The Capability of Astrotourism on Preserving Sustainability: A Case Study in Malaysia

Muhammad Syazwan Faid¹, Mohd Saiful Anwar Mohd Nawawi¹*, Mohd Paidi Norman², Dani Irwan Masbah³, Mohd Hafiz Mohd Saadon¹, Nurul Kausar Nizam¹

¹Academy of Islamic Studies, University of Malaya, 50603 Kuala Lumpur Malaysia
²Academy of Contemporary Islamic Studies, Universiti Teknologi MARA, 40450 Shah Alam Malaysia
³Department Of Civil Engineering, Kulliyyah of Engineering, International Islamic Universiti Malaysia,

*Corresponding Authors
msyazwanfaid@gmail.com, saifulanwar@um.edu.my, mhms@um.edu.my, nurulkausarnizam@gmail.com, apai_norman@uitm.edu.my

Received: 30 April 2022
Accepted: 12 October 2022
Online First: 15 December 2022

ABSTRACT

Astrotourism is tourism that uses astronomy as its main attraction. As astrotourism requires astronomy phenomena, it requires a location free from light pollution. As some have posited locations free from light pollution as one of the cultivating elements for maintaining sustainability, Astrotourism can be used to achieve sustainability. Sustainability can be put under the umbrella of Maqasid Syariah and halal tourism. It is thus of utmost importance to demonstrate the unique capabilities of Malaysia as a viable Astrotourism attraction and how it can help achieve the goal of sustainability, both of which are the objectives of this research. Two methods are employed in this study; the first is to identify potential Astrotourism sites using the dark sky database, light pollution mapping and Garstang formulation of light pollution. The second method is comprised of identifying the cultivating elements of sustainability. Through this method, three potential Astrotourism sites could enhance the notion of sustainability, including sustainability from the economic, well-being and biodiversity aspects and, more importantly, sustainability towards the holistic practice of Islam. This demonstrates the encompassing benefit of Astrotourism towards sustainability and its development potential in Malaysia.
Keywords: Astrotourism, Halal Tourism, Sustainable Development Goals, Light Pollution, Maqasid Shariah

INTRODUCTION

Astrotourism comprises touristic activities involving the astronomical sighting of comets, lunar eclipses, the Milky Way and star constellations in an unpolluted night sky (Fayos Solá et al., 2014; Soleimani et al., 2019). Some researchers have also included visitations to astronomical facilities, monuments and archeoastronomy sites as part of astrotourism. There is also literature that includes space tourism, which is tourism that involves going to outer space, under the field of astrotourism (Pásková et al., 2021). However, space tourism requires lavish expenditure, niche technology and very specific locations, making it not easily accessible to the general tourism market. As astrotourism involves natural astronomical sightings, it is considered ecological and sustainable tourism. This means it only requires natural resources and does not need maintenance or deployment, making it a great asset as a tourism product.

Astrotourism does not primarily rely on the astronomical sighting. This is because astronomical sighting depends on weather conditions that are unpredictable to a certain degree. In addition, certain astronomical phenomena, such as meteor showers and Milky Way sightings, only occur during specific time windows throughout the year. Therefore, astrotourism attractions such as the Mauna Kea Observatory Complex added various other activities to its arsenal, including education programs, galleries, and sightseeing. This enriches the experience of visiting an astrotourism site and reinforces that it should not limit itself to only astronomical sightings.

ASTROTOURISM, SUSTAINABILITY AND MAQASID SHARIAH

Sustainability is defined as development that meets the present needs without compromising the need for future generations to meet their own needs. Practising sustainability requires a careful balance between optimizing the needs of current stakeholders and preserving available resources for the consumption of future stakeholders (Narayanan, 2013). The balance between optimization and preservation is challenging, as optimization, primarily driven by economic endeavours, usually hampers the preservation efforts for future generations. Vice versa, the preservation of currently available resources is usually endangered as there is always a
need for optimization due to population expansion. For example, sustainable practices are usually poorly implemented in industrial areas because these practices require high expenditure and result in limited industrial activities.

On the other hand, the sustainability goal of education and social and economic development cannot be achieved in remote areas or poorer regions due to limited industrial activities that promote economic growth. The endeavour toward a state of sustainability is not an easy feat and requires intricate equilibrium between optimization and preservation. While achieving sustainability is less challenging in urban-suburban settings, rural locations, in comparison, have trouble achieving sustainable development goals, particularly those that concern economic and social developmental milestones. Rural locations usually do not have natural resources, nor are they capable of attracting industrial activities that can bolster economic growth. Hence, tourism is the driver for enhancing rural and remote locations, particularly those most vital to the development, namely economic, environmental, and sociocultural growth (Jacobs et al., 2020).

In term of economics, the tourism sector creates jobs for the local communities and provide opportunities for investment in the location. In addition, it contributes to providing skilled workers through training and education. This will bring a sense of economic direction to the local town without interfering with their prevailing cultural norms and daily activities, as tourism tends to highlight the unique cultural aspects of each location. A good example is how cultural tourism has benefited the Aboriginal people of Australia. It is found that 33% of Australian interstate tourists are interested in Aboriginal cultural tourism, and 30% are willing to pay for that kind of experience (Radomskaya, 2019). This revives the preservation efforts of aboriginal culture, creates employment opportunities, and increases the cross-cultural understanding of the aboriginal community (Dyer et al., 2003). The tourism sector also boosts the development of transportation networks and other infrastructure in rural areas to ensure its level of connectivity for the tourist (Jacobs et al., 2020).

Regarding the environment, tourism does not emit pollution from gases, water or noise. This is because most of these types of pollution originate from the manufacturing industry, require raw materials processing and then emit dangerous chemicals that are harmful to our
environment. Environmental aspects, such as unique flora and fauna, can act as tourist attractions, making preservation vital (Butler, 1991). This type of tourism is called eco-tourism. However, there are some cases where mass eco-tourism causes adverse effects on the environment, such as cadmium pollution, waste and water exploitation, vegetation clearance and wildlife displacement (Buckley, 2011; May 1991; Mikhailenko et al., 2020). Nevertheless, with the proper coordination of policies, proactive planning, acceptance of limitations on growth, education of all parties involved, and a strong commitment to a long-term viewpoint, a state of sustainability can be achieved through tourism (Butler, 1991).

In terms of social-cultural growth, tourism can promote positive growth of the locals’ quality of life at the tourism destination (Ndlovu & Ojong, 2018). Tourism also enhances the transformation of traditional ethics, values and norms towards being more positive and progressive without hampering its natural identities. Economy growth from the impacts of being a tourism destination leads to improvements in living standards, particularly concerning education and quality of medical care. This is because tourist destinations require exceptional hospitality to boost their attraction. Enhancing hospitality quality requires training, education, and emphasis on well-being through consuming a healthy diet and going for routine medical check-ups (Johnson & Park, 2020). This, in turn, boosts the educational and medical standards of the locals. Local culture is integral to the tourist attraction, so it can be preserved without compromising its identity.

Astrotourism has been found to strengthen the sustainability of developments in neighbouring areas. This is because astrotourism increases the community's economic activities without the expense of unneeded infrastructure development and construction. The cultural activities and beliefs can be preserved as it is found to be valuable for an astronomy-related attraction for astrotourism (Torabi, 2020). The International Astronomical Union's Office of Astronomy for Development (IAU OAD) listed astrotourism as a flagship project. In addition, astrotourism is also in line with the United Nations' Sustainable Development Goals (SDG). This includes, but is not limited to, Goals 4, 5, 8, 9, 10, and 11: gender equality; quality education; economic growth and decent work; reduced inequalities; and sustainable communities; industry, innovation and infrastructure.

As astrotourism requires a light pollution-free site, it can also
achieve the requirements of maqasid shariah by reducing light pollution. A recent study has found that light pollution impedes the notion of Maqasid Shariah through disruption of the protection of life, protection of intellect, protection of progeny and protection of property. This is because light pollution has proven to harm human health and degrade ecosystem balance and the severe notion of economic conversation. Thus, an exercise to develop an astrotourism destination with Islamic ethics is considered an exercise to achieve the notion of Maqasid Shariah. Astrotourism that is laden with Islamic ethics is not only considered an initiative to achieve Maqasid Shariah but is also considered part of the Halal Tourism endeavour. This is because Halal Tourism is tourism that conforms to Islamic teachings regarding behaviourisms, dress, conduct and diet.

**Astrotourism in Malaysia**

The Malaysian tourism industry was the third largest contributor to Malaysia's Gross Domestic Product, after the manufacturing and commodities sector, to the national account in 2019. The total contribution of Malaysian tourism to its gross domestic product (GDP) was 15.9% in 2019, with a contribution of RM 86.14 billion (Tourism Malaysia, 2020). While in 2021, Tourism in Malaysia observed a significant decrease, with RM 12.70 billion in receipts and 4.33 million in arrivals due to the Covid-19 outbreak and travel limitations, compared to 2019 RM 86.15 billion in receipts and 26.10 million in arrivals (Malaysian Tourism Promotion Board, 2020). Malaysia's top three international receipts in 2019 came from Singapore, China and Indonesia, each with RM 20.55 billion, RM 15.33 billion and RM 12.94 billion, respectively.

Malaysia's primary niche products are shopping, birding, golfing, cruising, diving, angling, yachting, biking, weddings and homestays, with shopping as the primary contributor to the tourist expenditure at RM 29 billion in 2019. While birding, diving and angling can be classified under eco-tourism, the Malaysian astrotourism market is still untapped, and Malaysian tourism agencies' focus on astrotourism is not thoroughly explored. This is primarily due to the lack of interest of the local industrial players to actively promote astrotourism as a viable touristic product. Currently, few government-linked bodies promote astrotourism through an educational and research focus, such as Planetarium Negara Malaysia, Klana Beach Resort, Balai Cerap Teluk Kemang and Balai Cerap al-Khwarizmi. In contrast, the sole private astrotourism industry player, Dark Sky Malaysia, primarily focuses on training the local tourism sites to add
astrotourism as their tourism attraction. Sabah Stargazers are partially funded by the Ministry of Science, Technology and Innovation Malaysia to mobilize the astrotourism scene. However, the fund is limited to Sabah and not cross-funded with the Malaysia Ministry of Tourism, Art and Culture. In order to further improve the market of Astrotourism in Malaysia, more funding and cross-ministerial and departmental cooperation are required to train local industry players, research and discover potential astrotourism sites and develop cross-tourism products.

To mitigate the impact of Covid-19 on the tourism sector, the government has launched the National Tourism Policy (NTP) 2020-2030 to ensure the continuity of the country’s tourism industry and make Malaysia a preferred tourist destination globally (MOTAC, 2020). Key approaches to achieving the NTP's agenda include effective recovery of the tourism industry based on new norms, strengthening competitiveness, sustainable and inclusive tourism development, and disaster risk management. These are in line with the positive economic, environmental and sociocultural growth stemming from the development of astrotourism. However, literature demonstrating the sustainability element of astrotourism in Malaysia is non-existent.

Several researchers have pointed out Malaysia's astrotourism potential (Hafiz Safiai et al., 2020; Tapada et al., 2021). However, like most research on international astrotourism, it only focuses on the concept of astrotourism, including its definition, potential and vital components (Gerasimova, 2021; Kanianska et al., 2020). The execution and impact of astrotourism, particularly on wide-ranging sustainability issues, are not thoroughly explored. Considering this gap in existing research and taking the sentiment of the National Tourism Policy, which emphasizes sustainability, this paper intends to study the current and prospective astrotourism sites in Malaysia and their potential to promote sustainability.

**METHODOLOGY**

**Identification of Astrotourism Site**

As astrotourism is primarily related to astronomical sightings, it requires a light pollution-free site. Light pollution is an alteration of the natural night sky through artificial lighting that causes the night sky to be brighter and deforms the natural brightness and colour of the night sky (Faid et al., 2019). As light pollution brightens the sky and distorts the supposed colour of the night sky, it hampers astronomical sightings such as stars, galaxies
and the Milky Way (Faid et al., 2016). This is because astronomical objects require certain brightness and colour contrast thresholds against the night sky to be visible. An increase in night sky brightness reduces the contrast between astronomical objects and the night sky, consequently making the astronomical objects invisible. Locations affected by light pollution are not viable as astrotourism sites as the main potential attraction, namely astronomical sightings, cannot be conducted effectively.

The astronomical sighting capability of a location can be measured quantitively by using the Bortle Scale classification. Bortle Scale measures the night sky brightness on nine numeric scale levels from 1 for 'excellent dark sky site' to 9 for inner city sky'. Bortle Scale classification is based on the Sky Quality Meter and Naked Eye Limiting Magnitude readings. Ideally, locations with a high potential for astrotourism would be located at Bortle Scale Number 1, with a Sky Quality Meter reading of 22.00 mag/sec² and Naked Eye Limiting Magnitude of 7.6. However, as most of our Earth is affected by excessive artificial lighting, it is difficult to find locations free from light pollution (Falchi et al., 2016). Therefore, a site with a Bortle Scale Number of 1 to 3 and a Sky Quality Meter reading of more than 18.50 with a Naked Eye Limiting Magnitude of less than 5.1 can be considered a potential astrotourism site.

Naked Eye Limiting Magnitude (NELM) is a formula from Knoll to determine the visibility of comets and astronomical objects (Knoll et al., 1946). The result of NELM and \( B(D)_{mag} \) is then used to determine the Bortle Scale of a potential site. The potential astrotourism site will be located through identification of the location through readings of light pollution, which are conducted and confirmed with light pollution mapping and Berry formulation of light pollution. Then, using the value of the sky brightness of the sites, NELM is calculated, and its position on the Bortle Scale is determined to measure the site’s astronomical visibility.

**Identification of Sustainability Elements of Astrotourism Site**

A literature study is conducted to identify the sustainability elements of astrotourism sites. The methodology develops a framework pipeline to focus on the objective. First, an investigation of any prior research that could be posited under sustainability is conducted. This includes energy conservation and waste mitigation, ethics and cultural preservation, economics and social life development and threat to biodiversity. Second,
how do these elements of sustainability relate to the concept of astrotourism, either through light pollution or tourism development? Energy and waste conservation can be located under the side impact of coordinated lighting, reducing light pollution, Unique biodiversity and photosensitivity, especially the exposure to light during the night due to light pollution. Ethics and cultural preservation can be promoted as a cross-tourism product at an astrotourism site, particularly ethnoastronomy. Economics and social life development is a by-product of a properly planned tourism location, including astrotourism. These sustainability elements and their relation to astrotourism are studied in detail and highlighted. Third, how the astrotourism site can enhance these sustainability elements is then inferred. A case study from another tourism site and how it relates to these elements of sustainability is then investigated. Next, the potential for sustainable development through the development of astrotourism is explored.

The literature research was conducted using various databases like ScienceDirect, Springer Link, Elsevier, Taylor and Francis Online, Emerald Insight and numerous scientific journals. Conference proceedings, reports, books, guidelines, online newspapers, open-access articles, governmental together with various organizations' websites and legislations were also included in the study. The latest peer-reviewed articles on the topic were mainly used as references. Since the discussion of astrotourism and sustainability is a fledging area of research, conference papers were used to fill information gaps and constitute the latest research on the topic.

RESULT AND DISCUSSION

Based on the methodology discussed in the previous topic, five astrotourism sites have the potential for positive sustainability enhancements in their neighbouring locations. These sustainability enhancements include electricity conservation, conservation of Islamic Prayer time observation site, conservation of language and culture, economic and socio-culture development and conservation of ecology. There are several astrotourism sites in Malaysia. However, the locations listed below are chosen specifically for their potential for sustainability enhancements. The details of the astrotourism sites are described in Error! Reference source not found.
Table 1. Astrotourism Site in Malaysia and Its Sustainability Element

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Sustainability Element</th>
<th>SQM (Mag/Sec2)</th>
<th>NELM</th>
<th>Bortle Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Balai Cerap Teluk Kemang, Klana Beach Resort, Negeri Sembilan</td>
<td>Electricity Conservation Through “Akta Kawalan Cahaya”</td>
<td>19.50</td>
<td>5.1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Srikandi Resort Mersing, Johor</td>
<td>Observation Site for Subh Prayer Times</td>
<td>21.51</td>
<td>6.4</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Tambatuon Homestead, Kota Belud and Tegudon Tourism Village, Kota Belud, Sabah</td>
<td>Cultural Preservation, Economic Preservation, and Biodiversity Preservation.</td>
<td>21.89</td>
<td>6.6</td>
<td>2</td>
</tr>
</tbody>
</table>

Balai Cerap Teluk Kemang, Klana Beach Resort, Negeri Sembilan

Balai Cerap Teluk Kemang has a sky quality meter reading of 19.50, Naked Eye Limiting Magnitude of 5.1 and Bortle Scale of 6. This signifies that several astronomical objects will not be visible at Balai Cerap Teluk Kemang, with some galaxy clusters, such as M3, visible to the naked eye. By using a refractor telescope, some galaxies can be sighted. Balai Cerap Teluk Kemang started as a moon sighting observation site for the new Islamic Month determination in the 1930s (Mohd Nawawi et al., 2015), with the current observatory complex completed in 2012.

Balai Cerap Teluk Kemang teamed up in collaboration with Klana Beach Resort to become the only public observation facility open for visitations to promote astronomy awareness. Balai Cerap Teluk Kemang is located 11 km from the nearest suburban centre, Port Dickson, and is far from any city centre, with the closest being located at Seremban, 38.3 km away. Balai Cerap Teluk Kemang houses a theatre Room, mini astronomy gallery, solar telescope, and observatory deck and has a monthly Islamic
moonsighting activity. Balai Cerap Teluk Kemang, despite being located near the lower end of the Bortle scale and with poor astronomical sighting, its facility and vicinity to the city centre make it a viable spot for astrotourism geared towards educational astronomy.

Balai Cerap Teluk Kemang is gazetted under the “Kawasan Kawalan Cahaya” (Artificial Lighting Control Area), which covers a 3 km² circular parameter with Balai Cerap Teluk Kemang at its centre. The Artificial Lighting Control Area means that the construction of new buildings and current building lighting design located under the area must adhere to specific lighting criteria. The 3km circular area is gazetted to mitigate light interference issues from unnecessary lighting while observing the new moon for Islamic Month determination. The gazettement is under the PLANMalaysia mission to enhance the sustainability of the Port Dickson coast.

Due to the gazetting of the 3 km² circular area around Balai Cerap Teluk Kemang, the artificial lighting surrounding the area can only be operated under a limited capacity. This does not impact the level of light pollution at the Balai Cerap, as it requires being at least 30 km away from any lighting source to reduce the impact of light pollution. However, this does reduce the glare or interference from spotlights that impede astronomical sightings. From the building's operations aspect, the limitation of lighting operations can conserve electricity and minimize wastage, as a light source from the likes of spotlights requires much power and constitutes a hefty chunk of the overall electrical bill. Considering a spotlight requires 1000 W per hour and consumes RM 0.50 per kWh, the total electrical consumption for one year would be 592,866.54 kWh. This corresponds to an electrical bill amounting to RM 27,4686.93. This electrical wastage and the hefty electrical bill would be minimized when the building is located under the Balai Cerap Teluk Kemang’s Artificial Lighting Control Area. This indicates that Balai Cerap Teluk Kemang has the potential for sustainability element through the Artificial Lighting Control Area Law, that limit the electrical usage of the area.

**Srikandi Resort Mersing, Johor**

Srikandi Resort Mersing has a sky quality meter reading of 21.51, Naked Eye Liming Magnitude of 6.4 and a Bortle Scale value of 3. This means that several astronomical objects will be visible at Srikandi Resort Mersing. Galaxies cluster, Milky Way and zodiacal light will be visible to the naked eye. Using a 12.5-inch Refractor telescope, astronomical objects
brighter than 16 will be visible. Srikandi Resort Mersing is located 16 km from the nearest suburban centre, Mersing, and far from any city centre, with the closest located at Kluang at a distance of 114 km. Srikandi Resort Mersing is renowned for its beautiful beach and proximity to Mount Arong and Pulau Mawar for jungle trekking activities. Srikandi Resort Mersing also offers boat fishing and beach trawling activities for those looking for a different touristic experience. Srikandi Resort Mersing Johor is located near the upper end of the Bortle scale and has good astronomical sightings. Armed with various touristic activities, it makes an excellent location for astrotourism.

Srikandi Resort Mersing is located facing east towards the South China Sea. The nearest Island is Pulau Sembilang which is 15 km away. Srikandi Resort Mersing’s beachfront is also free from industrial activity such as oil mining or harbours. This makes Srikandi Resort Mersing free from any interference from artificial lights, making it perfect for stargazing. This is evidenced by the visible presence of dusk zodiacal light at the eastern horizon of Srikandi Resort Mersing. Zodiacal light is a band of light in the night sky, thought to be sunlight reflected from cometary dust concentrated in the plane of the zodiac or ecliptic. This light is seen in the east before dawn, being easily visible in a light pollution-free location. Zodiacal light's visible presence at a certain site indicates its suitability as a site for dusk-twilight observation.

Dusk twilight observation is vital as it is used to determine the Subh prayer times. The zodiacal light is termed "Fajar Kadhib", while Dusk Twilight is termed "Fajar Sadiq". The presence of zodiacal light and dusk twilight in a light pollution-free location is vital as it can be utilized as an observation site to measure and study the Subh Prayer time. A designated location for Subh prayer time is vital as a location with artificial light interference. Light pollution will distort the measurement of Subh prayer times. This distortion will then lead to the inconsistent determination of Subh prayer times. The inconsistencies of Subh prayer times determination due to light pollution are demonstrated by Bahali et al. (2018), Faid et al. (2018), and Hassan & Abdel-Hadi, (2015).

These inconsistencies are due to the incorporation of light-polluted twilight sky brightness sites in the overall mean value. Twilight sky brightness is determined by changes in sky colour and brightness due to the depression position of the sun. With the presence of light pollution, minute changes in sky colour and brightness cannot be detected, as is the
overshadowed presence of light pollution. The more intense the light pollution in a location, the more significant the changes in sky colour and brightness required to detect twilight brightness. This explains why there are various readings of twilight determination. This also demonstrates the importance of a dusk-twilight sky brightness observation site to ensure a new measurement of solar depression without artificial light interference or distortion by light pollution.

A modern and contemporary definition of sustainability is the sustainability of religious practice (Narayanan, 2013). As light pollution hampers the consistent determination of Subh prayer times, light pollution hampers the notion of sustainability in religious practice. Skrikandi Resort Mersing is a suitable site for dusk twilight sky brightness. Positioning Skrikandi Resort Mersing as an astrotourism site will encourage the conservation of the location as a light pollution-free location, which can be utilized as a dusk-twilight sky brightness measurement site. This will also act as an impetus for sustainability, specific sustainability towards the practice of religion. This indicates that Skrikandi Resort Mersing has the potential of sustainability elements through the protection of religious practice by gazetting the Subh prayer observation site area.

**Tambatuon Homestead, Kota Belud, Sabah, Tegudon Tourism Village, Kota Belud, Sabah**

Tambatuon Homestead and Tegudon Tourism Village, Kota Belud, has a sky quality meter reading of 21.93, Naked Eye Liming Magnitude of 6.6 and a Bortle Scale value of 2. This denotes that several astronomical objects will be visible at Tambatuon Homestead and Tegudon Tourism Village. Galaxies clusters, the Milky Way and zodiacal light, will be visible to the naked eye. Using a 12.5-inch Refractor telescope, astronomical objects brighter than 16.5 will be visible. Tambatuon Homestead and Tegudon Tourism Village are located 41.6 km away from each other, representing a one-hour travelling time due to rough road conditions. Both sites are located far away from any light-polluted location, being 31.3 km from the nearest suburban centre of Kota Belud and far from any city centre, with the closest located at Kota Kinabalu at a distance of 72.5 km. Tambatuon Homestead has beautiful sceneries, with the background of Mount Kinabalu set in a beautiful valley by the Kedamaian River open for hiking and rafting and surrounded by paddy fields and fruit orchards. The resort is maintained by a Dusun tribe, meaning that tourists can enjoy the unique Dusun cuisine and culture.
Tegudon Tourism Village landscape comes with a scenic view of paddy fields, the Wariou River flowing over a tiny waterfall perfect for tubing activities and Minorit Hill, Ponohuan Waterfall and Mt. Tambuyukon for hiking and jungle tracking. Tambatuon Homestead and Tegudon’s pristine dark skies and various touristic attractions mentioned above make it a perfect location for astrotourism.

Kota Belud had an estimated population of around 111,800 in 2019, and its population is divided between the Bajau-Sama, Dusun and Illanun peoples. There is a Chinese minority, which consists mainly of Hakkas (DOSM, 2021). Kota Belud has various cultural activities such as Kota Belud Tamu Besar, a big market event with the main event being a Bajau Horsemen parade, Ratu Sarimpak beauty pageant and water buffalo race. The Dusun ethnicity is also rich in culture and language. Dusun has its language, Tindal, whose literal meaning is 'people who have come out from the Earth. The language, however, is now at risk of being out-practised, and Bahasa Melayu, the official national language, is favoured due to education and economic factors (Kijai, 2012).

Visitors to the Kota Belud Tamu Besar are primarily local (Langgat et al., 2012). While this encourages the survival of the Bajau culture, such as Bajau's unique cosmology (Yakin, 2013), additional interest from other states and international visitors will attract investors and promote more cultural activities in Kota Belud. The threat of the Tindal language being extinct could be mitigated by incorporating the Tindal language and Dusunic culture as part of the activities on offer at the astrotourism site. This will enhance local pride and interest in practising and maintaining the language amongst the local people. As an additional note, the Bajau race, like the Bajau Ubian in Mantanani Island, primarily worked as fishermen and practised 'fish bombing' to capture a huge number of fish (Hussin et al., 2017).

If the Tambatuon Homestead and Tegudon Tourism Village can demonstrate the generation of economic growth through astrotourism, this would inspire other locals, such as those in Mantanani Island, to migrate into more sustainability-focused economy generation opportunities such as astrotourism. This will reduce the unhealthy practice of fish bombing and promote the sustainability of sea life around Mantanani Island. Thus, the enhancement of astrotourism at Tambatuon Homestead and Tegudon Tourism Village could boost the sustainability of the culture and language of the locals with the added benefit of engendering better sustainability in
their fishery practice. This indicates that Tambatuon Homestead and Tegudon Tourism Village have the potential of sustainability elements through the sustainability practice of culture and fishery, protecting the area's cultural identity and marine life.

CONCLUSION

The astrotourism industry has adequately demonstrated its ability to achieve the goal of sustainability through the case studies of various astrotourism sites in Malaysia, namely the Balai Cerap Teluk Kemang, Srikandi Resort Mersing, Tambatuon Homestead and Tegudon Tourism Village, which has the NELM of 5.1, 6.4 and 6.6, and has Bortle scale of 6.3 and 2 respectively. Astrotourism can achieve the initiative of electrical waste reduction at Balai Cerap Teluk Kemang through its Artificial Lighting Control Area, which corresponds to Goal 12 of the SDG, Responsible Consumption and Production.

Srikandi Resort Mersing demonstrated its suitability as a dusk-twelight observation site for Subh prayer times determination which corroborates with the sustainable goal for religious practice and can additionally be located under the umbrella of Halal Tourism. Tambatuon Homestead and Tegudon Tourism Village demonstrated that it has the potential to boost the local economy and preserve the unique language and cultural identity of the locals. Tambatuon Homestead and Tegudon Tourism Village's success in astrotourism could inspire fishermen practising unsustainable ways of fishing to move towards more eco-friendly economic activities. This shows that Tambatuon Homestead and Tegudon Tourism Village are capable of biodiversity, culture, and economic sustainability enhancement. The case studies have illustrated how astrotourism could boost sustainability, particularly in rural locations where industrial activity is scarcer.

ACKNOWLEDGMENTS

Thanks to Dark Sky Malaysia for providing insight into the current status of astrotourism in Malaysia

CONFLICT OF INTERESTS

The authors declare no competing interests, such as financial or personal
relationships, in the writing of this article.

**AUTHORS’ CONTRIBUTIONS**

Mohd Saiful Anwar Mohd Nawawi, Mohd Hafiz Mohd Saadon and Nurul Kausar Nizam designed the study and gathered the literature. Muhamad Syazwan Faid, Mohd Paidi Norman and Dani Irwan Misbah analyzed the results and wrote the article.

**REFERENCES**


https://doi.org/10.22452/JAT.vol10no2.5


https://doi.org/10.1002/sd.1557


Tourism Malaysia. (2020). TOURISM CONTRIBUTES RM86.14 BILLION
TO MALAYSIA ECONOMY WITH 26.1 MILLION TOURISTS IN 2019. Tourism Malaysia.