

SUSANNE M. HOFFMANN DISCOURSE ON OBSERVING THE MOON

UNDERGRADUATE THESIS

Submitted to Sharia and Law Faculty
In Partial Fulfillment of the Requirement for Undergraduate Degree
In Islamic Law



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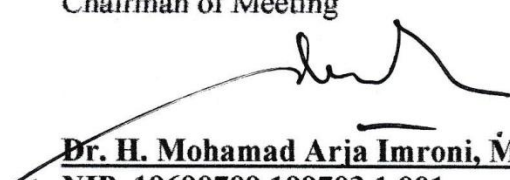
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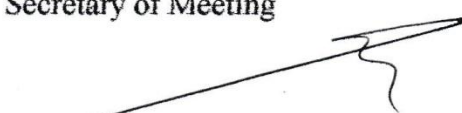
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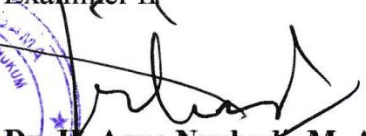

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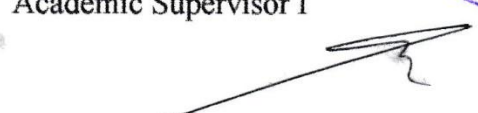
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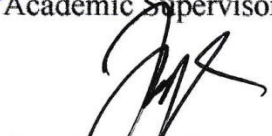

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MOTTO

هُوَ الَّذِي جَعَلَ الشَّمْسَ ضِيَاءً وَالْقَمَرَ نُورًا وَقَدَّرَهُ مَنَازِلَ لِتَعْلَمُوا
عَدَدَ السِّنِينَ وَالْحِسَابَ مَا خَلَقَ اللَّهُ ذَلِكَ إِلَّا بِالْحَقِّ يُفَصِّلُ الْآيَاتِ
لِقَوْمٍ يَعْلَمُونَ ﴿٥﴾

(يونس : ٥)

“It is He Who made the sun to be a shining glory and the moon to be a light (of beauty), and measured out stages for her; that ye might know the number of years and the count (of time). Nowise did All create This but In truth and righteousness. (thus) doth He explain His Signs In detail, for those who understand.”¹

(QS. Yunus:5)

¹ Abdallah Yousuf Ali, *The Glorious Kur'an*, p. 484-485

DEDICATION

This thesis is dedicated to:

My beloved parents who teach me everything

Aminuddin Soleh & Rusmiati

My lovely sister and brother

Salsabila Faradisa and Muhammad Nabil Karomi

All of my asatidz, teacher, and lecturer who guide me to study

my academics supervisor who give their time to me

Dr. H. Akhmad Arif Junaidi, M. Ag. And Dr. H. Ahmad Izzuddin, M. Ag.

My best German Astronomist who let me examine her discourse

Dr. Phil. Dr. paed. Dipl. Phys. Dipl. WissHist. Susanne Magdalena Hoffmann

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ABSTRACT

The process of observing the moon becomes one of the important things to do. Especially in the process determining from the beginning of month kamariyah or often referred as rukyatul hilal. Where is a challenge for the observers to see a very thin moon, moreover with weather conditions that are not always bright? In addition, observing the moon at the time of eclipse can increase the faith in understanding the signs and power of Allah SWT. With regard to the presence of Susanne M. Hoffmann at Islamic Astronomy Master Program Walisongo State Islamic University, the author is very interested in examining her thoughts about observing the moon. Susanne M. Hoffmann is an expert astronomist in the history of science, physics, and didactics. She expressed the bad condition of the sky and the air in Semarang. In addition, Susanne M. Hoffmann also suggested repeating Al-Biruni observation.

This study aims to find out Susanne M. Hoffmann discourse related observing the moon and to know her suggestion to repeat Al-Biruni observation on measuring the distance between two cities. This research includes for qualitative research and includes the type of library research. Primary data is taken from in-depth interviews and documentation of Susanne M. Hoffmann's writings, works, and photographs. While the secondary data obtained from the documentation of books, journals, and articles of others work related to research. Meanwhile, to study of Susanne M. Hoffmann discourse author uses descriptive analysis method.

The results show, that Susanne M. Hofmann discourse in observing the moon is divided into two lines. First, in response to the poor condition of the sky and air in Indonesia, or Semarang in particular, Susanne M. Hoffmann still recommends doing rukyatul hilal. Furthermore, rukyatul hilal is best to do with the naked eye than using a telescope or optical instrument. Second, about the lunar eclipse, in accordance with the field, she mastered the history of Science. Susanne M. Hoffmann was succeeding to repeat the Al-Biruni observation in measuring the distance of two cities by the lunar eclipse.

Keywords: Observing the Moon, Lunar Eclipse, and Susanne M. Hoffmann

ABSTRAK

Proses pengamatan bulan menjadi salah satu hal penting yang dilakukan. Khususnya dalam proses penentuan awal bulan kamariah atau sering biasa disebut sebagai rukyatul hilal. Dimana menjadi sebuah tantangan bagi para perukyat untuk dapat melihat hilal yang sangat tipis dan ditambah dengan kondisi cuaca yang tidak selamanya cerah. Selain itu, pengamatan bulan pada saat gerhana juga dapat menambah keimanan dalam memahami tanda-tanda kekuasaan dan kebesaran Allah SWT. Berkenaan dengan hadirnya Susanne M. Hoffmann di Program Magister Ilmu Falak UIN Walisongo, penulis sangat tertarik untuk meneliti pemikiran beliau tentang pengamatan bulan. Susanne M. Hoffmann merupakan astronom yang expert dalam bidang history of science, fisika dan didaktik. Beliau mengungkapkan buruknya kondisi langit dan udara di Semarang. Selain itu Susanne M. Hoffmann juga menyarankan untuk mengulang kembali pengamatan Al-Biruni.

Penelitian ini bertujuan untuk mengetahui pemikiran Susanne M. Hoffmann terkait pengamatan bulan dan untuk mengetahui keberhasilannya dalam mengulang pengamatan Al-Biruni untuk menentukan jarak antar dua kota. Penelitian ini termasuk jenis penelitian kualitatif dan termasuk tipe penelitian kepustakaan. Data primer diambil dari wawancara mendalam dan dokumentasi terhadap tulisan, karya dan foto Susanne M. Hoffmann. Sedangkan data sekunder diperoleh dari dokumentasi buku, jurnal dan artikel karya orang lain yang berhubungan dengan penelitian. Sedangkan untuk meneliti studi ketokohan pemikiran Susanne M. Hoffmann ini penulis menggunakan metode analisis deskriptif.

Hasil penelitian menunjukkan bahwa, pemikiran Susanne M. Hoffmann dalam pengamatan bulan terbagi dalam dua garis besar. Pertama, dalam menanggapi buruknya kondisi langit dan udara di Indonesia atau Semarang pada khususnya, Susanne M. Hoffmann masih merekomendasikan untuk melakukan rukyatul hilal. Terlebih menurutnya rukyatul hilal lebih baik dengan kasat mata daripada menggunakan teleskop dan alat optik. Kedua, tentang pengamatan gerhana bulan, sesuai dengan bidang yang dikuasainya yaitu history of Science. Dr. Susanne berhasil mengulang percobaan Al-Biruni dalam mengukur jarak dua kota menggunakan gerhana bulan.

Kata Kunci: Pengamatan Bulan, Gerhana Bulan dan Susanne M. Hoffmann

THESIS STATEMENT

I certify that this thesis is definitely my own work. I am completely responsible for content of this thesis. Other writer's opinions or findings in the thesis are quoted or cited in accordance with ethical standards.

Semarang, January 11th 2018

The writer,



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CHAPTER I

INTRODUCTION

A. Background

Observing the moon is an exciting activity to do for everyone. Not only for astronomist, but also for common people the moon is freely observed by everyone. They observed either with the naked eye or with optical instruments. The moon can well be seen every day with the different shape. These different moon forms are the moon phases due to a position of the moon, earth, and sun. As celestial objects that move in their own orbit.

The moon as closest celestial bodies to Earth has not owned light. But the moon reflects light from the sun. This reflected sunlight is what we see from earth surface as an appearance of the moon. The amount of sunlight reflected on the moon disc stated in magnification. The magnitude of the moon's appearance varies between 0% at the time of new moon up to 100% at a full moon.

Variety of moon's appearance figures out it phases. Common people can see phases of the moon every day, except at new moon that has little magnification. Beside them, there are astronomers and scholars who periodically observe the moon. Especially astronomist and Moslem scholar that observe the moon at sunset after conjunction. Why are they doing this? The beginning of month hijri is marked after successfully seeing young

crescent of the moon. This activity has been practiced since Prophet Muhammad SAW.

However, in the development of beginning month Hijri determination experienced different interpretations. One interpretation, as is commonly done, is used rukyatul hilal (see the moon). While the other hand says simply using by hisab course (computations). Both of these things also developed in Indonesia until now.

The determination of the beginning month from Hijri Calendar in Indonesia still has a problem and until now is not fixed yet. There are so many Islamic Organization that have their own method. Ministry of Religion Affairs as government always try to unite all Moslem in Indonesia to have the same way, especially in the beginning month of Ramadhan, Syawal, and Dzulhijjah. Some Islamic organization follows the instruction, but the other does not. They use their own method.

For example, we can see from year to year, there are at least five Islamic organizations that always do not obey the government instruction. Naqsabandiyah¹ and an Nadhir² society, they always have the earlier date with an interval of three days. Aboge (a method of determining the beginning month from Hijri Calendar by a certain day and pasaran)³ sometimes has an earlier or later date than government decision. The amount of their society is less than two big Islamic organization.

¹ In Padang, exactly Pauh, Padang, West Sumatera

² Romang Lampa village, Bontomarannu, Gowa, South Sulawesi

³ Aboge: "A" lip (first year from Javanese Calendar) "bo" shorten from Rebo Javanese day for Wednesday and "ge" is the wage, one of five pasaran days in Java. If the beginning month from a year is determined then from the other month could be known too

Nahdlatul Ulama and Muhammadiyah are two big Islamic organization in Indonesia. They have a big society and so on if one of them has the different beginning day on Hijri Calendar it will make a big impact on Indonesian Moslem society. By their big society, the difference is very visible. Both of them use a different method to determine it. Muhammadiyah uses calculations only, so they can predict early without proofing as long as the crescent is above zero degrees on calculation they will start the month. At the other side, Nahdlatul Ulama always uses *rukyatul hilal* (observe the young crescent).

Sometimes, an ordinary young crescent of the moon is above the horizon by calculation but at the low position or very close to the horizon. It makes the difference very contrast. In addition, the Indonesian humidity is very high. By natural condition that has huge of the sea. Make it easy to produce the clouds. Evaporating water into the air and so many smokers from human beings make the sky dark and polluted.

According to Indonesian sky condition along with observing the moon in general and seeing young crescent in particularly attracted attention for further research. Coincides with the arrival of Susanne M. Hoffmann as Senior Experten Service for post-graduate Islamic astronomy program, Sharia and Law Faculty, State Islamic University Walisongo Semarang. For approximately she was three weeks in Semarang and the author examines her thoughts.

It doesn't need to doubt that Susanne M. Hoffmann is a very competent astronomist in observing the moon. Experienced at some of leading planetarium in German, Portugal, and Austria. She equipped herself with a complete science of observing celestial bodies. In addition the number of publication shown her dedication and contribution to the development of astronomy. Having a qualified educational background in the field of astronomy too. Based on these considerations the author challenged to have a research about her discourse on observing the moon.

By the experience from Susanne M. Hoffmann observation in Indonesia the writer interested to have a research about her discourse on observing the moon. The discourses are Indonesian sky condition, the chance to young crescent observation and practice Al-Biruni experiment towards Partial Lunar Eclipse on August 7th to 8th 2017. From her observation during a stay in Semarang, she was taking so many sky picture. On an occasion, the writer accompanied her to Marina beach sunrise on August 3rd, 2017.

A comparison photos that she has been uploaded to spektrum.de blog, one photo taken in Semarang at the time and the other one taken in Austria last year. They show how dirt condition of Indonesian sky. It can be seen by the distinct two pictures, with same 6400 ISO and 10 seconds exposure, Austria picture give a beautiful sky with so many stars. Semarang shows fewer stars, not as much as in Austria.

Susanne M. Hoffmann has taken sunrise and sunset picture. Both of them give information about Semarang air condition. One morning she took a

picture at the east edge of the first campus. It shows many vehicles and factories blow smoke into the air. As a conclusion of various sunset photo taken on a connecting road between 2nd and 3rd campus that sun still a little bit visible behind clouds and smokes. So there is a chance to observe the young crescent.

The clouds are always in the sky by natural phenomenon. But we can reduce some pollution in the air. If the citizen cares about their environment by doing some exercise, it makes Indonesian sky more clear. Soon the observation of the young crescent is more easy to do. At the other side, the observation still faces some problems such as covered clouds near the horizon. The problem always appears during young crescent observation.

Sunrise observation in Marina beach on August 3rd proved that difficult to distinguish between clouds and smokes. Clouds usually move by the wind, illuminated by sunshine and located in the high air so far far away. At the moment there is a dark veil near the horizon. They are not moving, always there above the horizon. These occasions make observer confused to observe the object near the horizon.

Variety of clouds (on sunrise or sunset) should be known by its location and color. The clouds located near the horizon will be more darken such as reddish. The clouds above has more bright color: orange. Then yellow and on the top, there are white clouds. The blue sky indicates of clean air. At the opposite of the sun (sunrise or sunset), a shadow of the Earth is visible.

Like lunar eclipse in Germany, August 8th at moonset. The full moon is above the shadow of the Earth.

An interesting experiment that ever practiced by Al-Biruni examines in this research. The last contact earth shadow on moon surface time between two different cities through the country can be known. Two or more different city observation data examined to determine the distance between them. It requires the exact time to use Universal Time and repeat the experiment.

Susanne M. Hoffmann is an astronomist in three subjects: History of science, physics, and didactics. One of her suggestion reveals when introducing optical equipment in postgraduate Islamic astronomy laboratory first campus, is to observe the lunar eclipse on August 7th - 8th 2017. As she mastered in the history of science, Susanne M. Hoffmann was interested in repeating the experiment that Al-Biruni had done. This experiment requires two observers in different places. Then at the same time from those data can be known distance that lies between.

An interesting experiment to repeat the history of science measurement formerly conducted by Al-Biruni. He has predicted the great value of the Earth's radius. This predictive value turned out to have a slight deviation, almost closer to the real value based on current measurement. In fact, as we know Al-Biruni lived many centuries ago. Of course, Al-Biruni uses a good measurement method.

B. Statements of the Problem

The research will be formulated into some main problems in the following form of several questions below:

1. How is Susanne M. Hoffmann Discourse on Observing the Moon?
2. How is Susanne M. Hoffmann suggestion to repeat Al-Biruni Observation related to measuring the distance of two cities by lunar eclipse?

C. Objectives of Study

Objectives dealing with the problem statement, the following objectives were expected to cover:

1. To represent how is Susanne M. Hoffmann Discourse on Observing the Moon?
2. To show the relevance Susanne M. Hoffmann Discourse with the young crescent of the moon observation and lunar eclipse.

D. Significance of Study

This study was expected to give contribution in Indonesian Islamic Astronomy to enrich knowledge about Susanne M. Hoffmann discourse on observing the moon and to figure out her subject astronomy competence related to Islamic astronomy. This also could give benefits to student and people generally that can become a referral source for further research.

E. Review of Literature

This research is surely going to search for some kinds of literature or sources from books, which are generally told about Susanne M. Hoffmann discourse on observing the moon. As far as the writer observation, there is no

special detail research, which discusses it. Some researches related to this research are:

Fidia Nurul Habibah with thesis title: *Penentuan Awal Bulan Kamariyah Menggunakan Metode Rukyah Hilal Hakiki (Studi Analisis Pemikiran Ahmad Iwan Adjie)*⁴ in 2015 (Determine to begin of Month Hijri using Rukyatul Hilal Hakiki Method (Analysis Study of Ahmad Iwan Adjie Discourse). On her research discussed Ahmad Iwan Adjie discourse related with rukyatul hilal hakiki method to determine the beginning of month hijri.

Analyzing from Syar'i and Astronomy side, Fidia got result from her research as young crescent of the moon observation is enough with naked eye; don't need specific instrument, the high of visibility limit, wide value of elongation from 9,3° up to 10,5° and moon age has to between 12 – 15 hours at minimum after conjunction. Sharia point of view that have a different understanding about observer evidence, optical instrument usage in the young crescent of the moon observation and isya time concept as the edge of transition day and regional authority. Astronomically requires the high value of visibility criteria and the observation not based on Indonesia.

Equal with the research, there was also studies of "*Parameter Kelayakan Tempat Rukyat (Analisis Terhadap Pemikiran Thomas Djamaluddin Tentang Tempat Rukyat yang Ideal)*"⁵ (2014) by Noor Aflah.

4 Fidia Nurul Habibah, "*Penentuan Awal Bulan Kamariyah Menggunakan Metode Rukyah Hilal Hakiki (Studi Analisis Pemikiran Ahmad Iwan Adjie)*", Undergraduate Thesis, Sharia Faculty, Walisongo State Islamic University, 2015

5 Noor Aflah, *Parameter Kelayakan Tempat Rukyat (Analisis Terhadap Pemikiran Thomas Djamaluddin Tentang Tempat Rukyat yang Ideal)*, Undergraduate Thesis, Sharia Faculty, Walisongo State Islamic Institute for Islamic Studies, 2014

Results from this study stated that there are four criteria for the best place to the young crescent of the moon observation. They are: has open panoramic view between $28,5^{\circ}$ N to $28,5^{\circ}$ S from West point, free from physical and non-physical obstacle potential, there is no weather nuisance potential and best grade seen by geographical side.

Then, the research belongs to Nurul Badriyah (2016) with the title: "*Studi Analisis Pemikiran Muh. Ma'rufin Sudibyo tentang Kriteria Visibilitas Hilal RHI*". This research examines Muh. Ma'rufin Sudibyo discourse about hilal visibility RHI criteria concept. That his discourse is hilal will be seen when the moon has minimum height $3,6^{\circ}$ at $DAz 7,53^{\circ}$ until maximum $9,38^{\circ}$ at $DAz 0^{\circ}$, in the sunset from the horizon and observed from lowland.

In addition, there were some books and articles published by Susanne M. Hoffmann related to this research. Such as:

1. How time served to measure the geographical position since Hellenism. By Susanne M. Hoffmann, Excellence Cluster Topoi, Berlin. This article discussed how ancient measured distance between two cities based on observing a lunar eclipse.
2. Der historische Weg: tredition Verlag, Susanne Susanne M. Hoffmann, Hamburg, 2017. The book that explained the history of science greek ancient observing celestial bodies.
3. Islamiche mondische in natura, a blog article by Susanne M. Hoffmann based on her experience observing the moon in Semarang during the first-week stay.

Based on the preview literature mentioned above, the author did not find any research related to someone discourse about observing the moon. There was research about that but particularly in one aspect of the field: like determine beginning month Hijri only. Furthermore, by Susanne M. Hoffmann visiting that expert in the astronomy field. The writer has a high interest to do research of Susanne M. Hoffmann discourse on observing the moon as an undergraduate thesis.

F. Research Methodology

1. Research Design

This research with the title “*Susanne M. Hoffmann Discourse on Observing the Moon*“ belongs to qualitative design and library research⁶. In this research, the author emphasizes Susanne M. Hoffmann discourse about observing the moon. Her discourse delivered in the blog article, discussion, and talks. Compiled based on Susanne M. Hoffmann experience and written document (printed and electronic) and other archives. The researcher also collects information through interviews and asks for her photo document. In general, data obtained through formal talks such as interviews⁷, both directly and indirectly⁸.

2. Data Sources

6 Is a series of activities related to library data collection methods, reading, and processing of research materials. See: Mestika Zed, *Metode Penelitian Kepustakaan*, Jakarta: Yayasan Obor Indonesia, 2008, page 3

7 For more details see JR. Raco, *Metode Penelitian Kualitatif: Jenis, Karakteristik dan Keunggulannya*, (Jakarta: Grafindo), 2008, page 39

8 Indirect via E-Mail, Dropbox, and Skype

Considering the main source and data input of this research is Susanne Susanne M. Hoffmann herself who are interviewed directly to get more explanation from her discourse. so this research also called *library research*, which has two types of data, primary and secondary source.

The primary data comes directly from Susanne Susanne M. Hoffmann obtained from direct in-depth interviews both during her stay in Semarang and after departure to Germany. In-depth interviews reveal a range of responses and perspectives from the various data that has been collected.⁹

Secondary sources are data which obtained not directly from the research subjects, but it still relates to what the object of research. Secondary data were taken in the form of books, journals, scientific paper and many other that complete the necessary data of the study.

3. Data Collection Methods

The data collection methods in this research are done by collecting Susanne M. Hoffmann literature both personal and collaborative works (anthology) on moon observation topics. Then traced of others works on the same topic through encyclopedias, systematic and thematic books.¹⁰

a) Documentation: Susanne M. Hoffmann paper, article, and her own observations transferred by Dropbox, Skype, E-Mail (photos, written, description)

9 Septiawan Santana, *Menulis Ilmiah: Metode Penelitian Kualitatif*, (Jakarta: Yayasan Obor Indonesia) 2007, page 44

10 Syahrin Harahap, *Metodologi Studi Tokoh dan Penulisan Biografi*, (Jakarta: Prenada Media Group), 2011, page 48

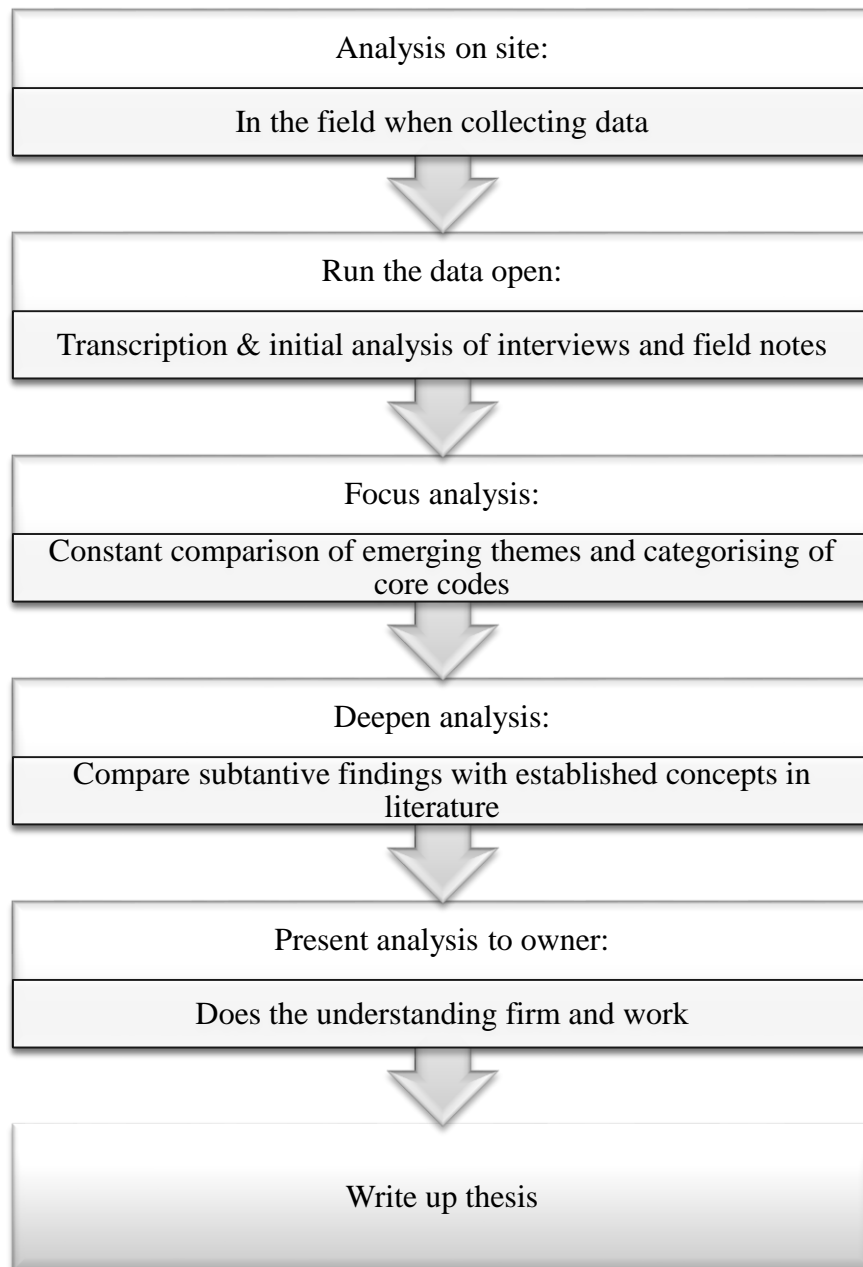
b) Interview (personally during her stay, via Skype and E-Mail)

4. Method of Data Analyzing

The method of data analyzing which will be used in this research is content analyzing by the descriptive qualitative method. Aimed to has a description what is Susanne M. Hoffmann discourse on observing the moon. So it can be implied correlation with Islamic astronomy, especially to determine the beginning of month hijri and lunar eclipse.

According to Eleanor Shaw¹¹ (a lecturer in the Department of Marketing, University of Strathclyde, Glasgow, UK) the analysis process could be drawn as below:

11 Eleanor Shaw, "A Guide to the Qualitative Research Process: Evidence from a Small Study, in *Qualitative Market Research: An International Journal*, Vol. 2 Issue: 2, 1999, page 59



G. Research Outline

This thesis consists of five chapters to figure out all the contents below:

CHAPTER I: INTRODUCTION

Mention the background of the research, statements of the problem, objectives of the study, significances of study, the preview of the literature, research methodology, and research outline.

CHAPTER II: OVERVIEW IN THE MOON OBSERVATION

This chapter discusses what is the moon, phases of the moon, how to observe the moon, the difficulties that the researcher faced during the observation, different types the beginning of the month, The conditions other observers in the world.

CHAPTER III: THE MOON OBSERVATION BY SUSANNE M. HOFFMANN

Present biography of Dr. Sussanne, usual observation of the moon, al-Biruni's observation repeated: determine the size of Earth by astrolabe observation and using lunar eclipse observations to measure the longitude of two cities

CHAPTER IV: SUSANNE M. HOFFMANN DISCOURSE ON OBSERVING THE MOON

Analyze Susanne M. Hoffmann discourse on observing the moon and Her suggestion to succeed young crescent of the moon observation.

CHAPTER V: CLOSING

This chapter consists conclusion of the research; what can we change to improve our observation of a faint object like the young crescent of the moon.

CHAPTER II

OVERVIEW IN THE MOON OBSERVATION

A. The Moon

The moon is one part of the solar system closest to the earth. The distance of the moon with the Earth is about 384,446 kilometers.¹² It is average distance, there are farther and shorter distance. In the farther distance, we see the moon in a smaller size than usual. When the moon in the closer distance it called as a supermoon, seems bigger.

The Moon is the only one Earth's natural satellite. It is exceedingly old, having existed as an independent body for around 4.6 billion years. The Moon formed approximately 4,5 billion years ago. That time a planet-sized rock hit the young earth and splashed matter into space. Gradually the material clumped into a ball, the moon.¹³ Afterward, there are spaces rock hit and hit the moon. They were creating the crater as the consequence.

Craters of the moon are the beautiful pattern on its surface. They make the moon not smooth like a flawless skin. Moon craters also visible such as mountainous plain. It forms the plateau and the lowlands. High areas are generally harsh areas, whereas low areas get little light or dark. Many parts are visible, forming a shadow to the lunar surface. In the lowlands sea

¹² Slamet Hambali, *Pengantar Ilmu Falak: Menyimak Proses Pembentukan Alam Semesta*, (Banyuwangi: Bismillah Publisher), 2012, hlm 133

¹³ Teuku Kemal, *Seri Pengetahuan Bintang & Planet* translated from *Kingfisher Knowledge Stars and Planet* by Carole Stott (Jakarta: Penerbit Erlangga, 2007) page 6

can be seen. Unlike the earth, the total number of oceans in the moon is only 16% of the total surface area.¹⁴

In order to measure the size of the moon, we must investigate some distant moon from the earth. One of astronomy's most enduring mysteries is how the Earth came to be partnered by such a large satellite. In comparison with the size of the planet it orbits, the Moon ranks as the Solar System's second largest satellite. At 3,476km across, the Moon measures about a quarter the diameter of the Earth (12,756km).¹⁵

The motion of the moon is not by means as simple and has posed a challenge to the ingenuity of astronomers for several centuries. Its orbit is not rounded. The moon does not always lie in the same field. Both the shape and its position relative to the sun and the earth are constantly changing. Because of this, the moon part that visible from the earth is somewhat different.¹⁶

B. The phase of the Moon

Looking at the moon is another great way to start to explore the night sky. So it's more fun to wait until the phase of the moon has changed and a shadow line, called a terminator is visible. A terminator is a boundary between the illuminated section of the moon and the area in shadow.

¹⁴ Lily Turangan, *Ensiklopedia Sains Spektakuler: Alam Semesta*, translated from *Visual Atlas of Science: Universe*, (Jakarta: Penerbit PT Aku Bisa, 2012) page 177

¹⁵ Peter Grego, *The Moon and How to Observe It: an Advanced Handbook for Student's of The Moon in the 21's century (Astronomer Observing Guides)*, (Singapore: Springer-Verlag London Limited, 2005, page 3

¹⁶ Tony S. Rachmadie, *Ilmu Pengetahuan Populer*, (Jakarta: PT Ikrar Mandiri, 2000), page 108

Observing the terminator is where the moon's mountains and craters are most clearly seen.¹⁷

The phases of the moon are determined by the configuration of earth, moon and sun position.¹⁸ The initial phase is marked when the earth, the moon, and the sun lie within an astronomical line. Then the moon is moving around the earth, the longer the surface of the moon is exposed to the sun. Until it reaches its peak point when the opposition of the moon will be fully illuminated. Then the light decreases and returns to the initial phase.

The moon phase is the changes on the moon's surface visible from the earth for a month.¹⁹ The phase of the moon includes the new moon where the moon is in the dark and not visible. Then entering the next week half a month begins to appear, this phase is called the first quarter. After that full moon, ie when the moon is fully illuminated. Finally, the last quarter, a phase when half the moon is dark and invisible.

The moon moves around the earth. One round takes 27.3 days.²⁰ During that time, the moon seems to have changed. The actual shape of the moon changes because of the difference in light received from the sun. When the earth is between the moon and the sun, a full moon appears. When the moon is between the earth and the sun, there is a new moon. The movement

¹⁷ Dominic Curran from Keighley Astronomical Society

¹⁸ A. Gunawan Admiranto, *Menjelajahi Tata Surya*, (Yogyakarta: Penerbit Kanisius, 2009), page 199

¹⁹ Ayse Sertkan, *Serial Ilmu Pengetahuan Populer: Bulan Satelit Bumi* translated from *Dunya'nin Uydusu Ay Populer Bilim Evren Dizisi* by Sema Gul (Yogyakarta: Penerbit Yudhistira, 2007), page 14

²⁰ Riandra Khairina and Sakti Hanato Yudo, *Pendaratan di Bulan* translated from *Die Monlandung* by Hanna Sörensen (Bandung: Penerbit Mizan, 2010) page 7

of the moon and the sunlight that shone on it makes the moon seem different. These forms are called moon phases.

When the moon encircles the earth, at the same time the Moon also orbits the sun. Humans on earth will see parts of the surface from different moons exposed to sunlight. The changes can be seen from the Earth and referred to moon phases.²¹ The sun, the earth, and the moon sometimes are aligned in an astronomical longitude so that the shadows of the earth fall to the moon. This results in a partial or total lunar eclipse.

The moon circulates from the condition of the new moon until the new moon circumstances. The time required is for 29.5 days known as one synodic month or one Hijri month. The time it takes for the moon to revolve around the earth is referred to as a Sideris month, i.e. for 27.3 days.²² While the moon is making its circuit of the Earth, the Earth itself is moving along its own orbit around the Sun. Hence the direction of the sunlight changes a little over time, instead of being fixed. Consequently, the Moon has to go a little further than one circuit around the earth to go from one New Moon to the next.²³

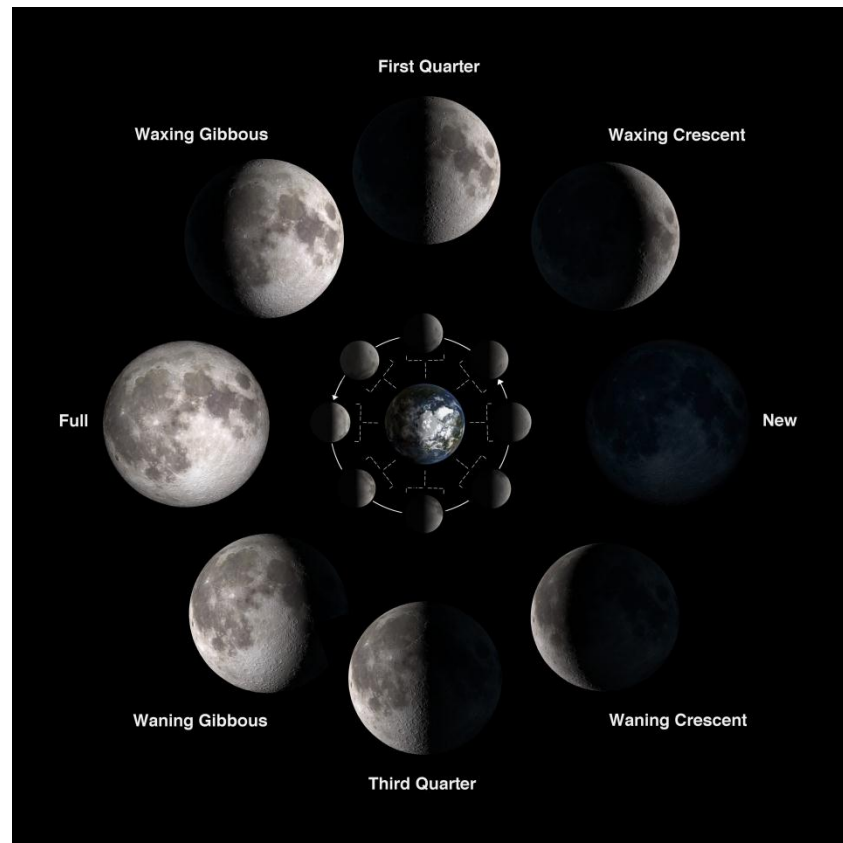
The Moon Phase is a different shape of the Moon when observed from Earth (crescent, quartile, gibbous, full moon). The moon is shining because it reflects the sun's light. Half of the Moon that faces the Sun will be

²¹ Hindrina Perdhanasari, *Intisari Ilmu Ruang Angkasa* translated from *Marshall Mini Space* by Ian Graham (Jakarta: Penerbit Erlangga, 2005), page 17

²² See Yusman Hestiyanto, *Geografi: Sekolah Menengah Atas Kelas X*, (Yogyakarta: Penerbit Yudhistira, 2007)

²³ Gerald North, *Observing the Moon: The Modern Astronomer's Guide*, (United Kingdom: Cambridge University Press, 2002), page. 4

bright, and otherwise, the half of the back to the Sun will be dark. But the moon phase seen from Earth depends on the relative position of the Sun, Moon, and Earth.



Picture 2.1 Phase of the moon. taken from www.moon.nasa.gov

In the 'New' position of the Sun, the Moon and Earth lie on one plane and the Moon between the Sun and the Earth. This position is called as a conjunction. In this position is called the New Moon. In the position of waxing crescents, only about a quarter of the brightest part of the Moon is visible from the earth. The moon in this phase is called the crescent moon. The subsequent sequence to the position of waxing gibbous month. The position of the relative moon between Earth and the Sun shows an

increasingly large part. Then at the position of the full moon, sun, earth, and moon lie in one field and the moon is behind the Earth. Such a position is called the opposition. In this position, all parts of the moon are bright and visible from the earth.²⁴

C. Observing the Moon

Unlike the stars and other planets, the moon emits bright light from the sun. The surface of the moon can be seen without the aid of optical instruments. The size of the moon visible from the earth because of the close distance. Surely something close would be easily visible and easier to observe.

The sun shines during the day and it happens every day. While more seconds the rays of the sun then radiate it. By the time the full moon phase of the moon looks glowing through the night. This condition is like the sun at night. At a time when this phase rises and rises at sunrise. Both of them luminaries in the sky.²⁵

Seeing the moon is probably the most common thing people do. Seeing the moon on a regular basis is certainly different from the observation of the moon. Observing the moon might be for a specific purpose such as to determine the beginning of the Hijri month. Although there are those who argue enough with just a computation.

²⁴ Hendro Setyanto, *Visual Ilmu dan Pengetahuan Populer Untuk Pelajar dan Umum: Memahami Alam Semesta* translated from *Understanding the Universe* by QA International, (Jakarta: PT Bhuana Ilmu Populer, 2006) page 31-32

²⁵ Thomas Hockey, *How We See the Sky: A Naked-Eye Tour of Day and Night* (USA: The University of Chicago Press, 2011), page 167

Certainly, the topic is not the subject of discussion here to study the difference of opinion. In this particular chapter and in this thesis generally tends to discuss in terms observation of the moon in general. Because it examines the thoughts of an astronomist who is associated with Islamic astronomy.

The field of astronomy related to worship, both obligatory and Sunnah is associated with observing natural phenomena. Like the prayers, we do every day. Determination of prayer time is determined by the appearance of the sky. Like the beginning of the shubuh prayer at fajr shadiq and ended at sunrise. Another case with the Maghrib prayer time that actually starts after sunset.²⁶

In addition to the early determination of prayer time, the early determination of the month of kamariyah is also through the observation of the sky. More specifically, by observing the moon to see the young crescent of the moon after conjunction. If at the end of the crescent month visible above the horizon then after the Maghrib has entered the new moon. However, if the crescent is not visible then the new moon begins on the next day. As stated in the following hadith:

حدثنا يحيى بن يحيى: أخبرنا إبراهيم بن سعد عن ابن شهاب عن سعيد بن المسيب عن أبي هريرة رضي الله عنه قال: قال رسول الله صلى الله

²⁶ Ahmad bin Husain asy Syahir bi Abi Syuja', *Fathul Qarib al Mujib* (Egypt: Musthafa al Babi al Halaby, 1343 H) page 12

عليه وسلم: إذا رأيتموا الهلال فصوموا و إذا رأيتموه فافطروا, فإن غم
عليكم فصوموا ثلاثين يوما. (رواه مسلم)²⁷

Means: "Narrated to us Yahya bin Yahya, narrated to us Ibrahim bin Sa'd, from Ibnu Syihab, from Sa'id bin Musayyab, from Abi Hurairah RA, he said: Rasulullah said: "when you see a young crescent of the Moon then you must do the fasting, and when you see it, then break your fast; in case the sky is cloudy, then do the fast for thirty days." (Narrated by Moslem)

Determination the beginning of month kamariyah, especially for three months of Ramadan, Syawwal and Dhulhijjah effect on three basic worship. They consist of Fasting, as it is held one full month during Ramadan. Then zakat, which must be done before Eid Fitri prayer. Finally in the month of Dhulhijjah which has no direct effect on the first day but on the 9th day of the pilgrimage: wukuf in the desert.

Seeing young crescent of the moon is not as easy as flipping the hand. Instead, it needs preparation and basic knowledge about moon observation. The preparation requires a healthy body and of course the eyes. Habitual to observe the moon is very suggested. To ease smart guessing young crescent of the moon will appear.²⁸

D. The Difficulties That The Researcher Faced During Observation

Since the Rasulullah SAW era, observing young crescent of the moon have been done to determine three big months (Ramadhan, Syawal, and Dzulhijjah). The observation practice continuously until now.

²⁷ Yahya bin Syarof An-Nawawi, *Shahih Muslim bi Syarhi an-Nawawi*, (Beirut: Dar al-Kutub Al-Ilmiyah, 1995), page 762.

²⁸ Michael P. Borgia, *How to Improve Your Observing Skills*, (USA: Springer Science and Bussiness Media, 2006) page 51

Perpetuating what like Rasulullah directly figure out. Although in this occasion, the condition is changed, but the importance of observing young crescent of the moon is still maintained.

The observation is still important to do now, that we could see the first phase of the moon through our eyes. Make sure that the moon is visible after sunset to begin a new month. Besides, it is not an easy task. Like what have been said N. Guessoum and K. Meziane in JAAH that several astronomical and, more importantly, atmospheric conditions must be satisfied for the thin crescent to be visible²⁹.

Indonesia is a tropic country, located throughout the equator line. The Sun shines almost along the year. In addition the water surface more than the land one. That combined two natural condition make evaporation easy to form. In rainy season rainfall, that rain is increasing in almost all region, reach more than 250 mm/month³⁰.

Evaporation produces clouds by time inactivity. When the air containing moisture rises into space, it becomes cold. Cold air can not carry water vapor as much as warm air so that it begins to condense into water. Water vapor forms a large number of very small water dots that

29 N. Guessoum and K. Meziane, Visibility of the Thin Lunar Crescent: The Sociology of an Astronomical Problem (A Case Study) in *Journal of Astronomical History and Heritage*, 4, No. 1, 2001, page 11

30 Erwin Mulyana, Hubungan Antara Enso dengan Variasi Curah Hujan di Indonesia, in *Jurnal Sains & Teknologi Modifikasi Cuaca*, (Badan Pengkajian dan Penerapan Teknologi) Vol. 3 No. 1 2002, page 3

appear as clouds. If the air is almost saturated with water vapor, in the low place then the low cloud is formed³¹.

From that fact about Indonesia that easy to make clouds. It has a big correlation with the young crescent of the moon observation. Observing young crescent of the moon needs a clear sky, of course, to see the thin of the young crescent. But almost in every observation, such as the last on Kendal Port³², 29 Sya'ban 1438 H or May 25th, 2017, clouds covered the sky near to horizon.

During the observation little rain also felt down. The wind blew up with sea water. Some observer covered their optical instrument to hide from the water. Fortunately, when the sun almost set the rain is over. All participant continued the observation. But until the moon set, that is approximately ten minutes after sunset, the young crescent of the moon was not visible³³.

This condition is similar for observation in al Husna Tower, Great Mosque of Central Java³⁴. Different location and the altitude which has 95 meters above sea level. A report in a group of the class reported that observer couldn't see the young crescent of the Moon due to thick clouds near the horizon. The same difficulties often occurred based on writer

31 John Woodward, *e.explore: Cuaca*, translated by I.N. Fauziyah, Penerbit Erlangga, 2008, page 40

32 Coordinate Point Kendal Port: -6° 55' 6.04" S, 110° 17' 16.5" E

33 Committed by Ministry Religion Affairs Central Java with the participate UIN Walisongo Students, Kemenag Kendal, Students of Islamic Boarding School in Kendal. Optical Instrument of observation: Binoculars, Telescope, and Theodolite.

34 Coordinate Point of al Husna Tower, Great Mosque of Central Java: 6° 59' 04.16" S, 110° 26' 47.85" E with 95 meters above sea level

experience as a member of Tim Hisab Rukyat Menara al Husna Masjid Agung Jawa Tengah (THR al Husna MAJT).

Al Husna Tower is a base place for the young crescent of the moon observation. Every end of month hijri THR al Husna MAJT observes young crescent. Therefore it is so easy to determine where the observer is familiar with exact direction. But the difficulties come when the sun will begin to set. Clouds covered near horizon hide sun and of course, the young crescent of the moon.

Beside two location mentioned above, the writer also compared by the other observer and so on location. Comparing other experience to conclude one proof statement. For the first, Ageng Riyadi³⁵ or known as Pak AR, initial from his name. He is an observer from as Salam Observatory³⁶, Solo. By the talks on November 1st, 2017, he said that one of the difficulties from young crescent observation is hiding by two mountains, Merapi³⁷ and Merbabu³⁸ mountains.

Of course, Merapi and Merbabu mountain tend to produce volcanic clouds. The clouds, as he said, not only come from two mountains that make a double impact. But also general clouds, evaporating result from the water surface. He added clouds love to be in the high place like mountains.

35 A physic teacher and expert in Islamic astronomy from as Salam Islamic Boarding School

36 Coordinate Point of as-Salam Observatory 7° 33'08.00" S dan 110° 46'15" E with equipment Vixen CV200L with Sphinx Mount, Canon 60 D

37 2986 meters above sea level, located in 7° 32'30" S dan 110° 26'30" E taken from Badan Geologi site, Kementerian Energi dan Sumber Daya Mineral

38 3142 meters above sea level, located in -7.4873655,110.4358621 , ibid

Mountains have low air pressure so the clouds move to thereby natural law that wind blows from high to low air pressure.

In the night we could see many lights around them. The next explanation stated that the lights did not affect the young crescent of the moon observation. Because they will turn on late after sunset and located so far away. From this statement can be implied that the obstacles young crescent of the moon in As Salam observatories are Merbabu-Merapi mountains and the clouds.

The clouds are made from water evaporation. The water rises up to the high air by hot temperature. Heating water makes a vapor, just like if we boil water then in the pan cover there are water dots. Then the vapor gathered in certain formation. It depends on the height the clouds reached. Specify and more detail will be described in the following chapter.

Troposphere has the air we breathe and the clouds in the sky. The air is densest in this lowest layer. In fact, the troposphere contains three-quarters of the mass of the entire atmosphere.³⁹ In the troposphere, there are weather phenomena such as temperature, pressure, particles in the air and cloud movements. Moreover, it is possible to make light absorption thus reducing vision power.⁴⁰

³⁹ <https://spaceplace.nasa.gov/troposphere/en/> accessed on Monday, December 11th, 2017 11:14 AM

⁴⁰ Thomas Djamaluddin, *Menjelajah Kekuasaan Langit Menembus Kedalaman al-Qur'an* Bandung: Khasanah Intelektual, 2008, page 96

One difficulty can be concluded by the clouds hiding young crescent of the moon observation. Surely, when the clouds are there in the young crescent of the moon direction, the observer could not able to see it. This condition is worse by the young crescent of the moon that locates very close to horizon, has a little value of azimuth with the sun, has a short period of moon lag and young moon age.

Cloud is not the only one difficulty from the observation. There is another factor hardly influence it. Such as light pollution that has been discussed in the magister thesis titled Light Pollution Effect on Rukyatul Hilal⁴¹. The researcher said light pollution is a lamp light scattered phenomenon from housing society by particles and aerosol on atmosphere and make the sky more bright.

Brighter sky by light pollution makes young crescent of the moon difficult to be seen. The light that comes from the lamps defeating low moon illumination. Lamplight sources will decrease vision power according to the young crescent of the moon visibility, due to strength lamp light has more intensity than young crescent of the moon illumination.

41 Abdulloh Hasan, Efek Polusi Cahaya Terhadap Pelaksanaan Rukyat (Study Kasus Pelaksanaan Rukyat di Menara al Husna Masjid Agung Jawa Tengah dan CASA Assalam Surakarta tahun 2014), Tesis Magister: Program Magister Ilmu Falak Program Pasca Sarjana Universitas Islam Negeri Walisongo Semarang 2015

E. Different Types Determination the Beginning of Month Hijri in Indonesia

We are often faced - at least in a few years ago - differences in start-end fasting in Ramadhan and in Eid al Adha. These differences make chaos in the society. They are confused about when to start and end the fasting. Furthermore, it is often to appear physical fight between Islamic society. Of course, this case decreases the unity and spirit of ukhuwah Islamiyah in Islamic society.⁴²

The development of Islamic astronomy in Indonesia cannot be separated from the problem determination of hijriyah months. Until now the determination beginning of the month hijriyah still raising the difference. This is due to differences in the understanding proposition and its application.⁴³ The argumentation by reference to relevant passages of al Qur'an and Hadis interpreted more than one purposes.

Development of determining the beginning month from Hijri calendar in Indonesia has been started since Islam came. In the beginning, the simultaneous observation was done by a society that went to beaches and mountains to see the young crescent of the moon without know the exact position. They did not notice where direction, they paid attention to

42 Ditbinbapera, Hisab dan Rukyat: Permasalahannya di Indonesia, in Selayang Pandang Hisab Rukyat, Direktorat Jenderal Bimas Islam dan Penyelenggaraan Haji Direktorat Pembinaan Peradilan Agama, page 1

43 Jayusman, Kajian Ilmu Falak Perbedaan Penentuan Awal Bulan Kamariah: Antara Khilafiah dan Sains, Al-Maslahah Jurnal Ilmu Syariah, Vol. 11, No. 1 2015, IAIN Pontianak accessed from <http://jurnaliainpontianak.or.id/index.php/Almaslahah> December 11th, 2017, 10:38 AM

different ways of direction. Someone observed and watched south-west direction, west or north-west course.⁴⁴

Hilal at the beginning of the month is still thin, not too contrast with the sky that covered it back and very fast to set after sunset. It is very hard to be observed by naked eyes, in addition, view direction that not purposed to a position where hilal located. The started observer before knowing Islamic astronomy did not know the data of hilal location.⁴⁵

After knowing Islamic Astronomy, Moslem society in Indonesia was able to count hilal position. Thus, the young crescent of the moon observation has been developed. Not only argued by estimation but basically supported by scholar computations. The computation gives information how much the height of hill above the horizon, how big the part of hilal can be seen, to where direction hilal will be looked out and other data that help the succession of observation.⁴⁶

Computation or hisab in the next following era that as the result from the young crescent of the moon observation in Indonesia development, divided into two opinions. One of them stated that a new month started in the sunset after conjunction. Another one gives

44 Ditbinbapera ... in Selayang Pandang Hisab Rukyat ...

45 Ibid

46 Ibid

argumentation that determining the beginning month not only based on conjunction but also consider the hilal position.⁴⁷

A group that holds on conjunction system, declared if conjunction occurred before sunset, then since the sunset beginning month is begun. They not considered at all on hilal visibility could be observed or not. In another side, a group that occupied on conjunction and hilal position declared if after conjunction dan hilal is there above the horizon, then after sunset is beginning of the beginning month from a new month.⁴⁸

Both of them have similarity in the process of entering new month: by calculation in the sunset conjunction has been occurred. However different in a declared young crescent of the moon position above the horizon. The first not take into consideration the hilal position above the horizon during sunset. In otherwise the second group requires hilal have to be above the horizon in the sunset after conjunction. If hilal still under horizon the day be last day in the running month.⁴⁹

The continuing development of them is divided into some branches for each argumentation. But the most developed in an opinion that considered hilal position above the horizon. Then there are so many computations to determine the beginning of month hijri. Back to history,

47 Jayusman, *Kajian Ilmu Falak ...*

48 Badan Hisab dan Rukyat. Dep. Agama Pusat, 1981, *Almanak Hisab Rukyat*. Jakarta: Proyek Pembinaan Badan Peradilan Agama Islam, page 99

49 Susiknan Azhari, *Ilmu Falak Perjumpaan Khazanah Islam dan Sains Modern*, 2nd edition (Yogyakarta: Suara Muhammadiyah, 2007), page 109

we could recognize traditional computation that just counts the average amount of days.

Traditional computation or well known as *Hisab Urfi* has been used in all Islamic world include Indonesia for a long time. For instance, the usage of Islamic Javanese Calendar. This calendar is a mix between Javanese-Hindu computation and Hijriyah computation by Sultan Agung Anyokrokusumo in 1633 AD or 1043 H or 1555 Saka.⁵⁰

By mixed between two different types of calendar, some element is still be maintained. Such as the number of days in a year, a little cycle in Javanese calendar and leap year in the calendar. The name is translated from Arabic into Javanese term. Due to this calendar still use traditional computation, its very simple to determine the new month. It makes a pattern in a big cycle, once in 120 years, to be repeated.

The repeated pattern is used to determine beginning month in a certain year and then could be applied in the following month. For example in a cycle from 1747 – 1866, beginning month or 1st Suro in the first year⁵¹, Alip, will be happening on Wednesday (Rebo) Wage. Simplify this pattern will be repeated in the next year. Indeed this old method still being used until now by some society named Aboge.

50 Susiknan Azhari dan Ibnor Azli Ibrahim, *Kalender Jawa Islam: Memadukan Tradisi dan Tuntutan Syar'i* dalam *Jurnal Asy-Syir'ah* Vol. 42 No. I, 2008. page 137

51 There is eight year in a little circle, they are Alip, Ehe, Jimawal, Ze, Dal, Be, Wawu and Jimakhir. For one big cycle consist of 15 little cycle or 120 years

Aboge society exists the computation even the period of cycles is changed. After Aboge, the next cycle running from 1867 to 1986 will be started their beginning month on Tuesday (Seloso) Pon, shorted in Asapon. The previous cycle from 1987 until 2106 called as Anenhing. It means the First year of the cycle (Alip) is on Monday (Senen) Pahing.⁵²

In the beginning 20th century the computation has innovated by considering the sun and moon position. The data taken from astronomical table Ulugh Beik, well known as Zij Sulthani. Where calculation table sources from Geocentric theory, believed the Earth as a center of the planetary system.⁵³ This computation called as hisab tahkiki taqribi.⁵⁴

Hisab tahkiki taqribi started astronomical table-based computation. Even data source comes from Geocentric one, but it is being the first step to modern computation. Advancing calculation by Indonesian Moslem scholar. They studied in Arabic and back to Indonesia then publish their book about computation. One of them that is Muhammad Manshur bin Abdul Hamid ibn Muhammad Damiri bin Muhammad Habib bin Abdul Muhit nin Tumenggung Tjakra Jaya. He wrote a book titled Sullam an-Nayyirain, published for the first in 1344 H/ 1925 AD.⁵⁵

52 Lajnah Falakiyah PBNU, Pedoman Rukyat Dan Hisab Nahdlatul Ulama (Lajnah Falakiyah PBNU, 2006), page 48-49

53 Slamet Hambali, Astronomi Islam dan Teori Heliocentris Nicolaus Copernicus, in *Jurnal al Ahkam*, Volume 23, Nomor 2, Oktober 2013, Fakultas Syariah, IAIN Walisongo Semarang, page 226

54 Jayusman, *Kajian Ilmu Falak ...*

55 Muhyiddin Khazin, 2008, *Ilmu Falak Dalam Teori dan Praktik*. Yogyakarta: Buana Pustaka, page 29

Sullam an-Annayyirain being the famous book of hisab tahkiki taqribi. It is still used as a literature on several Islamic boarding schools until now. Moreover in two decades before this computation ever being as a reference in determining beginning month of Hijri calendar by ministry religion affairs of Indonesia. At the time this book gives the best result of hilal data. So it used as standard computation before the more accurate computation introduced.⁵⁶

Exactly a decades after that, Khulashotul Wafiyah was being published for the first time. The author is Zubair Umar al Jailani. The difference with the Islamic astronomy before, he used an astronomical table based on Heliocentric argumentation. So the computation has more accuracy than based on the Geocentric one. There is also another book that has the same method computation: Ilmu Falak dan Hisab by K Wardan Diponingrat, al Qawaid al Falakiyyah by Abdul Fattah and Badi'atul Mitsal by Ma'shum Jombang.⁵⁷

In the last 20th century or at least in the beginning 21st century the computation or hisab has an evolution. It advances by program computation, a designed calculation in a computer software. They are: Mawaqit bi Netherland ICMI in 1993 then perfected to be Mawaqit 2001 version by Khafid, Falakiyah Najmi program by Nuril Fuad in 1995, Program Astinfo commercial astronomy software by Zephyr, and Badiah

⁵⁶ Jayusman, *Kajian Ilmu Falak ...*

⁵⁷ Mohammad Murtadho, *Ilmu Falak Praktis*. 1St Edition. (Malang: UIN Malang Press, 2008), page 29.

al Mitsal Program in 2000, Ahillah, Misal, Pengetan and Tsaqib by Muhyiddin Khazin in 2004.⁵⁸

To know when Ramadhan fasting is started and ended, Rasulullah saw has given a guide as hadis Bukhari Muslim: "Be fasting you because of seeing the young crescent of the moon and break of fast if you see it, if it covered or hidden by the cloud, completes the Sya'ban month into 30 days. But that guide has two interpretation, one said that sentence of seeing understandable have to see the reality. In the other one, have an argument it is enough for computation.⁵⁹

The difference happens in Indonesia, computations or hisab method by Muhammadiyah and observation or rukyat method by Nahdlatul Ulama. The governance has been giving a solution to unite both of them by imkanurrukyah. But it is often to be politically defeated.⁶⁰ Both of them wont to make a win-win solution and stand on each themselves argumentation. For instance, in a case, the height of the young crescent of the moon is about 1 degrees above the horizon. It is very difficult to be seen, but in another hand it is concrete, being tangible that hilal is above the horizon.

58 Ibid

59 Ahmad Izzuddin, Ilmu Falak Praktis: Metode Hisab-Rukyat Praktis dan Solusi Permasalahannya, Semarang: Pustaka Rizki Putra, 2012, page 141

60 Ibid

CHAPTER III

THE MOON OBSERVATIONS BY SUSANNE M. HOFFMANN

A. Susanne M. Hoffmann Biography

Susanne Magdalena Hoffman was born in Berlin Germany Europe on January 4th, 1980. An astronomist in three subjects: physic, history of science and didactics. She finished her High School in June 1999. She continued to study Physik and history of physics in the same year at Universität Potsdam. In September 2015 she got her Dr. Phil. Title after graduated from the Berlin Graduate School of Ancient Studies (*BerGSAS*) at Freie Universität Berlin and the Humboldt-Universität zu Berlin.

Susanne M. Hoffmann joined out-of-school on several locations: Archenhold-Observatory Berlin, Observatory of Mina de São Domingos Portugal (lectures and guided tours in English, French, German and individual information and exhibition in Portuguese) and Planetarium-Observatory Königsleiten Austria (lectures and shows in English, German and Dutch). She also participated in one week courses in astronomy and nature on caravans in Mauretania (talks and discussions in German and French).

Speaking in three languages: German, English, and French makes Susanne M. Hoffmann easy to grab more knowledge. At the basic (due to research), She also understands in Latin, Ancient Greek, Akkadian, Arabic, Dutch and Portuguese. In addition, she has at least five programming

knowledge: Wolfram Mathematica language, Fortran 90, HTML, XML, and C++. Of course in a field of astronomy, she has been got a certificate in Planetarium and Telescope (exam in 1998).

Experienced in organizing several astronomical summer school from 1999 until 2006, brought Susanne M. Hoffmann to reach bigger activities such as: freelancing author for publisher Franckh-Kosmos-Verlag, teaching at the Urania-Planetarium Postdam, in charge for hotel-observatory of “LaSabina” Portugal, tour guide for tour operator “wüstenwandern” Mauretania, Freelancer at the two larger planetariums of the Foundation Planetarium Berlin and the last, Senior expert guest at the State Islamic University Walisongo Semarang, Indonesia.

Recent activities in the personal development of Susanne M. Hoffmann at the moment is Scientific staff astrophysics Astrophysikalisches Institut und Universitätsternwarte (AIU), Friedrich-Schiller-Universität Jena (until August 2020). In December 2017 she also got Cartographica-Scholarship for studies of celestial cartography and the search for guest stars. Then suggested in a membership of International Astronomical Union (IAU) that for seen for 2018.

Susanne M. Hoffmann is very productive to publish her paper. It should be known from a huge amount of her list publications. In part of a book, she wrote three books in History of Science, five books in didactics/media studies, two books in Astronomy (general). Then five scientific papers

peer-reviewed, twenty scientific proofreading in history science and didactics. Reviews 14 journals, films and scientific research; Write at least 44 articles for journalism and oral history purposes. Susanne M. Hoffmann also publishes six popular astronomy-monographs. One of her scientific paper that used in this research is How time served to measure the geographical position since Hellenism, *Time in Astronomy & Society, Past, Present and Future*, Springer, 2017.

B. Usual Observations Of The Moon

Moon is sky object that we often see every day. Of course, different shapes are evidence as a phase of the moon from its movement. The objects of the sky from our solar system, include our Earth, are move through the orbit. This orbital track is around the source of light, the Sun. Because the shape is spherical, only half of each of these spherical objects or one hemisphere can experience sunlight at any moment. For the Moon, the entire illuminated face cannot usually be seen from the Earth. The relative positions of the Moon, Earth, and Sun at a given time determine what fraction of the illuminated face is visible.¹

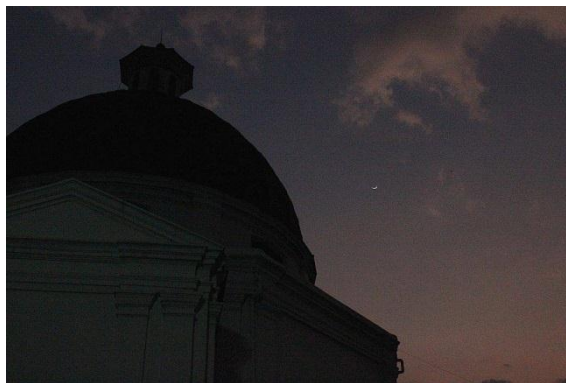
Normally the moon is visible once a day and it can be observed by the naked eye. It is very simple to do that we can recognize easily. When the moon is being on its first phase it will be seen in the western sky after sunset. The middle one, that is full moon will be visible along the night from east to

¹ <https://www.jmu.edu/planetarium/MoonPhasesandEclipses> - James Madison University, accessed on December 20th, 2017 09:37 AM

west sky. The last phase will be rise so lately, furthermore, at the beginning of this phase, we could see the moon after sunrise. Before starting the new moon, it will be invisible. Due to the position close to the sun.

The new and full phases are technically just the moment that the Moon's surface facing us is completely in darkness or completely revealed by sunlight. In the darkness we couldn't see the moon, known as a conjunction, a transition from previous month to afterward in the lunar calendar. In otherwise, an opposition of the moon will give its spherical shape. Biggest shape than the other phase. The sun illuminates almost all the moon surface and makes the sky so bright.

In this chapter will be displayed a number of the moon photos taken by Susanne M. Hoffmann. She called this activity as usual observation of the moon. Most of them taken in Indonesia and the left in her Germany. In the following pictures present a phase of the moon and figure out its shape. In Indonesia usual observation of the moon started on July 26th, 2017 and ended on August 5th, 2017. She also took of the moon picture in Germany the day on the lunar eclipse.



Picture 3.1 Waxing Crescent of The Moon above the Church

Credit: Susanne M. Hoffmann

On July 26th, 2017 Susanne M. Hoffmann took the moon picture in The Blenduk Church, Old City of Semarang. The shape of the moon is like lying down. In the west side closer to sunset. The moon is still in its first quarter, about three days after conjunction. It appears before sunset actually until the second quarter and depends on the age and location. Rather thin in shape with yellow color. The zooming picture above is below:



Picture 3.2 Zooming Waxing Crescent of The Moon

Credit: Susanne M. Hoffmann

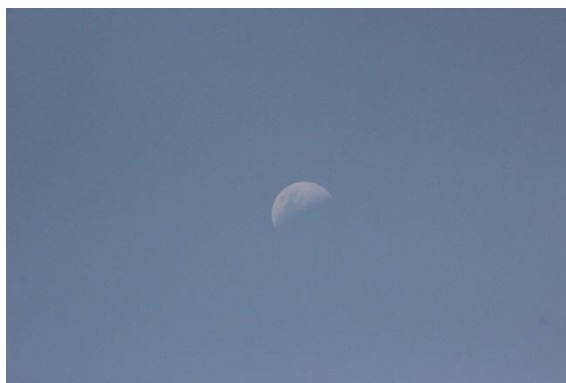
A little discussion in Marina beach (July 29th, 2017) Susanne M. Hoffmann said that the color of the moon reflects the atmosphere condition. The darker of the moon color the more dirty atmosphere condition from the location. Because in the clear sky, the light from outer space will continue freely to the earth surface. But, the dirty sky that consists of dust, smoke, and other pollution will influence the light transfer.



Picture 3.3 Waxing Crescent of the Moon

Credit: Susanne M. Hoffmann

On July 28th, 2017 second observation done by capturing the moon. This phase represents a progression of the moon phase. Thick surface begins filling out darken side. The waxing crescent reclined in west sky and resided more long night. This moon is visible toward the southwest in the early evening. As the moon moves eastward away from the sun in the sky, we see a bit more of the sunlit side of the moon each night. A few days after new Moon, we see a thin crescent in the western evening sky. The crescent moon waxes or appears to grow fatter, each night.²



Picture 3.4 Waxing Crescent Moon

² <https://moon.nasa.gov/> accessed on Friday, December 22nd, 2017 9:45 AM

Credit: Susanne M. Hoffmann

Two next days, on July 30th, 2017, the moon visible in the daylight. Not only at night, we also can see the moon during daylight. Of course, it depends on the moon phase. First quarter phase might visible in the daylight before sunset and third quarter after sunrise. We frequently see the moon in the day; the only phases of the Moon that cannot be seen in the day are a full moon (which is usually only visible at night) and the new moon (which is not visible from Earth at all).



Picture 3.5 First Quarter

Credit: Susanne M. Hoffmann

On July 31th, 2017, the moon entered the second phase. A half of surface has abounded. It reveals a new shape, gibbous cape to full moon. Then starting escalated up toward zenith after sunset. It is visible high in the southern sky in early evening. When half of the moon's disc is illuminated, we call it the first quarter moon. This name comes from the fact that the moon

is now one-quarter of the way through the lunar month. From earth, we are looking at the sunlit side of the moon from off to the side.³



Picture 3.6 Waxing Gibbous Moon

Credit: Susanne M. Hoffmann

On August 1st, 2017 there is more than half part of the moon illuminated. The moon already moves to the east side. It is hanging up in advance of sunset. People from earth could observe to the southeast in the early evening and goes up for most in the night. Then the moon continues to wax. Once more than half of the disc is illuminated, it has a shape we call gibbous. The gibbous moon appears to grow fatter each night.



³ Ibid

Picture 3.7 Waxing Gibbous Moon

Credit: Susanne M. Hoffmann

Beautifully captured on August 3rd, 2017. The sky is clear and bright. Thus, it acquires the best result of observation. There is no obstacle disturbing the observer to study from a phase by phase. Some people think that phases of the moon are caused by a shadow from the earth, clouds or the earth's or moon's rotation. The reality said our perspective of the moon's sunlit appearance changes as it orbits the earth.



Picture 3.8 Waxing Gibbous Moon

Credit: Susanne M. Hoffmann

This picture was taken by Susanne M. Hoffmann and the writer in front of Tugu Hotel. On August 4th, 2017, we have to wait for a big cloud. They hide the moon from an easterly direction. Then we get a moment that there a chance to capture. Big cloud quickly moves and show the dark side of the moon in this phase. The dark side of the moon is not eclipsed. The lunar eclipse occurs in the full moon phase. Some people believe that the same half of the moon is in darkness all the time in an example. There is a dark side of the moon. Actually, the moon has no side that is constantly dark. The front

and back are alternately lit as the moon rotates. The far side is a more accurate term.



Picture 3.9 Waxing Gibbous Moon

Credit: Susanne M. Hoffmann

Last moon observation in Indonesia, August 5th, 2017. Two days before Susanne M. Hoffmann departure to Germany. The writer ever asked her why the moon becomes larger on the horizon? Is it because of closer to earth? She answered this is an optical illusion. For reasons not fully understood by astronomers or psychologist, the low hanging moon looks unnaturally large when they beam through trees, building or other foreground objects.

Why do we see lunar phases? The "amount" of the moon that we see as we look from earth changes in a cycle that repeats about once a month (29.5 days). The relative positions of our sun, earth, and moon, cause these changes. The side of the moon facing the sun is always illuminated, just like earth's daylight side is illuminated by the sun. From our perspective on earth, we see different parts of the moon's illuminated surface as the moon orbits the earth.

C. Al-Biruni's Observation Repeated

Al-Biruni is a Moslem scientist in the middle Islamic era. He has been known for his masterpiece, *Al-Qanun Al-Mas'udi fi Al-Hai'ah wa Al-Nujum*. Born with full name Abu Raihan Muhammad ibn Ahmad Al-Biruni on Monday 15 Dzulhijjah 362 H/ September 973 AD in the edge of Khath city, Khawarizm.⁴ Productively to observe the natural phenomenon and writing to several books makes his name famous in the Moslem scientist world.

Al-Qanun Al-Mas'udi was presented to Sultan Mas'ud al Ghaznawi. There, Al-Biruni discussed all of the astronomy problems which developed at the time.⁵ Consists of 42 chapters and relates to *Al-Alat Al-'Ajibah Al-Rasyidah* by Al-Khazin (died in 1048 AD). In another side, he also wrote his strong observations result about land formations and mountain structures. Al-Biruni also found sediment character in Gangga river and knew about big geological changes in the past.⁶

In the process of finding the position of Ghazani relative to Baghdad, Al-Biruni used about 65 observations of the Sun, mostly measurements of meridian altitudes made at various places. The dates of the observations range from 829 to 1019. Al-Biruni also left a few miscellaneous observation of

⁴ Ahamd Rofi' Usmani, *Ensiklopedia Tokoh Muslim* (Bandung: Penerbit Mizan, 2015), page 192

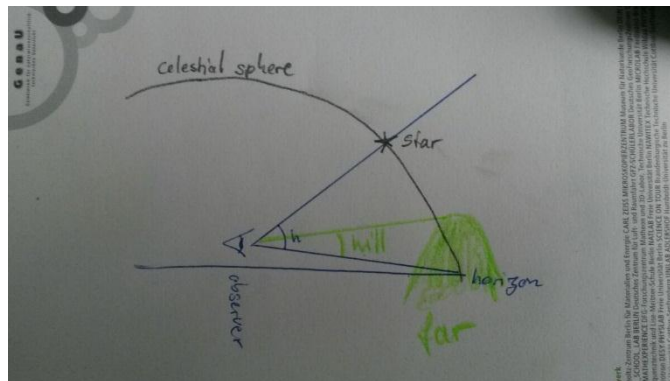
⁵ Sakirman, Memahami Konsep Dasar Gerak, Bentuk dan Ukuran Bumi Studi Analisis Kitab *Al-Qanun Al-Mas'udi* Karya Al-Biruni dalam Konteks Hukum Islam in *Al-Istinbath: Jurnal Hukum Islam* Vol. 2 No. 1, 2017 (STAIN Curug – Bengkulu) page: 20

⁶ Ahmad Rofi' Usmani ... *Ensiklopedia Tokoh Muslim* ... page 192

eclipses. These, taken in conjunction with the solar data, yield a lunar acceleration of 46.4 sec per century.⁷

1. Determine Size of The Earth by Astrolabe Observation

An 11th-century Persian mathematician, Al-Biruni, estimated the Earth's radius. His estimate was 6340 km, which is within 1% of the mean radius of 6368 km. The process was done by a large astrolabe constructed to determine the angle of declination from the top of a hill, overlooking the sea, to the horizon.⁸ Actually, Susanne M. Hoffmann is not sure if Al-Biruni did this measurement. The following methods explained by her from ancient suggested by Poseidonius of Rhode.

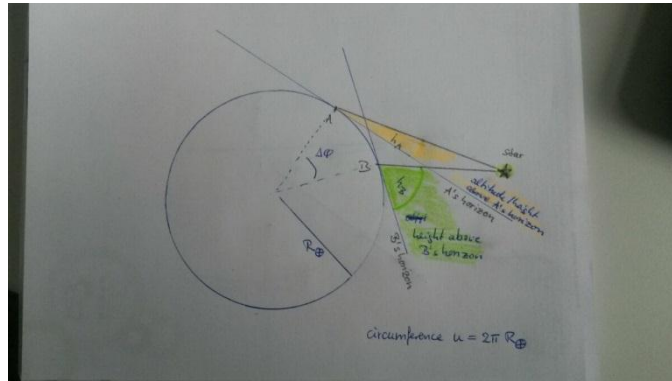


Picture 3.1 Observer measures the height

Credit: Susanne M. Hoffmann

⁷ R. R. Newton, The Earth's Acceleration as Deduced from al Biruni's Solar Data in *Monthly Notices of the Royal Astronomical Society*, Volume 159, Issue 4, 1 September 1972, pages 453 accessed from Oxford Journals on December 22nd, 2017 02:45 PM

⁸ WJA Colman, Measuring the Radius of the Earth, *The Mathematical Gazette* in Cambridge Journals, page 72, Downloaded from <https://www.cambridge.org/core>. UIN Walisongo, on 04 Oct 2017 at 06:51:58.



Picture 3.2 Compared two observer for measurement

Credit: Susanne M. Hoffmann

Measuring the size of the Earth needs two observers. Each observer has his/ her own local horizon which is a Tangent on the Earth's sphere. Both of them are observing a star simultaneously. But there is different, for one observer the star is high up in the sky and in other observers, it is close to the horizon. The difference of two altitudes is the difference of their geographical latitude ($\Delta\pi$).⁹

Since they know their Delta Phi ($\Delta\pi$) and can easily measure their distance in kilometers (or whatever unit had been used those days). They can easily determine the circumference (or radius or

⁹ Susanne M. Hoffmann, *Der Historische Weg, tredition Verlag*, Historische Erkenntniswege als außerschulische Vermittlungsmethoden für MINT-Fächer an Beispielen der Astronomie, Reihe UhuraUrania, Bd. 5, tredition, Hamburg, 2017, pages 68-70

diameter) of the whole sphere they are standing on. From the observation above then get an equation as follows:

$$|h_A - h_B| = \Delta\pi$$

$$\frac{\Delta\pi}{360^\circ} \times \frac{\text{distance}A}{2\pi R}$$

2. Using Lunar Eclipse Observations to Measure Distance Between Two Cities

The ancient explained measuring distance two cities using lunar eclipse method. But it has never been applied in antiquity as Susanne M. Hoffmann tried to prove. Only Al-Biruni and Abu Al-Wafa applied it to determine the position of Baghdad and Kath, today Khiva in Khawarism (today Uzbekistan) with the lunar eclipse on May 24th 997 AD.¹⁰ So the next following observation is in the case to repeat their great job observation.

Exactly one day after Susanne M. Hoffmann departure from Indonesia, August 7th, 2017 there was a partial lunar eclipse. As an astronomy phenomenon, astronomer did not pass this best moment away. Including the writer and Susanne M. Hoffmann. On August 2nd, 2017 she gave a suggestion to repeat Al-Biruni observation to

¹⁰ Susanne M. Hoffmann interview by E-Mail on September 12th, 2017

The writer did the observation in front of the house, with coordinate point $6^{\circ} 57' 16.9''$ S, $109^{\circ} 29' 40.71''$ E. Time contact exit 02:38 West Indonesian Time using a smartphone as equipment. The time displayed on the smartphone did not show the local time. Meanwhile, it is the meridian time whole zone. So we have to add 16 minutes: derivation from Jakarta Timezone. Pemalang located 4° east of Jakarta. The real local time in Pemalang will be like $02:38 + 16$ minutes = 02:54.



Picture 3.3 Mohamad Akyas – Partial Lunar Eclipse

Susanne M. Hoffmann observed the moon complete again in 21:23 in Berlin with coordinate point $52^{\circ} 30' 48.8''$ N, $13^{\circ} 30' 12.2''$ E. No longer after her arrival in Germany. Susanne M. Hoffmann smartphone displayed 21:23 but due to daylight saving time it should be 20:23 to be in the correct time zone and due to the local time difference of Berlin to the zone-meridian we have to subtract 4 min, thus, it 20:19 local time.



Picture 3.4 Susanne M. Hoffmann – Partial Lunar Eclipse

The last observer, Ms. Renate Ell from Bavaria-Germany, said that she did not have experience in lunar eclipse observation but she was able to see the rim of the moon complete again in 21:18, temperature 20.5° C, 59% humidity in the air. She observed from Hattenhausedn (Bavaria) on the balcony in the 1st floor of a house, close to a river with coordinate point $48^{\circ} 30' 31.8''$ N, $11^{\circ} 30' 12.1''$ E. So local time for Ms. Renate Ell is 20:06.



Picture 3.5 Ms. Renate Ell – Partial Lunar Eclipse

Before starting the computation we have to give an error bar to each time. Error bar is badged in the result even not counted in the computation. We need to do that because of it possible for each observer because it is not very easy to see or to identify the very moment when the shadow leaves the rim of the moon.

Pemalang – Berlin Computation:

$$\begin{aligned}\Delta t &= 02:54 \pm 1 \text{ min} - 20:19 \pm 1 \text{ min} \\ &= 06 \text{ hours } 35 \text{ minutes } \pm 2 \text{ min} \\ &= 360 + 35 \text{ minutes } \pm 2 \text{ min} \\ &= 395 \text{ minutes } \pm 2 \text{ min}\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= \frac{15}{60} \times 395 \\ &= 98^\circ 45'\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= 109^\circ 29' 40.71'' - 13^\circ 30' 12.2'' \\ &= 95^\circ 59' 28.51'' \approx 96^\circ\end{aligned}$$

$$\begin{aligned}\Delta t &= \frac{9559'28.51''}{15/60} \\ &= 380 \text{ minutes} = 6 \text{ hours } 20 \text{ minutes } \pm 2 \text{ min}\end{aligned}$$

Pemalang – Bavaria

$$\begin{aligned}\Delta t &= 02:54 \pm 1 \text{ min} - 20:06 \pm 1 \text{ min} \\ &= 06 \text{ hours } 48 \text{ minutes } \pm 2 \text{ min} \\ &= 360 + 48 \text{ minutes } \pm 2 \text{ min} \\ &= 408 \text{ minutes } \pm 2 \text{ min}\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= \frac{15}{60} \times 408 \\ &= 102^\circ\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= 109^{\circ}29'40.71'' - 11^{\circ}30'12.1'' \\ &= 97^{\circ}59'28.51'' \approx 98^{\circ}\end{aligned}$$

$$\begin{aligned}\Delta t &= \frac{9759'28.51''}{15/60} \\ &= 392 \text{ minutes} = 6 \text{ hours } 32 \text{ minutes } \pm 2 \text{ min}\end{aligned}$$

Berlin – Bavaria

$$\begin{aligned}\Delta t &= 20:19 \pm 1 \text{ min} - 20:06 \pm 1 \text{ min} \\ &= 13 \text{ minutes } \pm 2 \text{ min}\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= \frac{15}{60} \times 13 \\ &= 3^{\circ}15'\end{aligned}$$

$$\begin{aligned}\Delta\lambda &= 13^{\circ}30'12.2'' - 11^{\circ}30'12.1'' \\ &= 2^{\circ}\end{aligned}$$

$$\begin{aligned}\Delta t &= \frac{2}{15/60} \\ &= 8 \text{ minutes } \pm 2 \text{ mins}\end{aligned}$$

The result of the computation above gives us information that all of them are different. We could recognize that observing moon sometimes rather difficult because it becoming fuzzy. There is a deviation between computation result and the real size. Determining a longitude of Earth by the comparison of local times of observers, work with an accuracy 1° to 3° longitudes. Nevertheless, ancient scientific authors had only a handful of eclipses observed simultaneously and

among those, they always chose one famous example to explain the method.¹¹

The result gives us information that all of them are different. We could recognize that observing moon sometimes rather difficult because it becoming fuzzy. There is a deviation between computation result and the real size. Determining a longitude of Earth by the comparison of local times of observers, work with an accuracy 1° to 3° longitudes. Nevertheless, ancient scientific authors had only a handful of eclipses observed simultaneously and among those, they always chose one famous example to explain the method.¹²

11 Susanne M Hoffmann, *How time served to measure the geographical position since Hellenism*, (Berlin: Excellence Cluster Topoi, 2017) on page 10

12 Susanne M Hoffmann, *How time served to measure the geographical position since Hellenism*, (Berlin: Excellence Cluster Topoi, 2017) on page 10

CHAPTER IV
SUSANNE M. HOFFMANN DISCOURSE
ON OBSERVING THE MOON

A. Susanne M. Hoffmann Discourse on Observing the Moon

Observing the moon is one activity that usually done by astronomist. Not except for Susanne M. Hoffmann, an astronomist from Germany. In the middle of July 2017, She came to Indonesia in case visiting professor on Service Expert Service for Islamic Astronomy Master Program, Sharia and Law Faculty, Walisongo State Islamic University Semarang. Almost no one day she passed to observe the natural satellite of Earth.

In the previous chapter mentioned that Susanne M. Hoffmann observed the moon from a day to day during her stay in Semarang. She is analyzing the phase changing process and shape of the moon. Shape that, of course, different from what she usually see in Germany. In her paper of blog with the title *Islamischel Mondische in Natura*, she explains kind of causes the different shape of the moon for an observer that located near the equator and far away from it.

Moon at the first phase (waxing crescent) seen from Semarang, Indonesia looks like a flying boat. Not same with its shape in Germany, North Europe that for the similar phase like a banana. Surely, this difference due to the value of latitude that effects on moon's orbit. Nevertheless, by different

shape not means we see the different moon in two different places. In the other hand, we remained to see one moon in the same phase.

When observing the moon, at several chances it covered by clouds. So the observer has to wait for a few minute first until they moved and not covered the moon. This case very common occurred because they are easy to form. The clouds might come from the evaporation process and also a volcanic mountain. Both of them make Indonesia produce more clouds furthermore in the rainy season.

As delivered by Susanne M. Hoffmann, beside of two geographic factor that in nature being a specific type of Indonesia, there is an artificial factor too, that espouse the worse Indonesian sky condition. Smoke from vehicles and factory chimneys for the main. The environment in a big city like Semarang has been polluted by those things.¹ Can be seen from pictures taken by Susanne M. Hoffmann in the east edge of 1st Campus.



Picture 4.1 Chimneys industry blow smoke up to the air

¹ Interview and little discussion with Susanne M. Hoffmann and Anisah Budiwati, MSI in Marina Beach, July 29th, 2017

Credit: Susanne M. Hoffmann

We can see in the picture above, factory chimneys easily blow the smoke without filtering first. Of course, it being a serious problem that has to get the solution together. One of the solutions is providing good communication between internal factory management and government. The government should control, give strong regulation toward air pollution from factory chimneys.

Not only factory chimneys, the vehicles also contribute to making worse sky condition. Similar ways with industry, the vehicles did not have a filter in an exhausted pipe. Black smoke blows simultaneously and even disturb the respiratory system. Most of the type these vehicles are buses, truck and several old kinds of cars. This situation is drawn as the photo below.



Picture 4.2 Old car blows black smoke

Credit: Susanne M. Hoffmann

The number of vehicles is increasing every year along with increasing of amount Indonesian citizen. Although the development is

advanced and always there new innovation of products, in the reality, old type of car is still being used. This old type of vehicle make not comfortable on the road and it should not be used anymore.

This condition is further exacerbated by the presence of large vehicles such as containers and big trucks. In Semarang city, as the main route that is often passed by carrier-vehicles. When they are passing through a dirt road, they will blow away the dust. Elements of this particle become one of the compositions of smog.



Picture 4.3 Smog in Tanjung Emas Port

Credit: Susanne M. Hoffmann

Combination of fog, smoke, and dust is what makes smog. With the naked eye, we may not be able to distinguish between ordinary clouds and smog. According to Susanne M. Hoffmann is very difficult to distinguish both of them. But she added a commentary when observing the sunrise together in Marina Beach. She said that the movement of smog is not as fast as the clouds. Smog survives a little bit longer than the clouds.

Perhaps this is the obstacle of the observers when observing the moon in the early phase. These clouds and smog often block the view to the west as the sun sets. Even on several occasions, the sun is not visible before going down. It becomes a major obstacle if the height of the moon is lower than clouds and especially covered so that it can't be observed.



Picture 4.4 a half of sun's disc invisible before set

Credit: Susanne M. Hoffmann

Observing the moon is an important thing to do. Although in Indonesia, generally, to determine the beginning of Hijri calendar have two ways. There are two ways of determining it: computing or observing. Susanne M. Hoffmann discourse is the best way to do computing and observing, in any type of science. Concerning the Indonesian calendar there is the conflict: On the one hand, the Prophet himself only had observational means. Traveling in the desert its simple people (even today) have the only chance to

observe the crescent. This is the more traditional, (there, in the Near East desert) a more simple way to figure out the new month.²

On the other hand in Indonesia, it is more difficult because of the tropical climate and the nowadays huge amount of smog. Susanne M. Hoffmann idea is stated as follows:

In any type of science, it is very important to control by observation if the computation is still right. All sorts of algorithms we developed as best fit to some sort of data. People observed, fitted an equation to predict future data, collected further data and observed if the equation still gave good results. This is what science does.

Now, our equations to compute the position and phase of the moon is almost 2.5 Millennia-old; roughly 500 BCE Babylonian astronomers developed first algorithms to compute this (which still work very well) and since those days the algorithms have been developed further. Now with NASA/JPL data we are able to compute the position and phase of the moon for last centuries back and to the future. Therefore, we can say that for the moon the computation of the young crescent works very well. By astronomically we can rely on computations. But Susanne M. Hoffmann is not the person who is allowed to judge on religious relevance.

² Susanne M. Hoffmann Interview by Skype on December 28th, 2017

However, if somebody wants to really see the crescent it might not be possible. Especially under bad sky condition like in Indonesia. Since 1.5 Millennia Islamic calendar is determined by observation and judges/lawyers control the astronomist's observation of the young crescent in the sky. They cannot confirm an observation which did not take place. That is why Susanne M. Hoffmann suggest doing both, observation as well as computation. Astronomists are able to compute it correctly. But since this computation is difficult and most of the members of the religious community do not learn to perform it. But everybody is able to observe with a naked eye. Susanne M. Hoffmann thinks such an important issue for a Moslem society should not become "secret knowledge" of only a few astronomers. Everybody should be able to see, to confirm, to 'control' the reasons for the official decision or announcement of the beginning of the month.

So now Susanne M. Hoffmann suggestion to do it, that is:

- 1) the astronomical answer: in general it does not really matter if to observe or to compute. But in particular your sky conditions are bad and our algorithms are good. Dr. Sussane suggests to (at least randomly) check with natural experiences
- 2) the religious answer: Susanne M. Hoffmann is not allowed to decide
- 3) the social answer: Let the astronomist's job be transparent for the public

B. Susanne M. Hoffmann Suggestion to Succeed the Moon Observation

The success in seeing the young crescent of the moon does not depend on luck. Observer capabilities are needed absolutely. In addition, adequate equipment is accompanied by careful preparation. Then familiar with the location of the observation is highly recommended. Why? The observer who is accustomed to observing in the same place will know where the young crescent of the moon will appear. By seeing from the position of the last phase.

Climate and weather also need attention. Observations are easier on days without rain. So monitoring the weather forecasts before the observation is also an effective step. This is useful as an overview of the field condition at the same time of observation. It can be prepared the equipment well. Discussing these two things is not separated from the geographical area. Depending on where the observer does the observation.

In the tropics, a low humidity dry season may have a greater chance of success than the rainy season. Unlike the case with subtropical regions, as in the south of Europe for example, there is mild climate, it is not as hot as in summer anymore but it still warm and since it close to the sea temperatures do not really vary a lot. The observer had European conditions of the atmosphere. Obviously, the seeing was very good on this day. This can happen in Europe, especially in September due to the invasion of air layers. Normally it is short before a big change of weather. On those days the air is very calm, very transparent and people can see through it brilliantly.

Pollution of the air is less in Europe than in Indonesia, so the air is generally more transparent. The observer might have been taken photo short after (or during) sunset. The observer probably saw the young crescent with his eyes and then pointed the camera and telephoto lens to the crescent. The reason why it was possible for him to find it, is the clear air which is more transparent than in Indonesia.



Picture 4.5 Transparent sky in Austria, Europe
Credit: Susanne M. Hoffmann

The thick clouds are always there and produced by humans. Clouds are a natural phenomenon. They depend on the local weather which is ruled by the local and global climate. Indonesia has a tropical climate. Daily clouds are normal there and since this is close to the equator. It is always warm there and high temperature means much movement in the air, which means unlucky astronomers.

Europe is in the temperate zone, which means it depends on where people are and on the season. There are no clouds for many weeks in the summer, especially in the south of Europe. The upper north people get the more clouds they will find (roughly). In autumn or winter, there is more

humidity, especially in November European have a lot of fog. November is their "gray month". September is between summer and autumn, so the weather is still warm but starts to change. Sometimes there are clouds, that's also normal.

Clouds and fog are usually natural phenomena, but smog (a word which is an artificial word construction from "fog" and "smoke") is not natural. It is always artificial, human-made. The reason is any sort of fog (our European wet season fog or Indonesian naturally tropical humidity) combined with smoke emission from civilization: i.e. industry, cars, buses, motorbikes. In the streets of Indonesia, there are a lot of vehicles which blow dust into the air. Regarding the black smoke from busses.

In Germany (although not all over the rest of Europe) the busses do not emit such a black smoke. It is light gray normally because European put filters in the exhaust pipe, as well as in the chimneys of an industry. The big dust particles do not reach the air but stay in the filters. So European air is much more clean than Indonesian. Additionally, when Susanne M. Hoffmann came back from Indonesia in August, She realized that her streets are much emptier than in Indonesia.



Picture 4.6 Quite street in Berlin

Credit: Susanne M. Hoffmann

So Susanne M. Hoffmann suggested for us to be wise when using vehicles. It better to take an action, turn off the vehicles five minutes a day.³ Most People are enjoyed to use their own vehicles than use mass transportation. It is because of the complicated mass transportation system. Nowadays online-system transportations (application based) are growing so fast that imply to the development of vehicles.

On August 3rd, 2017 in front of Sharia and Law Faculty office Susanne M. Hoffmann saw a cleaning service sweeping the leaves and burning them. It is very common in Indonesia, to burn the rubbish include leaves, plastic, paper etc. But she suggests not to do that. Leaves are better to create into compost as fertilizer. Burning anything causes smoke and it is not good to keep good sky condition.

³ Interview with Susanne M. Hoffmann in the office July 27th, 2017

Susanne M. Hoffmann gives suggestion by e-mail on December 21th, 2017 to reduce the pollution in Indonesia to bring electro motorbikes, electro-cars, maybe even electro-busses to the country. This advantage is that they do not blow dust and smoke into the air. The disadvantage is that most of them have a smaller range. People cannot go from Semarang to Jakarta without "fueling" i. e. charging. In short, a distance which people normally have to overcome each day, that's very possible with electro-mobility.

E-Mobility at the moment in many cases is very expensive. In Europe, there are big funding programs to support individuals to buy e-cars. That's why European have more of them in the streets and charging stations have a suitable distribution in the meantime. That is the difficulty in Indonesia at the moment. But we can suggest it and if people follow the ideas we will contribute to a positive development for the future. Some decades ago, in Europe in some cities, it was almost as polluted as in Indonesia – but now it became better there. Those processes are slow but need the first step.

Electro-motorbikes: to be honest, Susanne M. Hoffmann does not know anything about development – but she follows the development of bicycles with an electromotor at the back. That is amazing for her. Instead, the price is expensive at the moment because it has the advantages of both: it can be used as a normal bike and also as an electric motorized vehicle.

This is also a contribution and an important development. But Susanne M. Hoffmann thinks there are earlier (and therefore main)

contributions: to put filters in chimneys of houses and of industry which absorb the dust and blow only white smoke in the air (instead of dark). Additionally, there is a much better network of public transport by trains in the big cities. In Berlin, there is buses, tram, underground train and city train. There are different types of trains for bringing students to the university, youngsters to high school and adults to work.

If the air becomes too polluted (maybe in summer, when it is not hot and humid and too many cars) the governments of big cities can forbid to ride cars and motorbikes in the inner cities. She does not remember any case this happened – but it is possible. That is to avoid such a huge amount of smog we photographed at Semarang. E-Mobility is not the only solution – but one of the many contributions and primarily it is a political decision to take this way of development.

CHAPTER V

CLOSING

A. Conclusion

The research Susanne M. Hoffmann discourse on observing the moon has conclusions as below:

1. Regarding the bad sky and air condition in Indonesia, or Semarang in particular, Susanne M. Hoffmann still recommends doing rukyatul hilal (observing young crescent of the moon). Because the observation controls if the computation (hisab) is still right. All shorts of algorithms scientist developed as best as fit to sort some of the data. They observed and fitted an equation still gave good results. The Astronomists developed the first algorithms to compute this (which still work very well) and since those days the algorithms have been developed further. Although the moon computation of the young crescent works very well and astronomically people can rely on computations. Since 1.5 millennia, the Islamic calendar is determined by observation and judges or lawyers control the astronomist's observation of young crescent in the sky. They cannot confirm an observation which did not take place. That is why Susanne M. Hoffmann suggests the best way to do observation as well as computation.
2. Susanne M. Hoffmann is an expert at History of Science. She suggests repeating Al-Biruni observation on measuring the distance between two cities by the lunar eclipse. Because it is a very great activity to do. Back to history, Al-Biruni is the best astronomist that estimates the size of the

Earth precisely, very close to the real size. Based on Susanne M. Hoffmann background in historical astronomy, this activity proves that Al-Biruni and Abu'l Wafa did a great job. Observe the last contact Earth's shadow on the moon surface. Compute deviation observer time to get result difference in time. Then multiply $15/60$ to determine longitude distance in degrees. Even convert in kilometers just multiply with the radius of the Earth. Susanne M. Hoffmann observation has an error bar, that usually happens in a measurement. She needs to take into account the time which she needed to take her eyes off of the moon and look at the smartphone. Beside the error bar, experienced observer also takes effect on the result. A participant from Bavaria that inexperienced in the observation has a deviation result. The time shown by any clock is not the "real" local time at the certain place, but it is the time of the meridian whole zone. So we have a correction to get the local time both of two measured cities. The correction computes a longitude, that is why we need the real-time for each observer. The last little correction being the last step before the computation explained above.

B. Suggestion

1. The vehicles and chimney's factory should provide a filter. Then put filters in chimneys of houses and of industry which absorb the dust and blow only white smoke in the air (instead of dark).

2. If the air becomes too polluted (when it is not humid and too many cars) the government of big cities can forbid to ride cars and motorbikes in the inner cities. That is to avoid such a huge amount of smog we photographed at Semarang. E-Mobility is not the only solution – but one of the many contributions and primarily it is a political decision to take this way of development.
3. Enter study History of Science in Islamic astronomy curricula. I think it is very important. Because we need to know the great history of science, that there are historical finding done by a Moslem scholar.

C. Closing

Thanks to Allah SWT, the One who is guiding me chapter by chapter and knowing my destiny. His sign, the writer finished the last assignment in Bachelor study. This is the best thing that could be given. Meanwhile, the writer realized there are so many mistakes in writing style and providing content. The writer will be delighted to accept critics, suggestions to make this undergraduate thesis be better in any perspective. Finally, the writer hopes this research gives advantages for the future learning, researching, and other purposes.

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