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RESEARCH ARTICLE

AL-KHAWARIZMI ASTRONOMY COMPLEX AS AN ASTROTOURISM DESTINATION AND ITS CONTRIBUTION TO ENHANCING LOCAL ECONOMIC ACTIVITIES

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Abstract

The Al-Khawarizmi Astronomy Complex is one of the observatories located in Malaysia. The complex was constructed by the Malacca State Government, starting in 2002 in phases, and was fully completed in 2008. The primary goal of establishing the Al-Khawarizmi Astronomy Complex is based on three aspects which are research, education, and tourism. Therefore, this study is conducted with the aim of discussing the astrotourism aspects that contribute to the potential of making the complex a new tourist attraction in Malacca. This study is qualitative research that utilizes document analysis, interviews, and observation as research methods. The findings indicate that Al-Khawarizmi Astronomy Complex has become a significant element contributing to the economic growth of the local population. Additionally, the complex is also seen as an internationally recognized astrotourism destination through the participation of many foreign visitors in the organized astronomical activities. Currently, the Malacca State Government recognizes Al-Khawarizmi Astronomy Complex as one of the Islamic tourism products in Malacca.

Introduction:-

Al-Khawarizmi Astronomy Complex is a prominent Islamic tourism landmark in Malacca, Malaysia. It symbolizes the image and identity of the Malacca State Mufti Department as a reference center for Islamic knowledge in astronomy and astrophysics in Malacca. Located approximately 25 km from the historic city center of Malacca, the complex is situated in Kampung Balik Batu, Tanjung Bidara, in the Alor Gajah District, at a latitude of 2°17’36” N and a longitude of 102°05’06” E. The Malacca State Government has officially designated the complex as a domestic tourism destination within the state. Positioned by Tanjung Bidara Beach at an elevation of 38 meters above sea level and facing the Strait of Malacca-the longest strait in the world and a major global maritime trade route, the complex’s orientation is strategically significant. The building is constructed facing west, aligned with the qibla at an azimuth of 292°52’22”. The establishment of this complex is a noble initiative by the Malacca State Government to ensure the continued development of astronomy in Malaysia, with government support and encouragement making the dissemination of astronomical knowledge more effective.

According to Ahmad (2003), the development of astronomy in West Asia flourished due to substantial support from Islamic rulers of the time. Historical accounts indicate that observatories received special attention from rulers such

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as Caliph al-Ma'mun (786-833 AD) in Baghdad, where the Shammasiyah Observatory was established. This initiative, conceived by Islamic scientists, aimed to facilitate research, education, and religious determinations related to astronomy. Ibrahim, Ahmad & Safiai (2013) note that the distinct role of observatories in West Asia, compared to those in Western countries, lies in their focus on religious determinations, particularly for prayer times, fasting, *zakat*, calendar formation, and the two Eids. Mujani, Ibrahim & Safiai (2012) records numerous other observatories across West Asia, including the Sharaf Al-Daula Observatory, Bab al-Taq Observatory, and Banu Musa Observatory in Baghdad, as well as the Mount Qasiyun Observatory, Al-Batani Observatory, and Ibn Shatir Observatory in Syria. Furthermore, the observatory built by Nasr al-Tusi (1201-1274 AD) in Maragheh, south of Tabriz, Iran, which garnered significant attention and encouragement from Hulagu Khan. During the reign of Sultan Ulugh Beg, a modern observatory was established in Samarkand in the 15th century, stemming from serious astronomical studies conducted in the early 14th century and following the fall of the Maragheh Observatory. The presence of these observatories highlights the extensive development of Islamic astronomy and its continuity in Southeast Asia, as evidenced by the establishment of observatories across Malaysia modeled after those in West Asia, with governmental support in financial and administrative aspects (Khadijah 2015).

The Al-Khawarizmi Astronomy Complex as an Islamic Tourism Destination in Malacca

The Al-Khawarizmi Astronomy Complex is an institution managed under the jurisdiction of the Malacca State Mufti Department. According to Ibrahim, Ahmad & Safiai (2013), the construction of observatories in Malaysia is influenced by features from West Asian countries, such as the use of names of prominent Islamic astronomers like Al-Khawarizmi and Al-Biruni. To honor these distinguished Islamic astronomers, the Malacca State Government named the complex after Al-Khawarizmi (780-850 AD), with construction spanning from 2002 to 2008. The complex comprises three main blocks which are the observatory, the planetarium building, and the training and accommodation center. The construction of the Al-Khawarizmi Astronomy Complex was executed in three main phases. The first phase included the establishment of the observatory and exhibition gallery, the second phase involved the construction of the planetarium and interactive gallery, and the final phase encompassed the training center and dormitory accommodations. The first phase commenced in 2002 on a plot of endowment land in Kampung Balik Batu, with a budget of RM2.5 million under the administration of the Malacca State Mufti Department. The need for an observatory arose due to the unsuitability of the previous moon sighting location at Pantai Rombang, Malacca, which was obstructed by the Petronas refinery in Sungai Udang, Malacca (Ibrahim et al. 2012).

Upon completion of the first phase, the Malacca State Mufti Department proceeded with the construction of the Al-Khawarizmi Planetarium in the second phase, which began in 2005 and became operational in March 2006. This block includes facilities such as a 3D and dome planetarium theater, interactive exhibition spaces, a control room, and restrooms. To complete the proposal for a modern and advanced astronomy complex in Malaysia at the time, the Malacca State Government included the construction of a robotic observatory, training center, and dormitory in the Ninth Malaysia Plan (RMK-9) budget, with construction starting in November 2006. By 2008, the third phase was fully completed, resulting in the construction of the Islamic Astronomy Training Center, which consists of several blocks, including dormitories, lecture halls, an auditorium, a computer lab, a multipurpose hall, an open dining area, a surau, and a robotic dome.The advanced technology and comprehensive facilities make the complex a progressive observatory that meets the needs of the community in exploring astronomy. The facilities developed by the state government are timely efforts to revive ancient astronomical knowledge, reminiscent of the advancements once made in West Asia. Its strategic location and logistical amenities position the complex as a potential site for astronomical tourism within Malaysia. The construction of the complex is anticipated to yield economic returns similar to those achieved in Japan, the United States, and other European countries (Mohamed et al. 2016).

According to Safiai et al. (2020), besides observatories, various other astronomy-based elements can be developed as tourist attractions, such as hilal observation stations, archaeoastronomy sites, mosques, and dark sky areas. Enhancing the development and functionality of these sites can significantly boost demand for astronomical tourism products. Consequently, it is unsurprising that the complex was recognized by the Malacca State Government as an Islamic tourism product in Malacca in 2020, as announced by the Chief Minister of Malacca at that time, YAB Datuk Seri Utama Haji Sulaiman bin Md Ali.

Figure 1:- Al-Khawarizmi Astronomy Complex.

Figure 2:- Al-Khawarizmi Observatory.

Instruments and Facilities of the Al-Khawarizmi Astronomy Complex

A modern and advanced astronomy complex is equipped with a variety of instruments, hardware, and comfortable facilities for visitors. The Al-Khawarizmi Observatory features a five-meter diameter dome, motor-controlled and capable of rotating both clockwise and counterclockwise. This dome stands as a landmark and an identifier of the observatory, matching the modern standards of observatories in West Asia. Inside this dome, the main telescope is a 16-inch Ritchey-Chretien Cassegrain reflector (f/9), equipped with an SBIG 10XME CCD camera and a Paramount ME robotic mount. To ensure the seamless operation of the telescope, the observatory is equipped with advanced information technology infrastructure, including a high-speed Local Area Network (LAN) upgraded by Telekom Malaysia (TM). The interior of the dome is also fitted with an automatic air conditioning system and a humidity control device to prevent the formation of spores or fungus on the telescope lens. In addition to the main 16-inch RCOS telescope, a 5-inch Takahashi FS128 refractor telescope is also installed to facilitate the observation of celestial objects through the telescope's focus lens. The observatory dome can accommodate only eight people at a time due to its limited space (Bahali 2006).

However, the observatory also includes portable telescopes, such as the 11-inch GPS Celestron telescope and the 8-inch GPS Sky-Watcher telescope. These portable telescopes are used on the main observation platform and the observatory square during nighttime sky observations and monthly moon sighting events. This enhances the excitement and engagement of nighttime sky observation activities for visitors. Additionally, the observatory is equipped with two spotting scope binoculars on the viewing deck, providing panoramic views of Kampung Balik Batu and the busy international shipping lanes of the Strait of Malacca. There is also an open observation platform on the first floor of the observatory, equipped with six observation pillars for placing Total Station measuring

instruments during moon sighting activities. These facilities add value for visitors to the observatory, allowing them to capture beautiful images and memorable moments against the backdrop of the Strait of Malacca (Ibrahim & Nordin 2005).

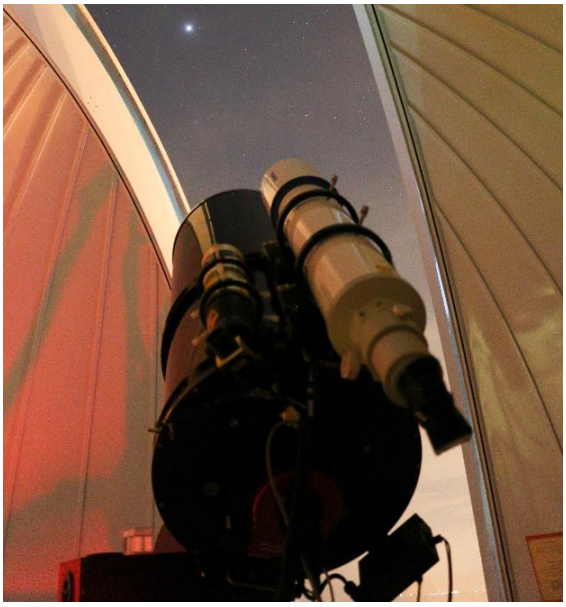

Figure 3:- Main Telescope at Al-Khawarizmi Observatory.

Enhancing Tourist Attraction at the Al-Khawarizmi Astronomy Complex

To further enhance the attraction for both domestic and international tourists, a planetarium block has been constructed adjacent to the observatory. This block features an interactive gallery themed around astronomical games. The gallery is equipped with Virtual Reality (VR) video games and holographic displays. Additionally, there is an Islamic astronomy section within the gallery showcasing traditional astronomical instruments such as the *rubu' mujayyab*, astrolabe, sundial, compass, sextant, solar system model, and antique telescopes. A particularly intriguing exhibit is an authentic meteorite believed to have fallen from space in Arizona, South America. The planetarium block also houses a theater that can accommodate up to 90 people. This planetarium simulates nighttime sky phenomena, including the movements of stars, the moon, and planets. It also provides simulations of solar and lunar eclipses, Venus transits, comets, and human space exploration missions through its digital planetarium projector. The system includes a fisheye projector with Starynight dome software and ATM4, supported by Renderbox and Preflight hardware, capable of receiving inputs from various sources such as CDs, DVDs, VHS, and digital cameras.

The planetarium is also equipped with a projector system and a silver screen for 3D effects during video presentations, complemented by a high-quality surround sound system. This advanced setup makes the Al-Khawarizmi Planetarium's shows more sophisticated and engaging. To ensure the content is accessible to local visitors, the Malacca State Mufti Department has established a strategic collaboration with Universiti Teknikal Malaysia Malacca (UTeM) to provide voiceover translations from English to Malay. This partnership helps visitors understand and appreciate the content and storyline of the videos. Furthermore, UTeM offers technical consultancy to the Malacca State Mufti Department in planning and developing the concept and design according to astronomical themes, aligning with advancements in IR 7.0 technology. The training and accommodation block was constructed in 2004 and began operations in 2006 to cater to visitors attending courses while touring the Al-Khawarizmi Astronomy Complex. This block features an array of facilities, including a 350-seat auditorium, a multi-purpose lecture hall, both indoor and outdoor dining halls, and a *surau* capable of accommodating up to 400 congregants. Additionally, it has a spacious paved observation square, a robotic observatory, and the complex administrative offices (Ahmad et al. 2022).

The training center also includes two accommodation blocks of various types, with a total capacity of 200 guests at any one time. The accommodation options comprise two dormitories on the third floor, semi-executive rooms on the first and second floors, and executive apartment-style rooms on the ground floor. These comprehensive facilities

ensure that visitors have a comfortable and convenient stay, whether they are participating in training programs or simply exploring the astronomical offerings of the complex.

Figure 4:- Virtual Reality Video in Planetarium Gallery.

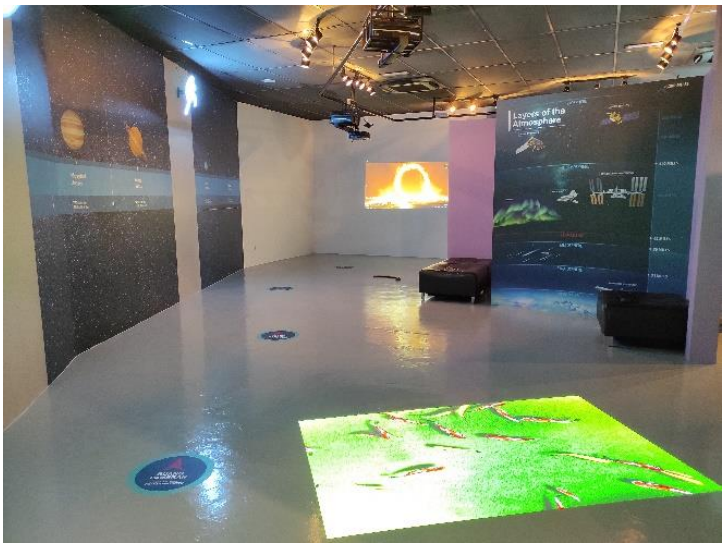

Figure 5:- Interactive Games in Planetarium Gallery.

Prospects of Astronomical Tourism at the Al-Khawarizmi Astronomy Complex

The establishment of the Al-Khawarizmi Astronomy Complex aims not only to support education and research in astronomy but also to promote astronomical tourism, an initiative supported by the Malacca State Government to enhance economic revenue. With modern and comprehensive facilities in place, the Malacca State Government has decided to charge an entrance fee for visitors to the Al-Khawarizmi Observatory and Planetarium. According to Mohamed et al. (2016), tourism activities centered around astronomical observations, utilizing observatory facilities, are referred to as astrotourism. Astrotourism is a popular activity in developed countries such as Japan, the United States of America, and various European nations. These programs contribute significantly to national income and create job opportunities for local residents while also upgrading the local area. Astrotourism gains particular interest during rare astronomical events, such as solar and lunar eclipses, comet appearances, and meteor showers, providing unique experiences for the public to enjoy and share (Zainuddin 2002). The detailed activities available at the complex are as follows:

1) Astrotourism Activities

Visitors have the opportunity to explore the Main Gallery of the Al-Khawarizmi Astronomy Complex located at the main entrance. This gallery features three themes: the solar system and planets, Islamic astronomy, and outer space. Additionally, visitors can explore the interactive planetarium gallery, which focuses on the science and physics of astronomy and offers engaging interactive games alongside exhibits of traditional astronomical instruments from historical periods. To enhance the visitor experience, the planetarium also screens astronomy-related videos and space exploration documentaries in its theater. Two types of screenings are available: planetarium shows or 3D screenings, each lasting 30 minutes. Research indicates that visitors are charged a fee based on the type of activity they choose, as outlined in Table 1. This approach not only enhances the educational and research value of the complex but also capitalizes on the economic potential of astrotourism, aligning with global trends and contributing to local development.

Table 1:- Admission Fees for Visitors to Facilities in Al-Khawarizmi Astronomy Complex.

Item	**Adult (13 Years Old and Above)**	**Children (12 Years Old and Below)**
Entry / Gallery & Exhibition, Planetariumor 3D	RM7.00	RM5.00
Night Sky Observation	RM3.00	RM3.00

Source: Author (2024); Al-Khawarizmi Observatory (2024)

The result indicates that the revenue collected from visitor admission fees at the Al-Khawarizmi Astronomy Complex is directly channeled to the Financial Unit of the Malacca Mufti Department and recorded as state income for the Malacca government. Table 2 illustrates the ticket revenue recorded as state income, while Table 3 shows the number of visitors to the observatory, which also contributes to the local economy. This includes income generated for local accommodations such as homestays, guesthouses, and food stalls around Kampung Balik Batu, Tanjung Bidara (Ariffin 2023).

Table 2:- Visitor Ticket Revenue Records for Al-Khawarizmi Observatory (2015-2023).

Year	**Revenue Collection**
2015	RM8,326
2016	RM7,672
2017	RM6,184
2018	RM12,021
2019	RM9,369
2020	RM1,326
2021	RM1,202
2022	RM20,907
2023	RM17,994

Source: Author (2024); Al-Khawarizmi Observatory (2024)

Table 3:- Numbers of Visitor toAl-Khawarizmi Observatory for the Years 2015-2023.

Year	**Total Visitors**
2015	6,195
2016	5,257
2017	4,675
2018	5,546
2019	6,129
2020	1058
2021	537
2022	3,744
2023	2,780

Source: Author (2024); Al-Khawarizmi Observatory (2024)

Based on Table 3, the number of registered visitors might be higher than indicated, as the figures only account for visitors to the Al-Khawarizmi Observatory itself, excluding those visiting the entire complex. In addition to ticket revenue, the Malacca Mufti Department also generates monthly rental income of RM6000.00 from Al-Khawarizmi Astronomy Complex Sdn. Bhd. (KFASB). This company, a wholly owned subsidiary of the Malacca Islamic Religious Council, was established on June 16, 2008, and tasked with managing the complex from December 1, 2008. KFASB engages in business activities by offering the facilities and activities available at the complex to visitors from various demographics. The company also plays a significant role in promoting the science of astronomy through educational activities supported by the Malacca Mufti Department. This initiative aims to disseminate astronomical knowledge to all segments of society via astrotourism. Additionally, KFASB provides recreational activities such as archery, cycling, camping, treasure hunts, and water activities for visitors staying at the complex. Local communities can also use the auditorium and multipurpose hall for social events like weddings, dinners, or high tea, thus enhancing astrotourism in Tanjung Bidara. These activities are seen as a means to boost the local economy by supporting homestays, hotels, and local stalls, especially in rural areas (Nizam 2023). As we can see, Table 4 presents the rental revenue collected by KFASB for the Malacca Mufti Department, while Table 5 shows the number of visitors who have visited and utilized the services at the complex.

Table 4:- Rental Revenue from KFASB to Malacca Mufti Department for the Years 2015-2023.

Year	Revenue Collection
2015	RM72,000
2016	RM72,000
2017	RM72,000
2018	RM72,000
2019	RM72,000
2020	RM72,000
2021	RM72,000
2022	RM72,000
2023	RM72,000

Source: Author (2024); Management Services Division, Malacca Mufti Department (2024)

Table 5:- Numbers of Visitor toAl-Khawarizmi Astronomy Complexfor the Years 2015-2023.

Year	Total Visitors
2015	27,255
2016	25,658
2017	25,070
2018	30,988
2019	29,273
2020	6,869
2021	2,628
2022	13,155
2023	14,686

Source: Author (2024); Al-Khawarizmi Observatory (2024)

2) Education and Research

Since the completion of the Al-Khawarizmi Astronomy Complex in 2006, the Malacca Mufti Department has strategically planned to establish the complex as a training center to advance astronomical knowledge in the state of Malacca. To broaden the dissemination of astronomical knowledge both within Malacca and across Malaysia, educational and research activities related to astronomy have been significantly enhanced. This is achieved by organizing activities at the district, state, national, and international levels. Among the educational activities, periodic workshops and courses are organized, tailored to different levels and target groups, ranging from kindergarten to primary, secondary, higher education institutions, and adult learners. The appeal of this astronomical education lies in its accessibility to all societal layers and educational stages. The Astronomical Community Gathering Program, held in conjunction with astronomical phenomena such as solar and lunar eclipses, crescent moon sighting, and meteor showers, is one of the educational activities contributing to astronomical tourism. The organization of such educational activities inevitably attracts students, university scholars, and civil servants. To enhance the vibrancy of these educational events at the complex, the Malacca Mufti Department collaborates with

strategic government partner agencies, local assembly members, and even the Chief Minister of Malacca, thereby elevating the profile of astronomical activities at both state and national levels. This engagement naturally stimulates spending at every level of these activities, encompassing catering services (food and beverages), rental of tents and tables, transportation via buses or vans, and prizes for competition winners. Furthermore, the organization of short-term courses related to astronomical education and the provision of facilities to visitors from various public and private sectors, schools, colleges, and universities (both public and private), also contributes to KFASB's revenue.

Figure 5:- Astronomical Community Gathering During the Crescent Moon Observation for Muharam1444H.

In terms of research, the complex consistently welcomes benchmarking visits from local and international higher education institutions (HEIs) focused on astronomical research, such as studies on crescent moon visibility, weather and rainfall patterns, and stellar observations. Such activities are key contributors to the growth of the astrotourism sector. For instance, the Malacca Mufti Department was invited by Kindai University, Japan, and Universiti Teknikal Malaysia Malacca to collaborate on a high-impact study on lightning voltage levels around the Strait of Malacca.

3) Small and Medium Enterprises Sector around Al-Khawarizmi Astronomy Complex

The establishment of the complex in Kampung Balik Batu, Tanjung Bidara, has significantly influenced the development and economic progress of the local community. This progress is evidenced by the construction of paved main roads by the government, the development of new housing estates by real estate developers, and the emergence of retail storesand food stalls around Kampung Balik Batu. Additionally, homestays and resorts are available for tourists visiting the area. Besides the complex, the clean and beautiful Tanjung Bidara Beach also attracts both local and foreign tourists. The beach is located approximately 500 meters from the complex's accommodation block, allowing visitors to easily walk there for restaurants, water activities and family recreation.

Figure 6:- Tanjung Bidara Beach.

Figure 7:- Restaurants Along Tanjung Bidara Beach.

Moreover, one of the tourist attractions around the complex is the highly popular local food industry product, Tapai Pulut Sarimah. Tapai Pulut Sarimah is a renowned local delicacy originating from Tanjung Bidara, Malacca. This traditional fermented glutinous rice dessert is crafted with meticulous care by the local residents, who have preserved the recipe and technique across generations. The process begins with selecting the finest quality glutinous rice, which is then steamed to perfection. Once cooled, the rice is mixed with a natural starter culture, usually consisting of yeast and some local herbs, and left to ferment for several days. This fermentation process imparts a unique sweet and tangy flavor to the rice, resulting in a soft, sticky texture that is highly cherished by both locals and tourists.

The popularity of Tapai Pulut Sarimah extends beyond Tanjung Bidara, as it is distributed to various supermarkets, retail shops, and food stalls across the region. It has also gained a reputation as a must-have dessert at celebratory events and gatherings, often featured prominently on dessert menus. Furthermore, the delicacy is supplied to KFASB, ensuring its presence at numerous festivities and activities hosted by the organization. Tapai Pulut Sarimah not only represents a culinary delight but also symbolizes the cultural heritage and community spirit of Tanjung Bidara, contributing to the local economy and fostering a sense of pride among its residents.

Figure 8:- Tapai Pulut Sarimah.

In addition, The Turtle Conservation and Information Center, located near the beaches of Tanjung Bidara and Pengkalan Balak in Malacca, plays a pivotal role in both wildlife conservation and tourism. This center is dedicated to the protection and propagation of endangered turtle species, particularly by providing a safe haven for turtle eggs laid on these beaches. It oversees the delicate process of incubating these eggs and ensuring the successful hatching and release of baby turtles back into the ocean, thereby bolstering the turtle population and aiding in species preservation (Streeting 2022).

Beyond its conservation efforts, the center serves as an educational resource, offering visitors insights into the life cycle of turtles, the threats they face, and the importance of conservation efforts. Interactive exhibits, guided tours, and informational sessions help raise awareness about marine ecology and inspire visitors to participate in conservation initiatives. The center attracts a significant number of tourists, which in turn stimulates the local economy by increasing revenue for nearby businesses, such as hotels, restaurants, and shops. Moreover, the Turtle Conservation and Information Center collaborates with local communities, researchers, and environmental organizations to enhance its conservation strategies and broaden its impact. This collaboration fosters community involvement, provides employment opportunities, and underscores the center's role as a critical player in the sustainable development of the region.

Figure 9:- Turtle Conservation and Information Center.

Conclusion:-

The potential of astrotourism as a novel revenue-generating sector underscores its significant economic and developmental impact. Astrotourism, characterized by activities centered around astronomical observatories and related educational experiences, has shown promise in both developed and developing regions. The Al-Khawarizmi Astronomy Complex in Tanjung Bidara exemplifies how astrotourism can be harnessed to boost economic income through a multifaceted approach that includes educational programs, research initiatives, and tourist attractions. Developed countries like the United States of America, Australia, and Canada have successfully capitalized on astrotourism by offering diverse products and experiences to visitors. These countries have established robust astrotourism infrastructures that attract significant numbers of tourists, generating substantial revenue and contributing to local economies. Observatories in these regions often provide a range of services, including night sky observation sessions, educational tours, and interactive exhibits, which not only draw tourists but also foster a deeper public understanding of astronomy.

In Tanjung Bidara, the Al-Khawarizmi Astronomy Complex has similarly demonstrated the potential of astrotourism to drive economic growth. The support and promotion by the Malacca state government have been crucial in attracting visitors, thereby enhancing the tourism appeal of the region. This influx of tourists has created lucrative income opportunities for both the state and local communities, supporting businesses such as hotels, restaurants, and local shops. Additionally, the complex has generated employment opportunities, further benefiting the local economy. Moreover, despite its primary mission of education and research in the field of astronomical science, the Al-Khawarizmi Astronomy Complex has shown that non-profit educational institutions can also contribute to economic development. By integrating tourism into its operations, the complex has provided a sustainable model that balances educational goals with economic benefits. In conclusion, the successful integration of astrotourism into local and national economic strategies highlights its potential as a valuable sector for generating revenue and promoting sustainable development.

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