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Development and Transformation of Bektang (Gawang Lokasi) For Astronomy

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ABSTRACT

This article attempts to trace the development and transformation of the Bektang or Gawang lokasi as a phenomenal astronomical tools which is often used by rukyat experts in observing the new moon (hilal). Bektang or Gawang lokasi is a simple tools that is quite accurate in localizing the new moon (hilal). As time has progressed, astronomical tools continue to develop and transform to help make it easier for astronomical experts to carry out calculations and practice in the field, including Bektang tools or Gawang lokasi. This article intended to trace the history related to the transformation and development of bektang or gawang lokasi to determine the beginning of the Qomariyah month so that the transformation of gawang lokasi can continue as technology develops. This article uses a qualitative method with a historical analysis approach obtained from various data collection sources and documents relevant to this research. With the framework of this research, it was discovered that the Bektang has actually been around since the 1900s, this tool was created by two prominent falak figures, namely Djambek and Tangsoban, so it was given the name "BekTang", this tool was then developed to become several tools that are more practical and easy to use, such as tiang koordinat, hilal trackers, and hilal locators.

I. Introduction

The use of auxiliary instruments in the practice of rukyatulhilal is one way that can facilitate the process of observing the hilal. The practice of seeing the hilal has been carried out since the time of the Prophet in a very simple way without the help of astronomical data calculations, namely on the 29th day of the month of Qamariah by waiting for the

sunset time of the sun, if there is a witness who sees the hilal, it will be determined as the beginning of the new moon, but if no one manages to see it, then the month will be completed to 30 days. However, with the development of the times, hilal observation is increasingly difficult to do, this happens because the fraction illumination on the hilal is very small and there are many disturbances such as bad weather, air pollution, and reflected light from the Sun produced by clouds that seem to form like hilal light, these disturbances can lead to errors in indicating the hilal. Therefore, to support the practice of rukyatulhilal with ease, and to minimize the obstacles that exist, astronomy and falak experts try to create tools in hilal observation. One tool that has been used since the 1900s to determine the approximate position of the hilal is the bektang or gawang lokasi. Gawang lokasi is a tool designed to be used in determining the approximate position of the hilal in the implementation of rukyat. According to Thomas Djamaluddin, the use of tools in the rukyat process is highly recommended to increase confidence in the object observed is the true hilal, not just resembling hilal.[2]

Based on the author's research and several existing studies, such as (Study on the Analysis of the Development of Astronomy Instruments in Indonesia by Zyubhi Zaretha et al) it was explained that the beginning of the emergence of the Gawang lokasi was known as "Bektang", Over time, it underwent a transformation into a modern Falak science instrument known as the *Hilal Tracker*.[3] In addition, Nur Qomariyah's research on Handmade Gawang lokasi as an instrument to localize the hilal at the beginning of the Hijri month explains the process of making Gawang lokasi using simple tools that can be found in the surrounding environment. But even though it is made of a simple tool, this tool can help in observing the hilal.[4] Based on several existing researches, the explanation and discussion of the history and transformation of this bektang tools has not been found structurally, therefore the author is interested in exploring the history of the journey from the emergence of the Gawang lokasi and its transformation from time to time until it develops into a very diverse modern tools.

The purpose of this article is to explore the history of the transformation and development of one of the most significant tools in determining the beginning of the Qamariah month. So that the transformation of this gawang lokasi also continues to grow along with the development of increasingly sophisticated technology.

II. Method

This study uses a qualitative method of literature or library research with a historical analysis approach to the development of astronomical tools, especially the Gawang lokasi, which is the subject of discussion in this study. In collecting data sources, this study uses primary and secondary sources. The primary source of this study is the book Almanac Hisab Rukyat by the Ministry of Religion of the Republic of Indonesia and secondary sources obtained from relevant documents such as books, theses, journal articles, papers, and several printed and non-printed documents that are in accordance with the discussion

of the Gawang lokasi to then be analyzed historically to understand how the development and transformation of the Bektang or Gawang lokasi tools in Astronomy.

III. Results and Discussion

A. History of Bektang/Gawang Lokasi

Along with times, Bektang underwent modifications and transformations, eventually evolving into various tools with different names, such as Gawang Lokasi, Tiang Koordinat, Hilal Tracker (hilal path tracker), and Hilal Locator (hilal position marker). Initially, Bektang developed, became widely recognized, and was commonly known as Gawang Lokasi, which was designed to estimate the position of the hilal during rukyat observations. Seperti theodolite, teleskop, patok rukyat, stick rukyat, gawang lokasi dan alat lainnya.

This tools consists of very simple components, is easy to operate, and is relatively inexpensive, making it a preferred choice for some scholars and rukyatulhilal practitioners. The tools was first introduced by two prominent Nusantara falak scholars: K.H. Sa'doedin Djambek from West Sumatra and K.H.T. Tangsoban from Sukabumi. However, when it was first introduced, it was not named as Gawang Lokasi. Instead, its name was derived from the combination of the founders' names, forming "BEKTANG" (*Djambek-Tangsoban*)[4]. This tool is estimated to have emerged around the 1900s.

K.H Saadoeddin Djambek or Datuk Sampono Radjo was an expert in Islamic astronomy (*Ilmu Falak*), born in Bukit Tinggi on March 24, 1911 AD (29 Rabiul Awwal 1329 H) and then died in Jakarta on Tuesday, November 22, 1977 AD (11 Dzulhijjah 1397 H).[5] He was the son of a great scholar, Sheikh Muhammad Djamil Djambek who came from Minangkabau. Since 1941 he has pursued Islamic astronomy by studying with Sheikh Taher Jalaluddin and continued his studies at FIPIA (Faculty of Exact Sciences and Natural Sciences) in Bandung. In addition to the Gawang lokasi or Bektang, Saadoeddin Djambek also made significant contributions to *Ilmu Falak* through his works, including '*Time and Schedule*' (published by Tintamas, 1957), *Al-Manak Jamiliyah* (published by Tintamas, 1953.) *The Qibla Direction* (published by Tintamas, 1956.) *Comparison of dates* (published by Tintamas, 1968) *Guidelines for prayer times all the time* (published by Bulan Bintang, 1974), *Prayer and fasting in the polar regions* (published by Bulan Bintang, 1974 7) *Hisab Early Qamariah* (published by Tintamas, 1976) [6].

Meanwhile, K.H.T. Tangsoban with the full name K.H.T. Tangsoban Marfu' is a great scholar and is known as the first rukyat practitioner from Sukabumi. He is also known for his nobility, charismatic and his knowledge in the field of Astronomy. This is reflected in one of his most enduring contributions tools designed to localize the hilal. This tool was developed based on the application of theories and formulas from K.H. Saadoeddin Djambek, eventually becoming a widely recognized tools among *hisab rukyat* experts, the tools was named "Bektang", this name was taken from the end of the name K.H.Saadoe'ddin Djambek and the beginning of the name K.H.T Tangsoban Marfu's name, to became *Djam-BekTang-soban*.[7]

After the Bektang or Gawang Lokasi was used multiple times for *rukyat* (hilal observation), the tools was further refined by Drs. H. Wahyu Widiana, MA, one of Indonesia's leading *Hisab* and *Rukyat* experts. The refinement of Bektang into Gawang Lokasi was based on the inclination of the hilal, which is approximately 15 degrees,

making the tools more precise and widely recognized as Gawang Lokasi [8]. Wahyu Widiana was a prominent *Ilmu Falak* scholar and a direct student of K.H. Saadoeddin Djambek. He was born in Ciawi, Tasikmalaya, on September 18, 1952. During his university years, he was entrusted with the role of Assistant Lecturer in Ilmu Falak in 1980 and later became a member of the Hisab and Rukyat Committee at the Indonesian Ministry of Religious Affairs. He also contributed significantly to the field of *Ilmu Falak*, including being part of the team that compiled the Kamus Istilah Falak (Dictionary of Falak Terminology), published by the Directorate of Islamic Religious Courts.[1] Wahyu Widiana has also been active in various institutions related to Hisab Rukyat and occupies an important role in the institution, one of which is as the Chairman of the National Team for the Alignment of Rukyat and Islamic Taqwim at the Southeast Asian Level (MABIMS) from 2001-2004.[8]

Furthermore, in 1997, Gawang lokasi was also developed by Mahfued Rifai who is a falak expert from East Java into a Tiang koordinat. The working concept of the tools is generally similar to the Gawang lokasi, only it has a different design. Tiang Koordinat has 2 poles placed parallel with a distance difference of 5 meters during the implementation of Rukyatulhilal. The height of this coordinate pole is 246 cm while the observation pole is 140 cm high and vertical and has 12 stairs with each distance between the stairs is 1°, so this tool is able to measure *altitude* from 0°-12°.[9]

And then, in 2006 the gawang lokasi was transformed into the Hilal Locator, this tools was developed by Mutoha Arkanuddin, an astronomy expert who was born in Kebumen on November 9, 1966. Gawang Lokasi was simply a rectangular frame that had to be held by hand during operation. However, it was later modified by adding a network of nylon threads arranged both vertically and horizontally. These threads functioned as a degree scale to measure the altitude and azimuth of the hilal. The Hilal Locator is a modernized version of the traditional Gawang Lokasi, designed as an auxiliary tools for *rukyat*. It consists of a large tripod-mounted frame and an optional sighting device such as binoculars or monoculars, also equipped with a supporting tripod. Made from non-metallic materials, this tools is lightweight, portable, and rust-resistant.[10]

The Hilal Locator was modified by Mutoha Arkanuddin into a *Hilal Tracker* by replacing the existing nylon threads with acrylic glass which is useful to help observers draw trajectory lines on the Hilal. *The Hilal Tracker Locator* consists of 3 important parts including: *First, Hilal Locator* (in the drawing plane there is a vertical line with a scale of 0°-15° to measure the altitude of the hilal when the sun sets and a horizontal line with a scale of 0°-10° to measure the azimuth difference between the hilal and the Sun), *Second,* the *field of the Hilal Locator* (there is a compass, and a waterpass). *Third*, *a tripod*.[11] Although modified from simple tools, these instruments are precise enough to assist in localizing the position of the hilal.[12] The thing that distinguishes *the Hilal Tracker Locator* from the Gawang lokasi is its smaller size (18 x 24 cm) and the distance between the aiming hole and the Gawang lokasi is only approximately one meter, while the Gawang lokasi is sized (20 x 50 cm) and the distance between the aiming hole and the Gawang lokasi is as far as 5 meters. This transformation has made *rukyat* tools more compact,

efficient, and accessible, significantly improving the accuracy and convenience of hilal observation.

B. Component of the Gawang lokasi

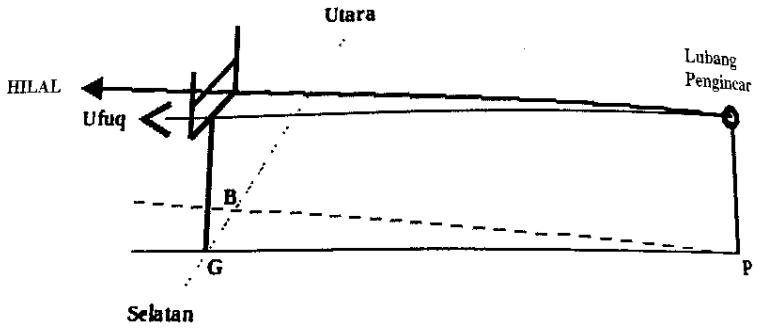
One of the advantages that this Gawang lokasi is that it consists of simple components and affordable price, but the principle is the same as theodolite by using two axes, namely *Horizontal Angle* and also VA *Vertical Angle* which represents the altitude or azimuth of a celestial object. Similarly, Gawang Lokasi relies on azimuth and altitude in the process of rukyatulhilal. The components of Gawang Lokasi include, first, the Targeting Pole/Viewing Pole, which is approximately 1-1.5 meters high, made of metal, and has a small hole at the top used for sighting the hilal. Second, the Gawang Lokasi itself, which consists of two upright pipe-like structures made of hollow metal. At the same height as the telescope pole, these two poles are connected by a flat ruler about 15-20 cm long. This design allows an observer to look through the small holes at both ends of the viewing device and align their sight with the top edge of the ruler, ensuring that their line of sight extends to the surface of the sea, which serves as the visible horizon (ufuk ma'rī).

On top of the two poles, there are two iron poles that have been connected by flat ruler. These two poles are then inserted into the cavity of the first two poles, so that the height or low size can be adjusted according to the position of the hilal during the practice of Rukyatulhilal. The ideal distance between the aiming post and the Gawang lokasi is about 5 meters or more. And to be able to operate this tool, we must have the results of calculating the height of the hilal and azimuth, and the place is equipped with the appropriate cardinal directions.[13]

C. Technique of Using Gawang Lokasi in Rukyatul Hilal

Rukyat is a practice or activity carried out as an effort to observe the hilal or crescent moon on the western horizon shortly after sunset. The hilal can be observed during the Rukyatulhilal process either with the naked eye or with the assistance of tools, while also considering the weather conditions at the time of observation.To help the process of practicing Rukyat, various tools can be used, ranging from traditional to modern tools for example, tools such as the theodolite, telescope, patok rukyat, stick rukyat, gawang lokasi, and others. On the other hand, a rukyat observer (perukyat) must have insight and experience in carrying out Rukyatulhilal, because even if he uses very modern tools, the limitations of experience can make Rukyatulhilal ineffective and not optimal in practice.

Gawang lokasi can be one of the preferred tools for conducting Rukyatulhilal because it offers good accuracy, even though it is a relatively simple tools. When carrying out the Rukyat practice using the Gawang lokasi, the tools must be placed on a completely flat surface, and its position must not be tilted, as this could affect the observer's field of view. Once the Gawang lokasi is positioned upright on a flat surface, a compass is needed to determine the cardinal directions, thereby facilitating the Rukyatulhilal process. Below is an illustration depicting the concept of the Gawang lokasi.[14]



Concept Picture of the Gawang Lokasi[14]

Information:

- P = Fixed upright pole (Sight hole)
- U = Upright pole that can go up and down (ufuq)
- H = The estimated position of the hilal (hilal)
- PB = East and west pointers
- B = West direction
- BG = North-south indicator
- G = A movable pole support.

The steps that can be taken in the process of Rukyatulhilal using the gawang lokasi are required careful planning preparation related to team formation, determination of rukyat places, transportation, rukyat equipment (such as gawang lokasi, compasses, as well as hilal azimuth and altitude data, etc) It is advisable to arrive at the observation location one or two hours before sunset. Upon arrival, the following procedures should be carried out: synchronize the timepiece, set up the tools, determine the cardinal directions using the UTSB, and record the current weather conditions.[11]

Next, determine the west and east directions using a compass for guidance or observing the east and west sun positions for careful calculation. Specify a point in the eastern part for the installation of the transmitter pole, for example point P. (see image above). From point P it is measured westward along the calculated size (e.g. 3 meters). Then it is given point B, so it becomes point PB. It should be noted that the Azimuth to the west is exactly 270°, if the hilal data is worth (-) 270° then the goal is placed on the left (south), but if it is worth (+) 270° then it is on the right (north).

Next, at point B, draw a line northward and/or southward perpendicular to line PB. According to the direction of the hilal (positive from point B to the north, and negative from point B to the south), mark this point as G, so it becomes BG. On this line, measure the distance from point B along the direction of the hilal (BG). The formula for determining the hilal's direction is Arah hilal = tan (difference in angle (270° - azimuth hilal)) × length of the side (corresponding to the distance between the sighting pole and the gawang) . Furthermore, at point G the location goal was placed, while the aiming hole post was placed at point P.

Try to keep both the location goal and the aiming hole post upright. Use a lot / pendulum to measure it At point G, the Gawang lokasi is placed, while the aiming hole post is placed at point P.[14] The gawang lokasi must be installed in the correct position; ensure that the left side is positioned above the moon's azimuth line and the right side above the sun's azimuth line (depending on the positions of the sun and the moon at specific times). To determine the string's height limit, you can use the following formula, String Height = (side length / cos(angle difference)) x tan(hilal altitude).

The gawang lokasi and the aiming hole are then adjusted (up or down) according to the eye level of the observer. Thus, the position of the hilal immediately after sunset becomes localized—meaning that when viewed through the aiming hole, the hilal will appear within the gawang lokasi. After sunset, all attention is directed toward the localized position of the hilal. Based on these hisab results, a rukyat map is then created to illustrate the potential emergence of the hilal. The final step after the observation is to report whether the hilal was successfully seen during the Rukyatulhilal process.

We can understand the findings in *the results* that bektang or now better known as the Gawang lokasi is still being developed by astronomy scientists, especially figures in the field of rukyat hisab to facilitate the process of implementing rukyatul hilal and maximize the accuracy of the hilal that will be observed. This can be seen in the development of bektang which is increasingly practical to use, starting from the Gawang lokasi that uses the aiming post and the goal, then developing into a Tiang koordinat that has a cooperative way of working but the shape is quite different from the Gawang lokasi, namely the addition of 12 stairs to measure *altitude*, then the Gawang lokasi is also modified into *a hilal locator* By using nylon thread on the goal to make the hilal more precise, then the previous nylon thread was replaced with acrylic glass to help the observer describe the position of the hilal with more precision known as *the hilal tracker.*

This article seeks to explain in detail how the development of Bektang or the Gawang Lokasi continues to be modified to describe the position of the hilal more accurately. Based on the discussion that has been written in the *result* section, this article can add a reference for the historical treasures of astronomy tools that have developed in Indonesia, the components contained in the Gawang lokasi, describe how to use the Gawang lokasi properly and correctly and as a reference material to continue to develop the goal into more modern tools to help the rukyatul hilal process.

IV. Conclusion

The development of the times certainly makes many new breakthroughs, including in the world of Astronomy, especially the tools used are also increasingly sophisticated, many traditional tools that are then transformed into modern tools that are more practical and more accurate, one of which is Bektang or what is more popular among the people is the Gawang lokasi. The Gawang lokasi has been developed and transformed into several tools such as the hilal locator, the hilal tracker locator and several other tools. The Gawang lokasi is a traditional tools that is still used today to help the perukyat in localizing the rukyat, although it is classified as a very simple tool, but this tool has good accuracy, besides that

the price is still affordable, so this tool is one of the choices of the perukyat to observe the hilal.

The Gawang lokasi is estimated to have appeared in the 1900s but is known as "BEKTANG" (Djambek-Tangsoban), the name of this tool is inspired by the inventor and initiator of Bektang itself, namely two prominent astronomy scholars, K.H. Sa'doedin Djambek from West Sumatra as the inventor of the concept (both theory and formula) and also K.H.T. Tangsoban from Sukabumi who realized and developed the concept to create Bektang or Gawang lokasi. Gawang lokasi has been developed and transformed into several tools to be able to localize rukyat such as tiang koordinat, hilal locator, hilal tracker and several other tools, this is done to increase accuracy and make it easier for observers to localize the hilal.

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