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Preliminary Study of Marine Debris from Selected Beaches in Malaysia

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ABSTRACT. Beach pollution is rising due to Malaysia's rapid urbanisation and population growth. Therefore, the objectives of the study are to identify the type and abundance of marine debris and to determine people's awareness of marine debris. Pantai Redang, Sekichan, Selangor, and Pantai Senok, Kelantan, were chosen. Samples were taken in 2018. The study is divided into two principal types of assessment which are coastal litter assessment and through questionnaires. At Pantai Redang and Pantai Senok, 1086 and 1429 marine debris of diverse forms were gathered. On both beaches, HDPE is the most common macrodebris. Both receive less than 1 debris unit per m^2. In addition, Pantai Redang and Pantai Senok recorded at least 6 and 3 grams of debris per 1 m^2 area. The two microplastics on both beaches weighed less than 0.001 grams. Less than 9 out of 100 survey respondents intend to fully accept responsibility for marine debris. Chi-square analysis proves that there are significant differences between the factors that cause marine debris at p=0.000. Marine debris is present on both beaches due to too few litter containers and too many single-use products. In conclusion, the increasing volume of marine garbage is frightening and requires action to prevent marine ecological degradation.

Key words: Abundance, HDPE, Marine debris

INTRODUCTION

Marine debris is defined as any persistent solid material that is manufactured or processed, then disposed of or abandoned in the marine environment. Marine debris, particularly items made of persistent synthetic materials, is now recognized as a major marine pollution (NOAA, 2023; Strand et al., 2015). It becomes worse when this large debris, macrodebris, eventually breaks into smaller particles, classified as microdebris when their size is less or equal to 5 mm. The sources of marine pollution are from land; their origins may be local or distant; and the environmental consequences are many and varied. Marine debris is very difficult to control because of its diverse origins (Chitaka et al., 2023; Duhec et al., 2015). There is an abundance of marine debris that comes from terrestrial sources, such as street litter, runoff from storm drains, landfills, solid waste, and sewer overflows (Andrades et al., 2016). In Malaysia, marine debris, including microplastics from Redang Beach, Sekichan, Selangor, and Senok Beach, Kelantan, is still not documented. Insufficient information on the source, movement, and effects of marine debris on marine ecosystems causes difficulties for development of effective approaches to addressing the problem. Realizing the relationship between beach cleanliness and beach users, a marine debris study is crucial to providing more scientific data on the abundance and composition of marine debris, especially on Malaysia beaches. Therefore, the aim of this

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study is to identify the types and abundance of marine macrodebris and microdebris along the coast of Redang Beach and Senok Beach and to determine the awareness of marine debris among the communities at both selected beaches.

METHODOLOGY

The study is divided into two principal types of assessment. The first one is a coastal litter assessment survey with debris classification and registration on the survey sheets. The second part is collecting data through questionnaires. The questionnaires are distributed randomly among 100 people (n = 100) at each beach.

Setup Quadrat and Date Selection

In quadrat setup, it was divided into three main components, which are site survey, measuring area, and quadrat setup. A site survey must be conducted to get an overall and actual picture of the study area before actual data sampling is carried out. The GPS application is used to obtain the distance and location of the study area. The study area is 100 meters long, and the width is 28 meters, which indicates the first vegetative plant from the edge of the beach. Thus, the area studied is 2800 m2. The sampling activity was carried out in July and August of 2018. The samples are collected twice per month, with four samplings. Debris collection was done two times during the spring tide and two times during the neap tide.

Macrodebris Sampling

There are several steps to macrodebris sampling: identify the type of macrodebris sample, record the weight, count the number and determine the volume. The samples were collected during the day, around 8 a.m. until 1 p.m. The marine debris is collected and then let air dry for a while. Macrodebris that have been collected are segregated based on categories. The categories of macrodebris are identified, such as paper, food waste, plastic, wood, and other organic and inorganic waste. Each category has been weighed, the number has been counted, and both data will be recorded. Next, the volume of the macrodebris was recorded by following several steps. Macrodebris was placed in the bucket that was scaled accordingly as per liter volume. The macrodebris is then added to the bucket, and the volume filled up by the debris is recorded.

Microdebris Sampling

Microdebris sampling is only focused on plastic categories. There are several steps to sampling microdebris. The 10 points are designed randomly in the 100-meter quadrat area. After the points were marked, the beach soil was collected by using a PVC pipe with a one-foot depth and six cm in diameter. Beach soils that have been collected are then placed on the sieve. Samples are sieved by using a sieve with 1 cm of pore size, followed by a sieve with 0.5 cm of pore size. The microplastic that stuck on the last sieve was collected by using the tweezer. The characteristic of microplastic is its shiny, colored, weird shape, and slippery surface. The mass was measured using the electronic pocket scales (MN-pocket series) with an accuracy of 0.01–500 g.

Meteorology Data Collection

The data regarding the wave height, speed, wind direction, and sea surface temperature of Pantai Redang area and Pantai Senok during the whole two-month sampling period were collected from Malaysian Meteorological Department, Malaysia (Ship Observation). This data is used to deduce the direction that contributes to the transport of marine debris.

Questionnaire

The main purpose of the survey was to evaluate the knowledge of people in both beach communities about littering and their beliefs about whether their actions have an impact on the marine environment. Surveys maintained respondents' confidentiality, took approximately 10–15 minutes to complete, and were divided into four sections: demographics, awareness, behavior, and perception. The questionnaire used where simplified form of standard questionnaire developed by Marine Litter in European Seas - Social Awareness and Co-Responsibility (MARLISCO). A total of 100 complete questionnaires were collected in both beaches, the respondents in this sample are representative of the total population of beach users.

Data Analysis

Data have been analyzed to examine the differences in debris composition and abundance (weight and count) with regards to research hypotheses. These analyses were conducted using Microsoft Excel. While Chi-square ($\chi 2$) tests of independence were used to analyze the survey data using SPSS.

RESULTS AND DISCUSSION

Macrodebris Composition

The following results show the percentage based on the number of items and the type of litter composition as a total of four samplings. It helps to create a better understanding of the current situation and see macrodebris distributions all along the study area of the coast. The total amount of marine debris that has been collected is 1086 items at Pantai Redang and 1429 items at Senok Beach, comprising various types of debris gathered from the studied plots at each location. Each category differs in form, composition, and physical characteristics. Figure 1 displays the variety of debris as a percentage that can be found along both beaches. The three most typical categories that are found in Redang Beach are HDPE (25.60%), organic waste (16.21%), and cigarette butt (8.93%). Whereas Senok Beach demonstrated that HDPE (32.00%), cigarettes butt (10.8%), and fishing line (10.28%) outreach other marine debris categories.

The most typical categories that are found in both areas are HDPE and cigarette butt. Due to its durability, HDPE has been used as the main material in making plastic-based products. This category of plastic is required for the widest range of purposes in household use; for example, it consists of soft drink bottles, toys, shampoo and mouth wash bottles, detergent bottles, and buckets. Plastic is always a serious issue in marine litter, not only in Redang Beach and Senok Beach, but other states also mention the same problems (Thushari & Senevirathna, 2020; Zhukov, 2017).

Redang Beach displays the present of plastic bags (5.34%), and polystyrene (3.00%). Whereas Senok Beach demonstrated that plastic bag (10.00%), and polystyrene (0.00%). Another socioeconomic activity among the locals is selling food from street stalls or hawkers. Many small hawkers sell fast food, snacks, and drinks. Plastic bags used as food packaging will be left on the sand, becoming one of the major debris in the study area. A recent study said that tourists who carry their own food in plastic bags or polystyrene boxes will leave the waste after finishing consuming the food (Thomas et al., 2016).

Cigarette butt is an item that should not be taken insensitively because, even though it is small, it is also hard to degrade. Cigarette butt can have a negative impact on marine life if accidentally swallowed, which can cause death. Principally, this debris comes from the visitors that have been visiting both beaches for relaxation and left the waste behind, which led to the accumulation of cigarette butts. Tobacco product waste has also become a serious problem along Thailand's coastline because of the tourism activity (Kungskulniti et al., 2018).

Next, Redang Beach is also being polluted by organic waste, which consists of 16.21%. Major organic waste is fruit debris, such as the skin and seed of durian, rambutan, and mangosteen. Basically, this type of debris comes from tourism or people who come for leisure at a study site and leave the waste at the beach. Besides, the seasonality of local fruit also led to a large amount of organic waste. Other than that, garden leftovers, also included in organic characteristics, come from the garden near the coastal area, such as coconut, banana, and palm leaf leftovers; however, they represent 3.87% of the total percentage. If the present organic waste and garden leftovers are combined, it will account for 20.08% of the total organic substance in this sampling survey analysis. This is because the sociocultural culture around Pantai Redang contributes massive organic substances to the studied area. There are many agricultures that surround the studied area, which mainly focus on oil palm plantations. Organic substances are not classified as pollutants for marine life because they are easily biodegradable in a short period of time.

Activities around the study are believed to correlate with the production of waste. Manufactured wood was also found on both beaches. On the other hand, Senok Beach is also polluted by bricks. These two pieces of debris may come from the construction site near the study location or from a fishing boat. It is predicted that these materials from those to the activity site are accidentally left or relocated from other factors, such as losses during transportation of the materials. One of the activities at Redang Beach and Senok Beach is fishing. Fishing activity around is high due to the socioeconomic activity of the locals, who are mainly fishermen. At Senok Beach, there are 2 categories of debris listed under fishing activity, which are fishing line (12%) and fishing net (2.09%), whereas Redang Beach is contaminated by fishing net up to 0.37%. This debris shows that fishing activity has a big impact on the environment. Any animals will be entangled and die if trapped in the fishing line and fishing net. The fishing net has a lower percentage than the fishing line because the fishing net is used in water, and the fisherman who uses the fishing net will stay on the water, thus the probability for this debris to drift to the shoreline is low compared to the fishing line that is extensively used by the fishermen on the shoreline. Eventually, the fishing line has a higher percentage than

the fishing net.

Residual hazardous materials consist of light bulbs, lighters, and electric wire. However, it is lighter, leading in terms of the number of hazardous items. A lighter contains pressurized, flammable gas that can potentially explode. Besides that, a light bulb is also classified as a hazardous object because it contains argon and a small amount of mercury vapor inside the compact fluorescent light bulb (Johnson et al., 2008). Anyhow, light bulbs and electric wires are only found in small numbers, yet they can have a negative effect on our marine ecosystem as well as our terrestrial ecosystem. Thus, even though that category is found about 4.70% and only in Redang Beach, if prevention is not taken seriously, it will contribute to a high negative impact. Tetrapaks are packaging products made from a combination of stiff paper, low-density polyethylene (LDPE), and aluminum foil (Al), which are usually used for the storage of perishable food products such as juice and dairy (Zawadiak et al., 2017). The tetrapaks categories in this survey were within reach: 5.25% in Redang Beach and 5% in Senok Beach. Tetrapak is also one of the most widely used packaging materials in our daily lives, but not as frequently as plastic. Rubber is the least counted item from Redang Beach, which is only 0.64%. The rubber that has been found is a tire. Even rubber is the least common item; however, the rubber that has been found is large and heavy. Basically, every type of macrodebris has a bad effect on the environment, especially the marine ecosystem. extensive citations and discussion of published literature

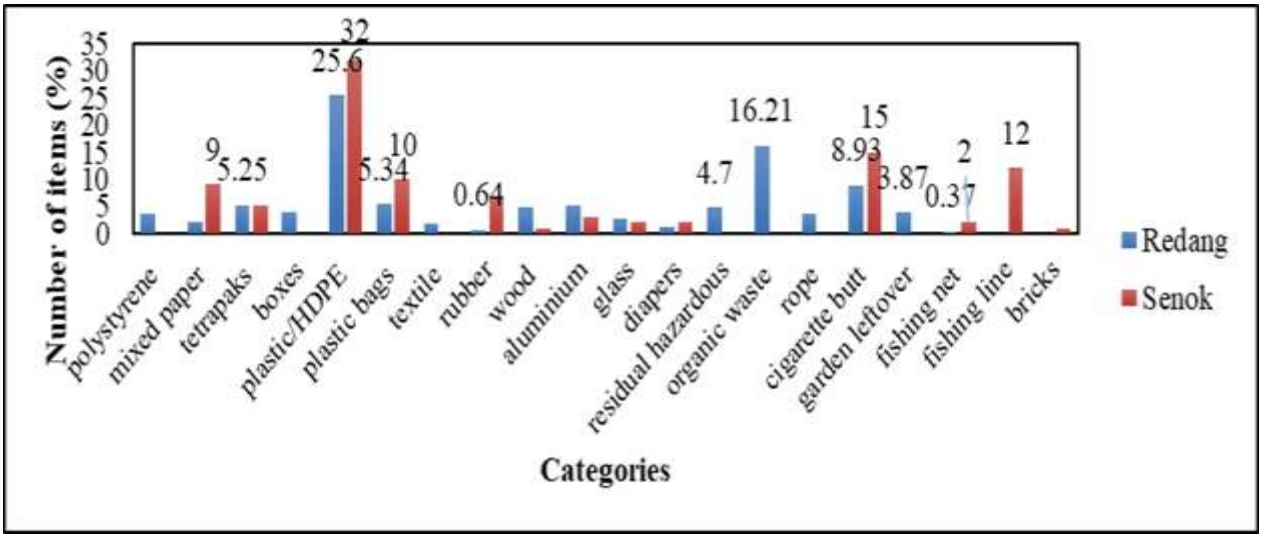

Figure 1. Percentage of the macrodebris collected at the study area during sampling time.

Macrodebris Abundance

Quantitative data in this research was presented using two different units: the first is the number of items per area (item/m^2), and the second is the weight per area. During the research, a variety of different debris items were found. Tables 1 and 2 show the amount of macrodebris found on Redang Beach and Senok Beach based on sampling dates, respectively. In total, the amount of macrodebris found on Redang Beach was 0.10025 items/m^2, meaning that less than one item will be seen in an area of one meter square and weigh 5.79060 g/m^2, which refers to the weight of macrodebris in one meter square of area. Meanwhile, the total debris from Senok Beach is 0.11878 items/m^2,

weighing 0.01955 g/m^2. The result shows that both beaches face deterioration in their cleanliness quality but are still in better condition as compared with other beaches in Malaysia, such as Kosuhoi Beach and Tg. Aru Beach in Sabah, which has been polluted since 2012 (Julyus-Melvin et al., 2017). To date, a lot more beaches all over the world have been heavily polluted by human activities (Fauziah et al., 2021).

At Redang Beach, plastic, or high-density polyethylene (HDPE), had the highest number of items recorded every sampling time, which contributed to the highest mean of 0.02475 items per m^2. The abundance differs when compared with weight; plastic or HDPE weighs less than rubber, wood, glass, organic waste, and garden leftovers, which weigh only 0.3000 g/m^2. Rubber was found to be abundant in Pantai Redang in terms of density (0.5965 g/m^2), which can be read as its heavy weight. Senok Beach also displays HDPE with a value of 0.02348 items per m^2, making it the most abundant among other debris. In terms of weight, the result is different. In comparison, the debris weight in Pantai Senok bricks has the highest abundance (0.7961 g/m^2), which leads to the highest means compared to the HDPE in terms of weight. A single brick weighs about 1-2 kg. The highest abundance of bricks is due to their high weight but low number.

Redang Beach as in comparison to the other sampling dates, the third sampling had the highest total number of items with 0.1440 item/m^2, followed by the second sampling with 0.1018 items/m^2, the first sampling with 0.0984 items/m^2, and the fourth sampling with 0.0568 item/m^2. The reason the third sampling had a higher number of items is related to the fact that the speed of wind on that sampling date was high compared to other dates based on meteorological data, which showed about 17 knots. Using the wind direction between the two locations calculated using tools at https://www.igismap.com/map-tool/bearing-angle retrieve on December 10, 2018. It indicates that the wind blows to the beach on the 3 dates of sampling, which are 14 July 2018 (first sampling), 14 August 2018 (third sampling), and 28 August 2018 (fourth sampling), whereas on 28 July 2018 (second sampling), the wind blows from land to sea. The high speed of wind can cause an increase in macrodebris abundance, especially in samples that are easy to move, such as plastic bags and HDPE. In terms of waste density, the second sampling dominated the weight recorded at 7.8410 g/m^2, followed by the third sampling at 7.0790 g/m^2, the first sampling at 4.4440 g/m^2, and the fourth sampling at 3.7984 g/m^2. For Senok Beach, the highest number of items collected were found on the second sampling (0.28760 item/m^2), followed by the fourth sampling (0.09082 item/m^2), the third sampling (0.05090 item/m^2), and the first sampling (0.04578 item/m^2). The lowest number of wastes on the first sampling day is caused by several factors, such as the beach cleaning by the locals on the first sampling day. The second sampling day has the highest number of wastes, which is caused by the previous gathering event from the visitor that led to the high accumulation of waste at the sampling area. This situation often leads to beach litter because the differences in people's perspectives will lead to different behaviors (Kruglanski et al., 2018). The fate and transport of marine debris are discovered by poorly understood geophysical processes, such as ocean mixing within the surface boundary layer and vertically distributed due to wind-driven mixing (Sumich & Pinkard-Meier, 2016; Kukulka et al., 2012). However, it is undeniable that marine debris is from human activities on land.

Table 1. Composition of macrodebris collected at Redang Beach: (A) Abundance, number of items per area; (B) Density, weight of items per area.

	A. Number of items (item/m²)					**B.** Density (g/m²)				
	1st Sampling	**2nd Sampling**	**3rd Sampling**	**4th Sampling**	**Mean**	**1st Sampling**	**2nd Sampling**	**3rd Sampling**	**4th Sampling**	**Mean**
Mixed paper	0.0040	0.0040	0.0000	0.0010	**0.00225**	0.1790	0.0040	0.0000	0.0020	**0.04625**
Tetrapaks	0.0030	0.0090	0.0070	0.0010	**0.00500**	0.0010	0.0010	0.0001	0.0004	**0.00085**
Boxes	0.0000	0.0080	0.0060	0.0010	**0.00375**	0.0000	0.0410	0.1460	0.0050	**0.04800**
Plastic/HDPE	0.0360	0.0190	0.0260	0.0180	**0.02475**	0.2960	0.1540	0.5360	0.2140	**0.30000**
Plastic bags	0.0030	0.0030	0.0200	0.0060	**0.00800**	0.0030	0.0020	0.1070	0.0180	**0.03250**
Polystyrene	0.0030	0.0050	0.0060	0.0004	**0.00360**	0.0080	0.0090	0.0430	0.0040	**0.01600**
Textile	0.0010	0.0020	0.0010	0.0020	**0.00150**	0.0210	0.2500	0.1250	0.1430	**0.13475**
Rubber	0.0004	0.0007	0.0000	0.0010	**0.00053**	2.1430	0.0180	0.0000	0.2250	**0.59650**
Wood	0.0020	0.0070	0.0080	0.0030	**0.00500**	0.7140	4.5710	1.2860	1.0710	**1.91050**
Glass	0.0020	0.0080	0.0090	0.0010	**0.00500**	0.2670	1.2860	1.5000	0.4460	**0.87475**
Aluminium	0.0030	0.0020	0.0050	0.0010	**0.00275**	0.0380	0.0980	0.0300	0.0040	**0.04250**
Diapers	0.0000	0.0010	0.0030	0.0004	**0.00110**	0.0000	0.1500	0.5710	0.0710	**0.19800**
Residual Hazardous	0.0040	0.0050	0.0050	0.0040	**0.00450**	0.1070	0.1140	0.0930	0.2250	**0.13475**
Organic waste	0.0180	0.0160	0.0250	0.0050	**0.01600**	0.1610	0.1430	1.0000	0.2640	**0.39200**
Rope	0.0060	0.0007	0.0040	0.0030	**0.00343**	0.4930	0.0640	0.0250	0.5640	**0.28650**
Cigarette butt	0.0130	0.0070	0.0090	0.0060	**0.00875**	0.0130	0.0070	0.0090	0.0060	**0.00875**
Garden leftover	0.0000	0.0040	0.0090	0.0030	**0.00400**	0.0000	0.8930	1.2860	0.5360	**0.67875**
Fishing net	0.0000	0.0004	0.0010	0.0000	**0.00035**	0.0000	0.0360	0.3210	0.0000	**0.08925**
Total	0.0984	0.1018	0.1440	0.0568	**0.10025**	4.4440	7.8410	7.0790	3.7984	**5.79060**

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Table 2. Composition of macrodebris collected at Senok Beach: (A) Abundance, number of items per area; (B) Density, weight of items per area.

	A. Number of item (items/m²)					**B.** Density (g/m²)				
	1st Sampling	**2nd Sampling**	**3rd Sampling**	**4th Sampling**	**Mean**	**1st Sampling**	**2nd Sampling**	**3rd Sampling**	**4th Sampling**	**Mean**
Mixed paper	0.00327	0.0072	0.0041	0.0106	**0.0063**	0.2118	0.1741	0.033	0.063	**0.1205**
Tetrapaks	0.00327	0.0076	0.001	0.0025	**0.0036**	0.0309	0.112	0.0216	0.0302	**0.0487**
Plastic/HDPE	0.0265	0.0321	0.013	0.0223	**0.0235**	0.3953	0.7906	0.2139	0.2279	**0.4069**
Plastic bags	0.00327	0.0083	0.005	0.0081	**0.0062**	0.0744	0.0332	0.0997	0.153	**0.0901**
Polystyrene	0.00327	0.02045	0.003	0.0088	**0.0089**	0.06976	0.2093	0.0218	0.0569	**0.0894**
Rubber	0.00327	0.0053	0.0076	0.003	**0.0048**	0.0083	0.0102	0.013	0.003	**0.0086**
Wood	0.00327	0.0009	0.0011	0.0006	**0.0015**	0.6046	0.3255	0.1955	0.1918	**0.3294**
Glass	0.00327	0.0009	0.0004	0.0027	**0.0018**	0.0434	0.1439	0.4039	0.4186	**0.2525**
Aluminium	0.00327	0	0.002	0.0074	**0.0032**	0.1441	0	0.0297	0.4186	**0.1481**
Diapers	0.00327	0	0	0.00069	**0.0010**	0.0553	0.0837	0	0.0658	**0.0512**
Cigarette butt	0.00327	0.0051	0.0055	0.0151	**0.0072**	0.0223	0.0051	0.0439	0.0069	**0.0196**
Fishing net	0.00327	0.0021	0.001	0.0021	**0.0021**	0.0053	0.0046	0.0395	0.0053	**0.0137**
Bricks	0.00327	0.0009	0.0002	0.00023	**0.0012**	1	1.231	0.3023	0.6511	**0.7961**
Fishing line	0.00327	0.0127	0.007	0.0067	**0.0074**	0.0418	0.0181	0.0213	0.0376	**0.0297**
Total	0.04578	0.2876	0.0509	0.09082	**0.11878**	**2.70726**	**3.1413**	**1.4391**	**2.3297**	**2.52925**

Microdebris

Table 3 displays microplastics being detected in the soil of Redang Beach and Senok Beach. There were only two microplastics identified during the whole sampling duration from both locations. The microdebris found is made from plastics with different shapes. From observation, microdebris are part of some plastic-made materials that have been broken apart. Microplastic origin came from two sources: introduction from runoff and weathering degradation of bigger macroplastics (Zhang et al., 2021). Since the location is exposed to direct sunlight and different weather conditions, any plastic will degrade slowly over time, thus breaking into smaller parts and being mixed with sand. A small number of debris, such as microplastics, is already present in marine and freshwater life (Harith et al., 2021; Lusher et al., 2015).

Table 3. Weight of microplastic in gram

	Weight (gram)			
	1st Sampling	**2nd Sampling**	**3rd Sampling**	**4th Sampling**
Redang Beach	-	-	< 0.01g	< 0.01g
Senok Beach	none	0.12g	<0.001g	none

Community Awareness

Forty-five people out of 100 respondents in each location said that they visit the beach once a month. From this data, the rate of community visits to this area is high, and this is closely related to the pollution of the study area since the location is in a densely populated area. This situation is like the recent study, which said that the number of visitors is one of the factors that control the amount of litter on the beach (Ormaza-Gonzaìlez et al., 2021; Grelaud & Ziveri, 2020).

Figure 2 shows the frequency with which respondents see litter or witness people littering. Most respondents always saw litter on both beaches. Seventy-one out of 100 individuals said always, followed by 25 individual reports sometimes, and only 4 individual reports never saw litter when visiting Redang Beach. Senok Beach demonstrated the same trend of feedback. This indicates that both beaches are not clean, and the community of residents, tourists, and users noticed the presence of marine debris that disrupted the aesthetic view.

Besides that, most respondents admitted that they were witnessing people littering on both beaches. This frequency proved that the respondent was aware of the presence of litter and noticed that litter was disposed of by people daily. It's a reflection of how many individuals realize that they contribute to litter. Litter is a solid waste problem based on people's perceptions and actions (Brooks & Davoudi, 2017).

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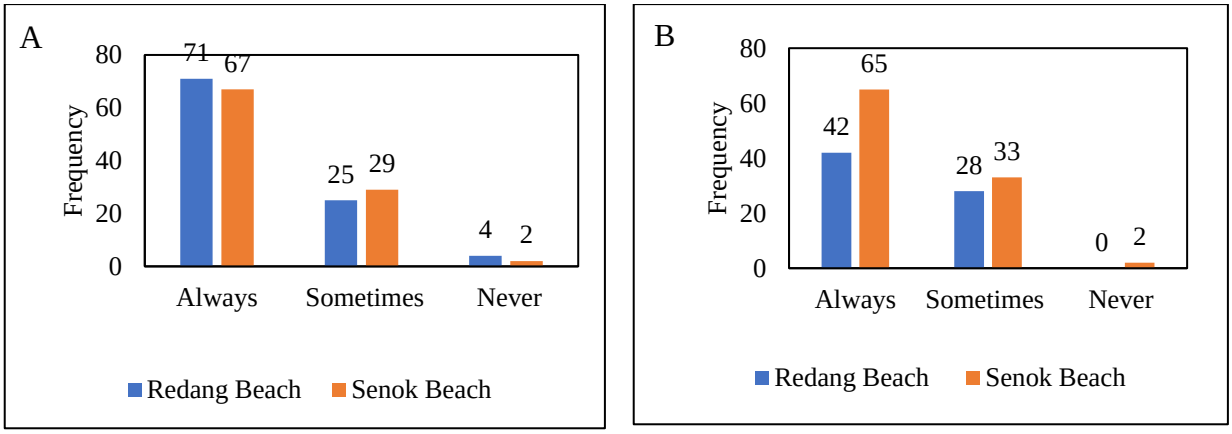

Figure 2. Frequency of the respondents: (A) Aware the presence of marine litter; (B) Respondents report witnessing people litter in daily life.

Behavioral Intention to Reduce Marine Litter

The behaviors of people related to litter are shown in Table 4. The level of awareness among people will define how they will react to the litter and ensure the beach stays clean. The majority of those interviewed in the study area feel a strong responsibility to keep the beach clean. However, some individuals admit that they just leave litter in a closed bag, either because they believe it is the beach cleaners' responsibility or because the litter is not significant enough to be a pollution issue. In the worst scenario, 11 respondents at Senok Beach are not responsible for their own waste. Among the 100 respondents, only 9 individuals (Redang) and 4 individuals (Senok) were positively aware of the importance of marine ecosystems through their behaviors of collecting other litter that they found, putting it in a bag, and then disposing of it in a dustbin.

Table 4. Respondent behaviors in terms of intention to keep the beach clean.

Questions	Frequency of respondents	
	Redang Beach	Senok Beach
A) Leave your litter on the beach. It was not so clean anyway	0	11
B) Leave your litter in closed bag.	24	15
C) Carry your litter with you until find a bin where you can dispose it.	67	70
D) Collect other litter that you find as well and put it in your bag and take it	9	4

Perception Regarding the Factors Contributing to Marine Debris

A range of descriptive methods were used to describe people's perceptions of littering. Chi-square (χ^2) tests of independence were used to analyze the survey data for H_0 (all factors equally contribute to the presence of marine debris) and H_1 (some factors are more likely to be the cause of marine debris). A 5% level of significance ($\chi^2 = 0.05$) is used. The chi-square analyses were conducted using SPSS 25. There are seven factors listed in the question survey, and respondents may choose one out of four scales of preference (1: not at all, 2: not very, 3: somewhat, 4: extremely). The factors are people's behavior in disposing of litter, lack of bins in public areas, redundant single-use products, extensive plastic material used in daily life, coastal industry activity, lack of enforcement, and losses during waste transportation. Redang

Beach demonstrates that all seven factors are significant, including people's behavior in disposing of litter, χ^2=20.240, p=0.000, lack of bin in public area, χ^2=119.120, p=0.000, redundant of single-use products, χ^2=42.480, p=0.000, extensive plastic material used in daily life, χ^2=106.640, p=0.000, coastal industry activity, χ^2=68.240, p=0.000, lack of enforcement, χ^2=86.000, p=0.000, and losses during waste transportation, χ^2=69.920, p=0.000. χ^2 = 119.120 indicates that the major contributor to waste is a lack of bins in public areas.

Senok Beach also shows that the community is aware that the factors stated in the survey contribute to marine pollution. The factors are significant: people's behaviors when disposing of litter (χ^2 = 67.280, p = 0.000), lack of bins in the public area (χ^2 = 36.560, p = 0.000), single-use nature of daily products (χ^2 = 62.960, p = 0.000), extensive use of plastics (χ^2 = 37.680, p = 0.000), coastal industry (χ^2 = 34.160, p = 0.000), and losses during waste transportation (χ^2 = 29.520, p = 0.000). Senok Beach displays that χ^2 = 67.280 indicates the major contributing factors of people's waste disposal behaviors when disposing of litter. Self-responsibility to reduce marine plastic litter varies considerably across and within countries and is among the issues that should be solved wisely (van Oosterhout et al. 2022). In general, respondents show that they are aware that the sources that contribute to marine litter are a lack of bins in public areas, extensive plastic material used in daily life, and a lack of enforcement. Besides, people's behavior, redundant use of single-used products, coastal industry activity, and losses during waste transportation also contribute to marine litter. The top three reasons people litter are insufficient availability of litter bins, laziness, and out of habit (Straughan et al. 2011).

CONCLUSION

In conclusion, both Redang Beach and Senok Beach can be classified as recreation beaches and attract many visitors for different purposes. A huge number of macrodebris were recorded at Redang Beach and Senok Beach. It contains various types of marcodebris with different abundances and density values. Both beaches were dominated by plastic and HDPE. Other categories are cigarette butt, hazardous waste, fishing line, mixed paper, rubber, tetrapaks, plastic bags, fishing nets, diapers, manufactured wood, and bricks, among others. Each of these categories alarm us because the two beaches are heavily polluted. Microplastics is also documented at both beaches, and aggressive action must be taken to stop the problem. Perception regarding the factors contributing to marine debris can lead to the conclusion that community awareness is a fundamental attitude to reduce such an environmental threat. The community should take their steps. The principal attitude to reduce marine debris is to think globally and act locally. The data obtained can be used as a baseline for future reference, particularly in improving waste management on beaches in Malaysia.

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Siti Suhaila Harith is responsible for research ideas and writing the original draft. Anas Iylia Osman and Nurul Afiqah Shamsholanwar are responsible for data collection and data analysis. Fauziah Shahul Hamid is responsible for editing and checking language and grammar.

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COMPETING INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

COMPLIANCE OF ETHICAL STANDARDS

Not applicable.

SUPPLEMENTARY MATERIAL

Not available.

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