much as ten months of rainfall data for each year. Rainfall data were processed manually and plotted using Microsoft Excel software.

IV. CONCLUSION

Based on the results of the analysis, the block diagram of the Rain Gauge instrument type 7052.0100 starts from rainwater that falls and then enters the measuring tube which has been equipped with a filter to filter foreign objects carried by the wind. The measuring tube is also equipped with a reed switch sensor which will detect the movement of the tipping bucket for 1 minute per count. The signal captured by the sensor will be forwarded to the data logger. Furthermore, the data logger will be sent to the PC for processing. The block diagram of the Optical Rain Gauge type 815 instrument starts with the incoming raindrops being captured by the TX lens, then the output from the TX lens will be received by the photodiode. The output of the photodiode will be amplified by the initial gain connected to the AGC circuit. From AGC will proceed to the signal conditioning stage. The output will be connected to the microprocessor. The results from the microprocessor will be forwarded to the monitor to display the results. Based on the analysis of the rainfall parameter data that has been processed, it shows that the rainfall in Kototabang in January - October 2020 and January - October 2021 has a high rainfall value. This causes the intensity of rainfall in Kototabang to be categorized as heavy rain. Based on the accumulated rainfall in 2020 and 2021, it can be concluded that the average monthly rainfall in the Kototabang area is 497,031 mm and 0.602 mm using the Rain Gauge. While measurements using Optical Rain Gauge in 2020 and 2021 can be seen the rainfall intensity values are 0.207 mm and 0.221 mm. This proves that the intensity of rainfall in 2020 is greater than the intensity of rainfall in 2021.

ACKNOWLEDGMENT

During the completion of this thesis, the author has received help, and suggestions from all parties who have been willing. Therefore, on this occasion, the author would like to thank all the assistance that has been given to the author, especially to the LAPAN Kototabang who have taken the time to guide and assist the author in research activities and writing this thesis.

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