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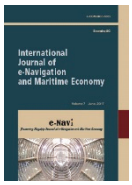

Original article

# The Utilisation of Pisang Island as a Platform to Support the Current Safety and Security Needs of Marine Navigation in the Straits of Malacca ☆

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## Abstract

Current marine navigational practice relies less on long-range visual marine signals such as lighthouses for reference purposes. This is due to the availability of Global Navigation Satellite Systems (GNSS), which are integrated with other navigational aids on ships. Therefore, the objective of this study is to review the function of Pisang Island lighthouse and to propose the most relevant use of Pisang Island for current navigational needs. The function of the lighthouse was reviewed according to the IALA Navigational Guide and the AIS data image. The result showed that the most suitable navigational use of the lighthouse is to act as a reference for Line of Position (LOP). The AIS data image indicated that mariners are not using Pisang Island lighthouse for LOP. The trend in the Straits of Malacca (SoM) was compared with the trend in the Straits of Dover, UK. The selected experts verified that LOP was not practised there. As a specific example, a tanker ship route in the South China Sea was used to further support that LOP was not practised. This evidence supported the view that Pisang Island lighthouse is less relevant for current navigational practice and does not directly support the coastal state VTS operation and the establishment of the marine electronic highway. Furthermore, the existing shore-based VTS radar has limitations on range and the detection of targets near Pisang Island. Therefore, this study proposes the establishment of a new radar station on Pisang Island at the existing site of the lighthouse. The proposed new radar station on Pisang Island will add to the existing coverage of the VTS radar, bridging the coverage gaps to overcome the weakness of the existing shore-based radar and improve the safety and security of marine navigation in the SoM.

*Keywords: lighthouse, marine, navigation, safety*

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## 1. Background

Islands have been used as a base to establish facilities to support maritime operations. Japan established a military radar facility on Yonaguni Island in March 2016 as a monitoring station in East China Sea to increase its military presence over there (Lewis, 2016). The island is part of a chain of islands disputed between Japan and China. In 2014, India planned to establish a radar station at Narcondam Island, which is part of the Andaman and Nicobar groups of Islands for security and surveillance measures. The island is significantly important due its location near the Malacca Straits, which provides the ability to monitor the movement of all vessels to and from the Indian Ocean through the Malacca Straits (Vasan, 2014). The island would also enable India to monitor the Chinese naval activity in the North Andaman Sea and around Coco Islands. China built a military base in December 2016 on an artificial island reclaimed on Fiery Cross reef, which is part of the disputed Spratly Island archipelago (Buckley, 2016; Hunt, 2015). The facilities at the base are harbours, runways, and hangars. The purpose of the base is to support China's operations and claims over the Spratly Islands.

This study is about Pisang Island, which is one of a Malaysian islands at the southern part of the Straits of Malacca (SoM). The importance of Pisang Island to marine navigation was identified by the British colonial government in the mid-19th century upon charting the straits and using the island to mark a hazard (Yong, 2008). The SoM became more important upon the completion of the Suez Canal, where it formed part of the shortest shipping route from west to east. A 16-metre-high cylindrical iron tower lighthouse was established on the highest point on the island in 1914. The current lighthouse's solar powered lighting system produces a luminous range of 21 nm (Yong, 2008).

## 2. Problem Statement and Objective

Currently, long range visual marine AtoNs such as lighthouses are less important for marine navigation, as shown in the UK. The UK 2010 marine AtoNs review resulted in the decommissioning of 20 lighthouses and another 14 lighthouses were transferred to local authorities (ATKINS Ltd, 2010). The Review by the General Lighthouse Authority UK between 2010 to 2015 resulted in the following: 41 lighthouses reduced luminous range, 6 lighthouses discontinued operation, 14 lighthouses were transferred to local authorities, 1 lighthouse was replaced with a Port Entry Light, 1 lighthouse reduced fog signal range, 1 lighthouse was fitted with an Automatic Identification System (AIS), and the remaining 76 lighthouses were unchanged (Commissioners of Northern Lighthouses, Trinity House, & Commissioners of Irish Lights, 2010). Most of the 76 unchanged lighthouses have a range of light below 18 nm, which was previously reviewed between 2005 and 2009. The results of these reviews showed the trend of mariners to depend less on lighthouses due to a higher reliance on GNSS. This long-range marine signal form is not required anymore and has thus resulted in the reduction the light range of lighthouses and even the discontinuation of their operation.

With respect to the current trend in marine navigation, Pisang Island lighthouse remains operational by providing a long-range marine signal, which is not required by current navigation practice. Hitherto, no review of the operation of Pisang Island lighthouse has been performed with respect to current navigational needs such as supporting the operation of Vessel Traffic Services (VTS) and the marine electronic highway to ensure the safety and security of navigation in the SoM. Therefore, the current study addresses this issue by examining the function of Pisang Island lighthouse and identifying more relevant AtoNs with current marine navigation practice to support the safety and security of marine navigation in the SoM.

## 3. The Function of Pisang Island Lighthouse

This section examines the function of Pisang Island lighthouse. A lighthouse is generally considered to be a large conspicuous structure (visual mark) on land, close to the shoreline or in the water that acts as a daymark; it provides a platform generally for higher range marine AtoN signal lights (IALA, 2014). The purpose of a lighthouse is to perform one or more the following functions; mark a landfall position; mark an obstruction or a danger; indicate the lateral limits of a channel or navigable waterway; indicate a turning point or a junction in a waterway; mark the entrance of a Traffic Separation Scheme (TSS); form part of a leading (range) line; mark an area; and to provide a reference for

mariners to take a bearing or line of position (LOP) (Hooff & Sirks, 1979; IALA, 2014; The Nautical Institute, 2002). With respect to Pisang Island Lighthouse, it's only relevant function is to provide a reference for mariners to take a bearing for a line of position (LOP).

Figure 1 shows the radius of the lighthouse light, which indicates that several coastal beacons are within the radius of the lighthouse light. For a vessel going either north or southbound in the straits, the LOP is performed by taking a visual bearing of the lighthouse's tower during the daytime and by using the lighthouse's light as a reference during the night time.

However, as an alternative to taking a LOP using visual means, the LOP can be performed electronically by using the ARPA radar of the ship. This LOP is performed by using a distinct horizontal feature on the island identified on the radar screen, such as, the edge of the island instead of the lighthouse's structure. This is because the ship's radar is unable to distinguish the lighthouse from the rest of the island's features horizontally. Therefore, the LOP can be performed either visually or by electronic means, where the former is using the lighthouse, while the latter is using the island's physical features.

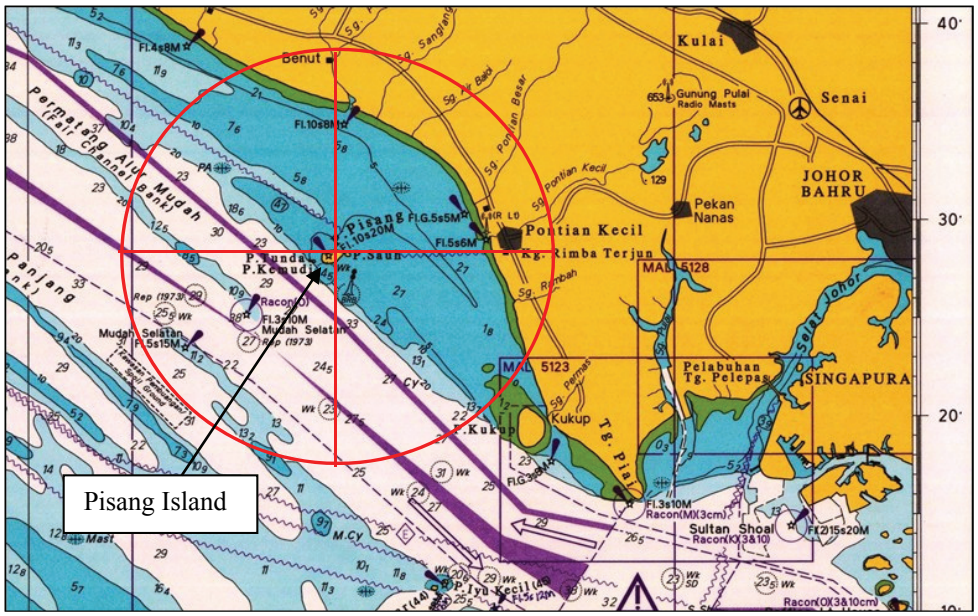


**Figure 1: Pisang Island in the bull's eye and Lighthouse Pisang Island 20 nm light's radius**

The application of GNSS, which is the most commonly used Global Positioning System (GPS) in the current trend of marine navigation, makes the lighthouse redundant and less important for a positional fix. With the incorporation of GPS, Electronic Navigation Charts (ENC), radar, Echo Sounder, and Gyro Compass into a single display of information in an Electronic Chart Display and Information System (ECDIS), mariners are less likely to be looking out from the bridge to perform the laborious manual positional fix by visual means due to an easily available accurate automatic positional fix. This is the current situation in the Pisang Island Lighthouse area, where the LOP is assumed to not be practised by mariners on board passing ships, as shown in Picture A of Figure 2.

This situation is due understandably to the high reliance on GPS for navigation and for complying with the Traffic Separation Scheme (TSS). Picture B of Figure 2 shows the overall view of ship's traffic in the southern part of the Malacca straits, which shows the Indonesian coast (the west of the straits) and Singapore (the south of the straits.

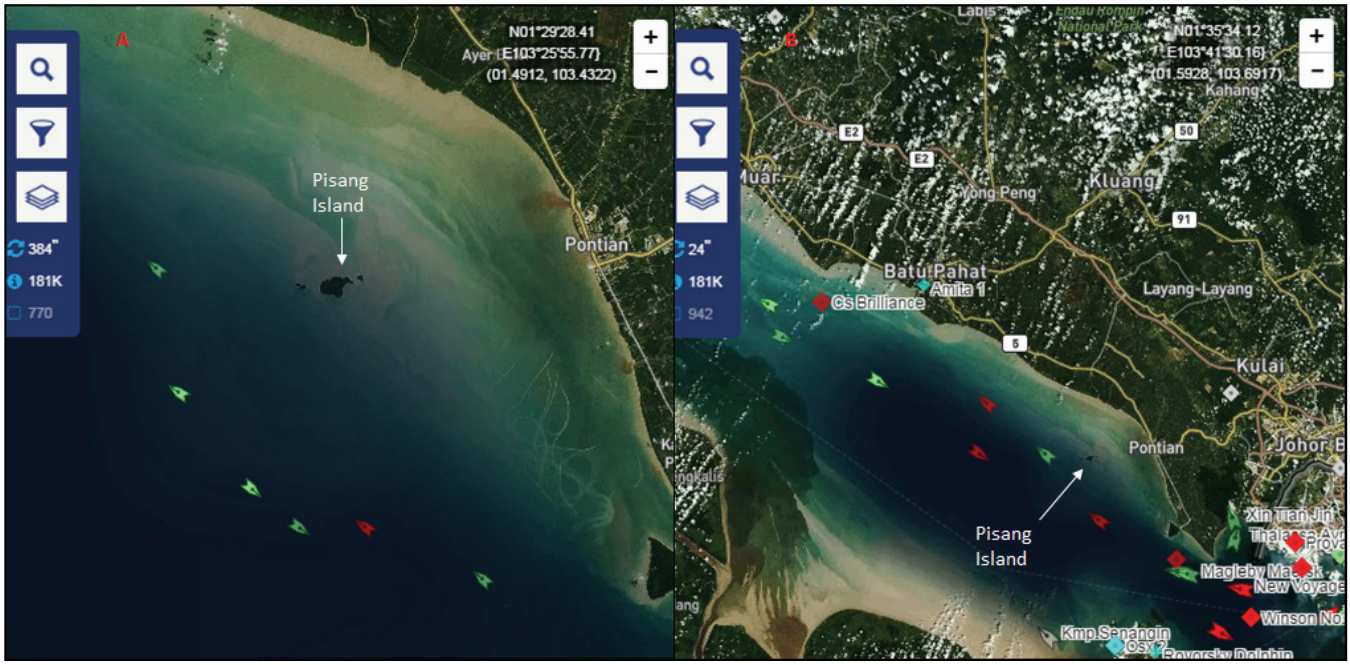


**Figure 2: Picture A of Figure 2 (left) shown a close-up view near Pisang Island, while picture B of Figure 2 (right) gives an overall view of southern part of the straits. The red coloured are tankers, while green coloured are cargo vessels.**

Source: www.marinetraffic.com (2016)

Nevertheless, Figure 2 is unable to clearly show that the passing ships were not practising LOP while navigating because that part of the straits is quite narrow. To determine the current trend of marine navigation, the movement of ships in the Dover Straits in Figure 3 was used as a reference for the study. The top picture shows the movement of ships in the straits based on AIS data on November 2016; picture A (bottom left) shows the traditional inbound and outbound shipping pattern in the Dover Straits using the lighthouses as the landfall light at Ushant and Casquets points; and picture B (bottom right) shows the shipping pattern in the straits using radio navigation (Hooff, 1982). To determine whether pattern of middle picture is similar to A or B, Figure 3 was shown separately to three lecturers of the Nautical Science and Maritime Transportation Program, Universiti Malaysia Terengganu who hold the Master Foreign Going qualification, during January 2017. Each of them agreed that the ship's route pattern in the middle figure is like the pattern in picture B as proposed by Hoof in 1982. The reason was that most of the ships entering the Dover straits were in the middle of the straits mouth; instead of near to the lighthouse at Ushant point to practice LOP. This shows that the mariners are currently not relying heavily on the lighthouse for navigation. This example supports the similar practice of mariners in the waters surrounding Pisang Island.

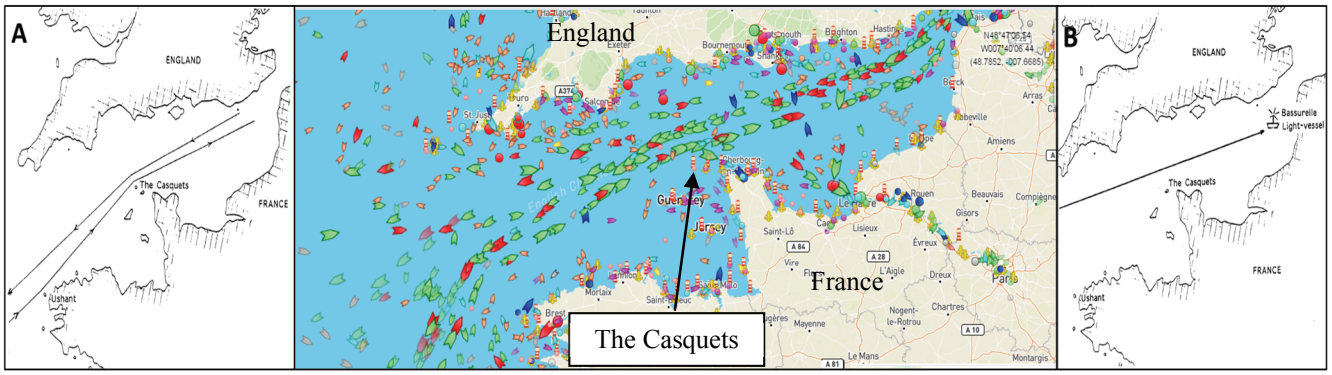


**Figure 3: Middle picture shows shipping in Dover Straits. Picture A (left) shows the traditional in and outward bound of shipping pattern in Dover Straits. Picture B (right) shows in and outward bound of shipping pattern using radio navigation.**

Source: Hooff, (1982); www.marinevesseltraffic.com (2016)

Another example to support the view that mariners currently do not practice LOP on lighthouses is shown in Figure 4. The previous and forecast track of a Japanese registered tanker Hakkaisan on its way from Malaysia to Japan on 1st April 2017 was used. The track shows that the vessel was navigating too far from any coast to take a bearing from a lighthouse for a LOP fix. This route clearly shows that the vessel was relying mostly on GNSS for navigation.

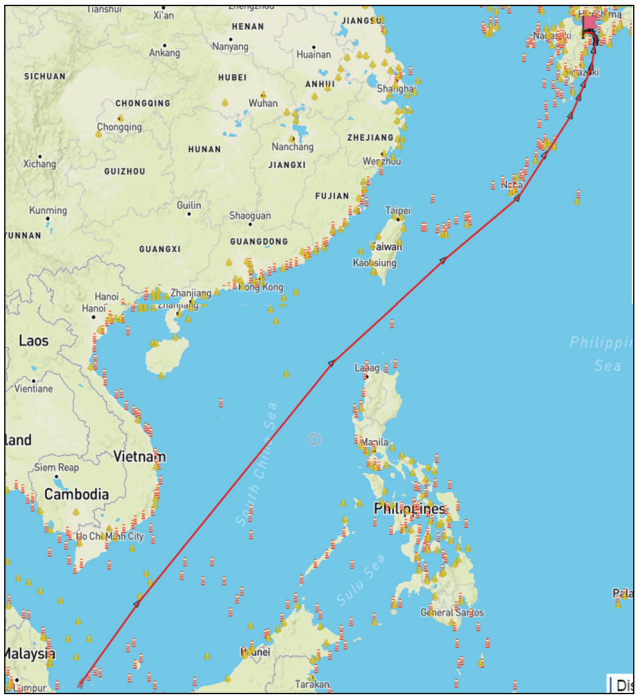


**Figure 4: Track of Tanker Hakkaisan from Malaysia to Japan on 01 April 2017**

Source: www.marinetraffic.com (2017)

The example of the shipping pattern in the Dover Straits, UK, the route of tanker Hakkaisan, the significant reduction of range of light of lighthouses and the discontinuation of the operation of lighthouses in the UK has proved that lighthouses are less relevant for current marine navigational practice. The current role of lighthouses is to complement the current marine navigational aids during the very rare event of the failure of all means of radio/electronic navigation such as GNSS, radar, VTS and land-based radio navigation.

## 4. The Relevance Use of Pisang Island for Current Navigation Practice

Since Pisang Island lighthouse is less relevant for current marine navigational practice, the question arises, what is the most relevant use for Pisang Island to support current marine navigational needs? To answer that question, the current requirements for marine navigation in the Straits of Malacca are investigated. The Mandatory Ship Reporting System in the Straits of Malacca, known as the STRAITREP, has been enforced since 1st December 1998 to support the Traffic Separation Scheme (TSS) (IMO, 1998). STRAITREP consists of 9 sectors (Figure 5), sectors 1 to 6 fall under the responsibility of the government of Malaysia, while sectors 7 to 9 fall under the government of Singapore's responsibility (IMO, 1998). The Malaysian sectors of STRAITREP are maintained by the Malaysian Vessel Traffic Services (VTS). Pisang Island is in Sector 6 (Piai) and near to the border of Sector 5 (Segenting). The sectors of the Malaysian VTS are supported by a series of surface radar, VHF radio and AIS transponders.

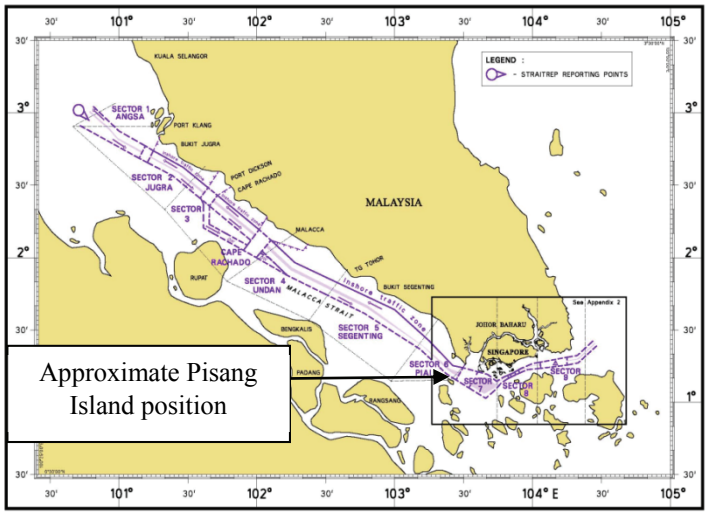


**Figure 5: STRAITREP Sector 1 to 9**

Source: MPA Singapore (2009, 2012a, 2012b)

There are two shore-based facilities, namely Klang and Johor VTS. Each of these facilities is equipped with telephone, facsimile, telex, VHF radio and real-time display consoles for "X" and "S" band radar signal from remote radar stations (MPA Singapore, 2012a). There are seven remote stations that support the VTS, namely Pulau Angsa, Bukit Jugra, Cape Rachado, Pulau Undan, Bukit Segenting, Tanjung Piai and Bukit Pengerang. Each of these stations is equipped with 1 unit "X" band radar facility, 1 unit "S" band radar facility, and VHF radio transmitters and receivers.

Figure 6 shows the 48 nm (89 km) radius of the VTS radar coverage from two shore-based remote stations, namely Bukit Segenting (north) and Tanjung Piai (south). There is a small gap area between the coverage of those two radars. The VTS operator can increase the range of the radar to complete the coverage by reducing the radar pulse frequency rate, which increases the radar pulse length. However, this would degrade the detail of detection or the ability to discriminate two or more targets on the same bearing but at different ranges. The long radar pulse length would merge two targets on the same bearing that are half the pulse length as a single target on the radar screen (Bartlett, 2002; Bole, Dineley, & Nicholls, 1992). The ability to discriminate targets on the same bearing is critical for a VTS operator to detect the movement of a suspicious boat such as a small fast pirate boat approaching a larger commercial vessel. Therefore, the maximum current range is the best setting based on the trade-off between range and the detail of detection. However, the movement of small boats in the area near the maximum radius of both radars around Pisang Island are difficult to detect especially when these boats are made of fibreglass or wood. This is due to the radar pulse being less reflected or absorbed by these materials compared to metal. Another issue related with the VTS radar in the Pisang Island area is the existence of a shadow zone behind the island that faces the radar. The shadow zone exists due to the side of the island that faces the radar blocks the radar beam from reaching any target on the other side of the island. These radar issues may provide opportunity for unlawful activities to happen in this area such as sea robbery and human trafficking, which compromises the safety and security of marine navigation in the SoM. The best way to address this issue is by establishing a radar station on Pisang Island that would serve as a remote station for the SoM VTS.

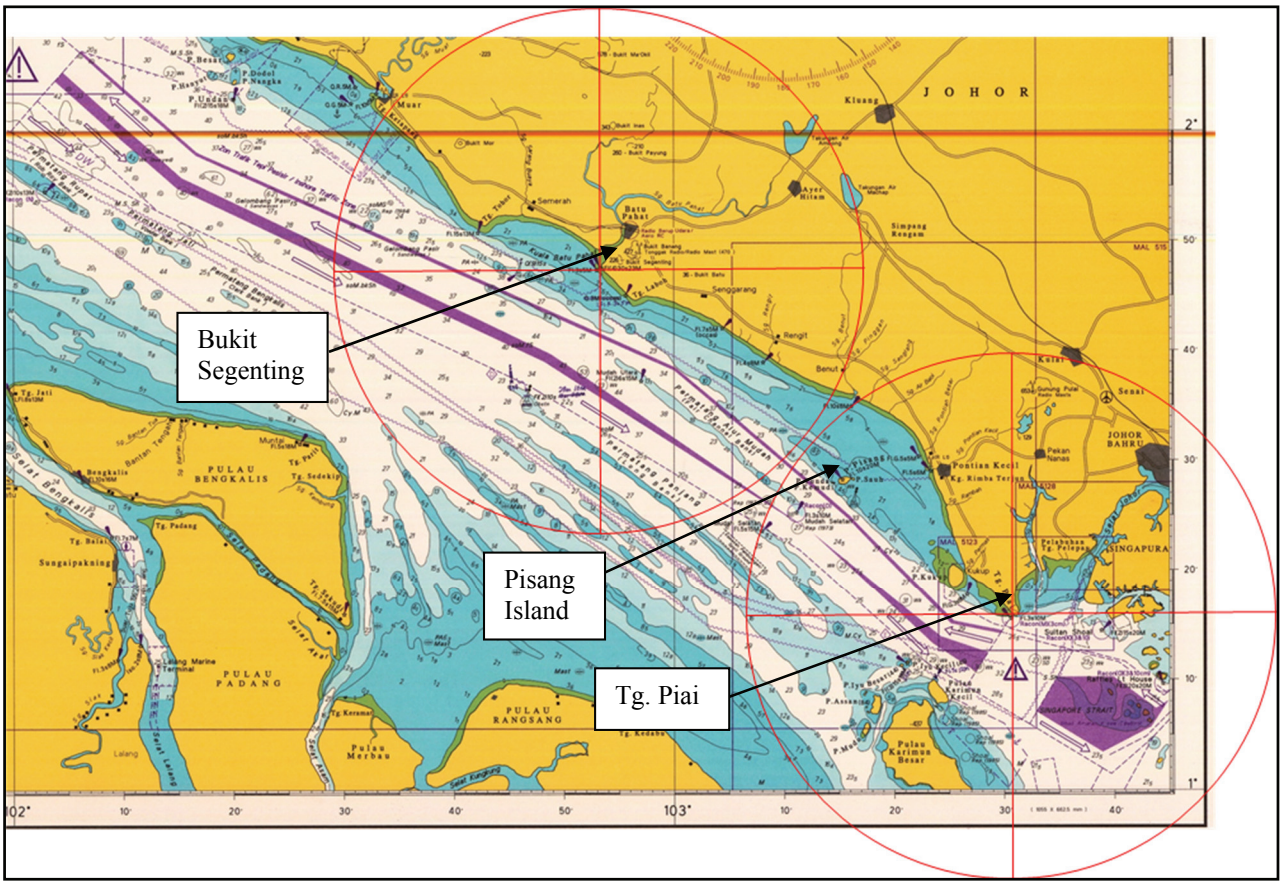


**Figure 6: The existing VTS radar Coverage**

Therefore, a radar station is more important than the existing lighthouse to support the operation of the SoM VTS and to ensure the safety and security of marine navigation in this busy strait. Corresponding to the current needs, there is no other site that is suitable to place the radar station other than the existing site of the Pisang Island lighthouse. This is the most suitable site in the area because it is located at the highest point on the island, which will give the fullest performance on range and detail of radar detection. Figure 7 shows the radius coverage of the proposed radar on Pisang Island by using a similar specification of the existing VTS radar. The radar on the proposed site would eliminate the existence of the shadow zone around the islands, which currently exists by using the shore-based radar. The Pisang Island radar can serve as a backup in the event of

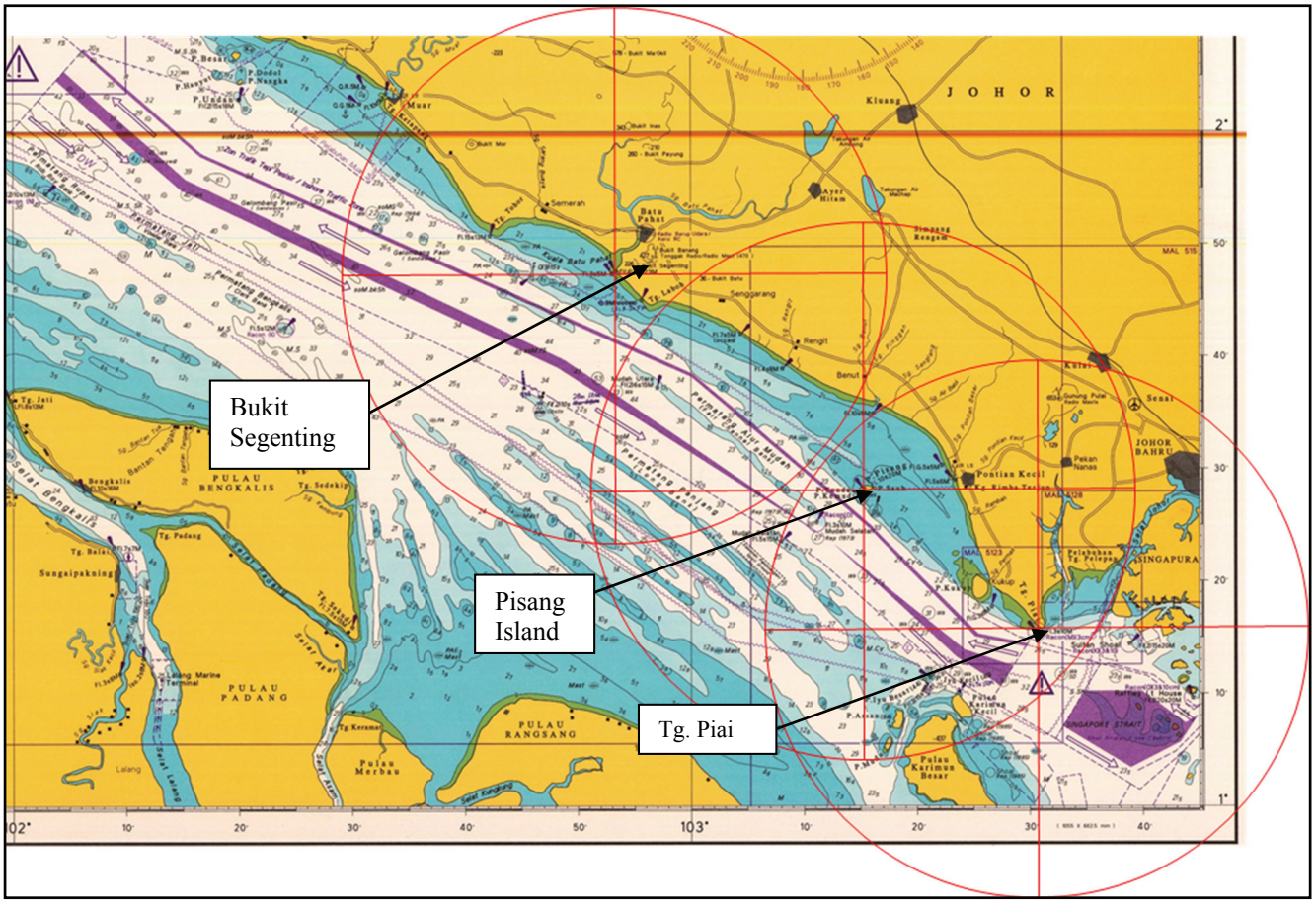


**Figure 7: The proposed Pisang Island radar coverage with existing VTS radar coverage**

radar failure at either Bukit Segenting or Tanjung Piai. To accommodate the establishment of an "X" and "S" band radar facility on Pisang Island, the existing lighthouse should be discontinued from operation and replaced with a beacon to mark the island. The metal lantern house of the lighthouse should be removed to prevent any obstruction to the radar wave. Relevant equipment to support the operation of the marine electronic highway such as the AIS and Automatic Weather Station should be established on the site. The proposed beacon to replace the lighthouse should be established without a day mark and should produce a luminous range that is as minimal as possible and corresponding to the speed limit of commercial vessels in the SoM TSS.

## 5. Conclusion and Recommendation

Current marine navigational practice is relying less on long-range visual marine signal such as lighthouses for reference. This is due to the availability of GNSS, which are integrated with other navigational aids on ships. The current trend shows that Pisang Island lighthouse, is less relevant for current navigational practice and is not incorporated directly into the coastal state VTS operation and the establishment of the marine electronic

highway. Furthermore, the existing shore-based VTS radar has a limitation on range and detail of detection in the area near Pisang Island. Therefore, a new radar station should be established on Pisang Island and the most suitable place is at the existing site of the lighthouse. The establishment of a new radar station as an addition to the existing radar for VTS would eliminate the weaknesses of the existing VTS radar and improve the safety and security of marine navigation in the SoM. This study has justified technically the reason to replace the Pisang Island lighthouse with a radar station to support the current needs of safety and security of marine navigation.

Therefore, this study recommends that further research be carried out to establish a radar station on Pisang Island as an additional remote station to the existing VTS system that would improve the safety of navigation in the Straits of Malacca and security of Malaysia.

The practical feasibility to conduct further research in the aspect of safety of navigation is to bridge the gap of coverage between the two coastal VTS radar stations that ensure a continuous detection of vessels in the straits, especially the hard to detect small glass-fibre or wooden construction vessels for better maritime traffic control and accident prevention.

In terms of the maritime security aspect to conduct further research, the continuous radar detection and elimination of shadow zone would be used to prevent the smuggling of illicit materials from Indonesia to Malaysia such as drugs and small arms; the smuggling of tax evasion materials to Malaysia such as liquor and cigarettes; and the smuggling of consumer products from Malaysia to Indonesia such as subsidised fuel and rice.

The cost to establish a new radar station on Pisang Island would be compensated easily by the saving from losses of the smuggling of materials mentioned above.

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