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Introduction of Floating Vessel Breakwater System for Coastal and Tourism Sustainability using Re-Use Vessel

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ABSTRACT

Coastal erosion problem is not only happened in Malaysia water, however it becomes a worldwide issue that leads to destroying of shoreline and marine ecosystem. Therefore, the objective of this study is to propose a potential coastal protection solution based on the innovation of reused vessels due to this particular problem. A descriptive qualitative approach has been used for determining the respondents' perceptions on the impact of existing breakwater system towards the five aspects (economy, environmental, technological, operational, and safety benefits). The raw data obtained from 300 respondents have been analysed using an Average Mean Value (AMV) technique. As a finding, more than 70% of respondents described that the existing breakwater system has affecting the national coastline and coastal activities. Therefore, an innovation idea of floating vessel breakwater system is proposed for enhancing the sustainability of coastal area and tourism industry with a combination of commercial and social benefits. The contribution of this study is that an innovative model of coastal protection system incorporating with both commercial and social benefits to ensure the coastal and tourism sustainability. Also, a variety of benefits can be offered to the local community such as job opportunities and encourage them to do businesses on the developed facilities.

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1. Introduction

Coastal erosion problem in Malaysia water becomes worse due to the big wave phenomenon and the shoreline changes that are taking place over a range of time scales. They may occur in response to smaller-scale (short-term) events, such as storms, regular wave action, tides and winds, or in response to large-scale (long-term) events such as glaciation or orogeny cycles that may significantly alter the sea levels (rise/fall) and tectonic activities that cause coastal land subsidence or emergence. This indicates that most coastlines are naturally dynamic and cycles of erosion are often an important feature of their ecological character. Wind, waves and currents, for instances are natural forces that easily move the unconsolidated sand and soils in the coastal area, resulting in rapid changes in the position of the shoreline (Prasetya, 2006; Braatz et al., 2007). As a result, the loss of property, people, financial and facilities are happened. Due to the phenomenon, an effective solution of coastal protection is needed to protect homes, natural habitats, local economic and social activities along the coastlines from being damaged and destroyed by the coastal erosion or flooding (Li, 2014).

Over the years, many types of coastal protection techniques were introduced and used in order to reduce or overcome the impacts of the coastal erosion. Such methods were in the forms of hard and soft coastal engineering (Prasetya, 2006; Braatz et al., 2007; Jackson, 2012). However, when certain aspects are considered such as the installation and maintenance costs, impacts on the environment and the duration of effectiveness, then the existing erosion protection system becomes doubtful. Thus, the introduction to various types of floating breakwaters came into picture and many conclusions were made as to their effectiveness and economical functions (Farmer, 1999; Fousert, 2006; Biesheuvel, 2013). Although the systems of breakwaters have been used as a mechanism to protect the coastal areas

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from rough sea, however, it is viewed that to date there are no existing breakwater systems that have the potential not only to provide an environmental and economic but also the culture elements that offer benefits to the investors and societal wellbeing. Given that the unconventional system of the breakwater is less applicability, therefore a better recommendation should be provided in order to improvise the functions and applicability of the floating breakwater system, in particular from the ships' structures by addressing the green technology and 3R concept (reduce, reuse, recycle) along with social and commercial benefits.

2. Literature Review.

The use of breakwater technology continues to be the main option in order to control and reduce the impacts of erosion at the coastal areas. Breakwaters represent the structures that constructed in water or along the shoreline with intention to protect the area against the impacts of waves. Depending on the type of breakwater, each breakwater has their own functions and ability to reduce the wave actions such as wave reflection, wave run-up, wave transmission, overtopping and diffraction (Biesheuvel, 2013).

A variety of breakwater types developed with their own structural features. According to the literature, the breakwaters used to be categorised into three main categories, which were the hard structural breakwaters, the soft structural breakwaters, and the combination of both of the breakwater systems (Mangor, 2008). Hard structural breakwaters were the options that use hard structures constructed on the beach such as seawalls, groynes, breakwaters/artificial headlands or offshore breakwaters, and these options influence coastal processes to stop or reduce the rate of coastal erosion but these options commonly expensive and spoiled the nature of the beaches or coastlines. Meanwhile, the soft structural breakwaters introduced were the options that aimed to dissipate the wave energy by mirroring natural forces and maintaining the natural topography of the coast. These options represent the processes of nourishments/feeding, dune building, revegetation or other non-structural management options which basically took longer time to become effective (Mangor, 2008). Despites, at one time, the combination of both of the hard and soft structures were chosen and though to be necessary to improve the efficiency of the options and provide an environmentally and economically acceptable coastal protection system. Yet no existing breakwater systems that have the potential to provide an environmental and economic benefits to the investors and societal wellbeing. This is the gap to be filled in this study by introducing an innovation concept to the existing breakwater technology.

Other than that, the existing breakwaters systems were also distinct in terms of conventional and unconventional types of breakwaters. The conventional types of breakwaters were classified as the breakwaters that mostly been used all around the world and a lot of researches have been conducted on its features and applicability. This type of breakwater basically works by reflecting the incoming wave and is mounted on the bottom. Examples of conventional-type breakwaters are the mound types, monolithic types and composite types (Fousert, 2006; Biesheuvel, 2013). Meanwhile, unconventional-type breakwaters are classified as special type of breakwaters as they are often only suitable in special cases. However, this type of breakwater appeared to be uneconomical and less applicable due to the high cost of development and maintenance, and also high structural strength of the breakwater elements was required. Examples of the breakwaters that considered being unconventional are floating breakwater, pneumatic or hydraulic breakwaters and pile breakwaters (Verhagen et al., 2009; Biesheuvel, 2013).

In this study, the technology of floating breakwater is to be improvised in forms of its applicability, structural and economical wise. Floating breakwaters are classified as a special type of breakwater system that was applied at particular locations where conventional breakwaters are not suitable to apply (Verhagen et al., 2009). Floating breakwaters have found extensive application in many areas as they were relatively less expensive protection system to endure the wind- and ship-generated waves, and where open water wave conditions are not unduly severe and water depths are relatively large. The cost of existing bottom-founded breakwaters increases significantly with water depth, so that a floating breakwater is a relatively attractive option in deeper water (Isaacson and Byres, 1988; Verhagen et al., 2009).

The layout of the location to construct a breakwater using the floating structure can easily be changed and can be incorporated with other functions such as be used as walkways. From an economical point of view, it is often cheaper to apply a floating breakwater in deep waters instead of a conventional breakwater (Elchahal et al., 2008). Floating breakwater is divided into four basic categories such as box, pontoon, mat, and tethered float (McCartney, 1985; Farmer, 1999; Ruol, 2013). Description for each category is shown in Table 1.

Undeniable, breakwater system is the technique that applicable in most of the places as it's functioned to work immediately in attenuating waves. However, the applicability of the existing breakwater systems somehow still questioned regarding of its effectiveness to become a good coastal protection solution as several considerations should be taken into account such as the costs (construction and maintenance), impacts on environment, economic and effectiveness in long-term application (Farmer, 1999; Prasetya, 2006; Roul, 2013; Biesheuvel, 2013). The previous applications of the floating breakwater systems in British Columbia corresponding to location are shown in Table 2.

It should be pointed out that as a starting point in the impact identification, the information about the stock taking of the physical and social means is relevant. These stocks are general ones, that is, they derive from taking on account those components of the physical environment and the areas in the social media susceptible to be affected in the case a hydrocarbon spillage happens in a specific coastal area. The environmental spill is assessed with the Leopold Matrixes and this inventory.

Due to less of applicability on this unconventional system of the previous researches, this study intends to provide recommendation in order to improvise the functions and applicability of the floating breakwater system, basically from the ships'

Table 1: Categories of Floating Breakwaters.

	Category	Description of floating breakwaters	Advantages	Disadvantages	Sources
1.	**Box breakwaters**	• Mostly reinforced concrete, rectangular-shaped modules that may be flexibly or rigidly connected to other modules to make a larger breakwater. • Frequently constructed of steel or built with used barges, ballasted to the desired draft with sand or rock. • The modular system as applied and the mooring system are primary points of concern for this kind of structures • Examples of box type breakwaters include solid rectangle, ship and barge.	• The connections of the structure can be either flexible, allowing preferably only the roll along the breakwater axis, or pre or post tensioned, to make them act as a single unit. • the efficiency is higher • Promotes recreational functions and temporary boat moorage.	• The forces between modules are also higher • More expensive than mat types and require higher maintenance.	Farmer, 1999; Ruol, 2013.
2.	**Pontoon breakwaters**	• Include several different models, such as the ladder type, catamaran type, sloping-float (inclined pontoon), and a frame type. • Attention must be paid to the Length/Width parameter, to control deformation	• They are effective since the overall width can be of the order of half the wavelength • The prismatic structures are ideal for other uses such as floating walkways, storage, boat moorings, and fishing piers • Less expensive than box types and have similar advantages to the box type.	• Have similar disadvantages as the box type.	Hales, 1981; McCartney, 1985; Farmer, 1999; Ruol, 2013.
3.	**Mat breakwaters**	• The most mat breakwaters used are made with tires. • It is a way of dealing with the ever-increasing number of old tires which is to bind a group of them together to create a floating breakwater. There are three basic designs for tire mat breakwaters; these are known as Wave Maze, Goodyear, and Wave-Guard	• Made use of old tires • Low cost, • Can be removed more easily, • Can be constructed with unskilled labour and minimal equipment, • Lower anchor loads, • Reflect less and dissipate relatively more wave energy. • Simple design and construction, • More portability, • Greater effectiveness than box and pontoon types	• They are less effective • Lack of buoyancy, • 15-20 year design life, • Do not effectively damp long wave lengths, • Cannot be moored year round because of icing effects, and • Can break apart if not constructed adequately and would create floating debris.	Hales, 1981 DeYoung, 1978; McCartney, 1985.
4.	**Tethered float**	• A breakwater that consists of a submerged pontoon which is anchored with cables to the seabed and particularly attached with a large number of floats on the pontoon. The floats are at or just below the water level surface. • Tethered float types are seldom used. • Unlike the other types of breakwaters, which use their mass to attenuate waves, the tethered floating breakwater uses its mooring system to dissipate wave energy. • This is accomplished by restricting the motions of the breakwater by use of a mooring system. • Waves move the breakwater around until the mooring system restricts its motion; then wave energy is transferred to the anchors and ultimately the sea floor, dissipating the wave height. • This type of breakwater is still under investigation and there is not a significant amount of information on these moored breakwaters to make any conclusive remarks.	• The floats provide wave attenuating effect that result in wave energy losses as due to the fluctuating pressure gradient. • The floats cause high relative flow velocities which results in large friction, hence large energy dissipation. • The surface of the structure is much wider. • Efficiency to reduce the wave action is higher.	• The draft is quite smaller. • Greater risk of damages as interconnection between adjacent modules and mooring system are primary points of concern for this kind of structures. • Lacked sufficient prototype experience for detailed analysis. • The basic costs (without mooring system) are more costly than pole-tire mat-typed breakwaters.	Harms, 1980; Hales, 1981; PIANC, 1994; Biesheuvel, 2013; Ruol, 2013

Source: Authors.

Table 2: Applications of the floating breakwater systems in British Columbia.

No.	Location	Type	Year
1.	Richmond	Caisson	1979
2.	Port Moody	Log Bundle	1976
3.	Deep Cove	Caisson	
4.	BurrardYC	Caisson /barge	1977
5.	BurrardYC (Destroyed 1983)	Scrap tire	
6.	Eagle Harbour	Pontoon / tire	
7.	Horseshoe Bay	Caisson / ship	
8.	Powell River	Ship Hull	1930+
9.	Lund	Caisson	1987
10.	Lund (removed 1987)	A-frame	1963
11.	Brown Bay	Tank Car	1983
12.	Fanny Bay	Log Bundle	
13.	Deep Bay	Log Bundle	
14.	Ford Cove	Log Raft	
15.	Northwest Bay (destroyed 1980)	Log / Styrofoam	1975
16.	Nanaimo	Caisson	1974
17.	Pt Browning	Log	
18.	Bedwell Hbr	Log	
19.	Maple Bay	Caisson	1977
20.	Victoria Hbr	Caisson	
21.	Esquimault	Caisson	
22.	Becher Bay	Log	
23.	Sooke Basin	Log	
24.	Prince Rupert	Log	
25.	Prince Rupert	Log	
26.	Qn Charlotte City	Log	
27.	Qn Charlotte City	A-frame	1967
28.	Kelowna	Log Bundle	1978
29.	Nakusp	Caisson	1986
30.	Tahsis	Log	

Source: Isaacson and Byres, 1988.

structures, by addressing the green technology and 3R concept (reduce, reuse, recycle) along with social and commercial benefits.

2.1. Overview of the coastal problem in Malaysia.

Coastlines are important to the national economic of Malaysia in particular for the tourism industry and other related businesses opportunities. However, in recent years it is viewed that some of these coastlines are adversely affected by the erosions, in particular the peninsular of Malaysia. It is understood that the erosions of coastlines in Malaysia are driven by natural and manmade factors. Of the factors, Olaniyi et al., (2012) claim that the climate change is the crucial driver that contribute to the coastal erosion in Malaysia. It has resulted in the deterioration of the quality of the beaches on the sandy coasts and the loss of its valuable land. The consequences of coastal erosion are severe in Malaysia as much of the economic and social life of Malaysians depend on activities at the coastal areas (Asmawi and Ibrahim, 2013; Jaafar, et al., 2016; Hassan and Rahmat, 2016). Many of these activities are served by facilities that have either been damaged or will be damaged in the nearer future. The affected activities are including agricultural community life, recreation, transportation and tourism (Lee and Douglas, 2012; Hassan and Rahmat, 2016). Some of the coastal areas in Malaysia that were affected by the erosion includes Terengganu (Lee and Douglas, 2012, Li, 2014), Kelantan (Jaafar et al., 2016), Selangor (Asmawi and Ibrahim, 2013; Rajendra, 2016), Pahang (Azid et al., 2015), Johor (Awang et al., 2014), Melaka, Negeri Sembilan, Perak, Pulau Pinang, Kedah dan Perlis (Lee and Douglas, 2012).

Terengganu, for instance, is the longest shoreline in Malaysia and was threatened by coastal erosion problem due to adverse wave actions. Besut, Dungun, Chendering, Kuala Terengganu and Kuala Nerus are among the districts that are significantly affected of its coastlines in which indicate the rapid changes of the shoreline position (Li, 2014; Bernama, 2016a; Bernama, 2016b; Zakaria, 2016). A report from the Department of Irrigation and Drainage (DID) indicates that almost 62% of the 244km state's coastline is currently wearing away, plus, 20km from Kuala Terengganu town, is also being gnawed away by the sea (Li, 2014). These areas had been significantly affected by high and strong wave actions every year especially in monsoon. Many families had to be evacuated from the areas as their homes or shelters were threatened by the severe shore erosions (David, 2016).

DID engineer, Salmiah Abdul Rahman, predicts that these areas of erosion within a rate of 11 meters annually may left nothing if there is no effective and proactive action taken. While the state is prone to face the erosion issue due to strong waves during the monsoon, any coastal development projects and various man-made structures along the coastlines can worsen the situation (Li, 2014).

In 2014, about 4.2km of coastline at Tok Jembal (between the Sultan Mahmud Airport and Mengabang Gelam) is seriously affected as the sea has engulfed 80m of the beach and it has been classified under Category 1 which indicates the most serious level, as at stake are village houses, local shops and a cemetery (Li, 2014) (Figure 1, 2 and 3). The amount of losses is predicted to be more than the amount indicated as it was not included the losses of local facilities around the area that also been damaged such as roads, chalets, village houses and local shops (Sinar Online, 2015).

Due to the events, the Malaysian government has allocated an amount of 120 million in total through the Terengganu state's government and Work Department Malaysia in order to overcome the erosion problem in Terengganu and to recover the losses due to the erosion. The budget allocated is to be used in order to build the systematic breakwater system at the affected areas and to repair or rebuild the damaged facilities (UMNO Online, 2016). Along with worldwide climatic changes, the incidences of shoreline erosion are significantly increased (Hassan and Rahmat, 2016) and effective control measures are crucial to protect these shorelines.

Generally, coastal structures were developed to tackle the erosion problems at most of the eroded places. Despite of the main function of the structure was to tackle the erosion problem; however, the existing coastal structures did not promote the sustainable tourism at the area of developments, thus caused significant impacts to adjacent shorelines, especially when these shorelines are composed of sand. Due to improper planning prior to the design and construction of the structures, these shoreline impacts have not been often expected and consequently, resulted excessive erosion and/or deposition of sediment which is costly to repair, and in some cases, need continuous maintenance operations (Noble, 1978). Besides, improper planning of the breakwater structure could also give negative impact on landscape values which can create barriers to recreational use of the beach. This because they may not function as intended and diminishes the tourism attraction places. The beach areas with the artificial breakwaters could be both unpleasant and unsafe where may lead to the occurrence of unforeseen negative cases (CLIMATE-ADAPT, 2015).

This phenomenon has directly affected the tourism sustainability together with the decrement of local economy at this particular area. In addition, this disaster has given negative impacts to the local community, travellers, cultural heritage and also the environment at the same time (UNESCO, 2010). Therefore, this study highlights the objective of proposing an innovative idea in enhancing the tourism sustainability industry through the development of floating vessel breakwater system.

3. Methodology.

In this study, a descriptive qualitative research method is used to gain information and users' perception regarding the existing breakwater system (Abdul Rahman et al., 2016). In total, there are of about 300 respondents that covering three different groups, 1) business decision-makers, 2) academic members, and 3) local community. There are several steps involved in this study which shown as follows:

3.1. Identify research problem.

After thoroughly reviewing the literatures this study managed to identify the main problem that has caused the coastal

Figure 1: Destroyed existing breakwaters and facilities near to the beach.

Source: Authors.

Figure 2: Destroyed houses and roads near to the beach.

Source: Authors.

Figure 3: Destroyed stalls and houses near to the beach.

Source: Authors.

erosion. Such main problem is due to the impact of wave action which is the biggest factoring that affecting the rate of coastal erosion (Jackson, 2012). The impacts are not only seen in form of coastal erosion but also on the aspects of community, development and facilities at the affected areas which have incurred huge losses and the state's authority needs to spend a huge amount of money to recover the facilities and development around the areas along with restructuring the shorelines in which also bring adverse impacts on environment and social activities.

3.2. Determine research goal.

The aim of this study is to introduce an innovative and dynamic coastal protection solution based on the use of used vessels that incorporating with the concept of green technology and 3R concept which also focus on commercial and social benefits that can contribute to the coastal and tourism sustainability.

3.3. Data collection process.

The quantitative approach was conducted by assistance from the relevant respondents, comprising of 80 business decision-makers, 20 academic members from a higher education institution and 200 people from the local community who are related to the area of the case study. Their perception on the impact of coastal erosion in Malaysia is very importance as well as on the current technique used as the coastal erosion protection solution. The respondents were chosen because they know how to evaluate the subject that was investigated in this study and the effectiveness of the previous and the current system used to tackle the coastal erosion problem at their areas.

A set of closed-ended questionnaires has been used to collect the required data to measure the perception of the respondents on the issue studied. The questionnaire consists of two main sections which are Section A relates the questions on the impacts of wave actions towards the national coastlines, while, Section C associates with the questions on the impacts of existing breakwaters system towards the coastal activities. The closed-ended question was designed to measure the perception of the respondents as described in Table 3.

Tables 4 and 5 show the questions that had been asked in the survey in order to answer the impacts of wave actions towards the national coastlines and also the impacts of existing breakwaters system towards the coastal activities, respectively.

3.4. Data Analysis.

The feedback of the respondents of this study were analysed using a systematic average mean value as shown in Equation 1 and 2 (Medhi, 1992; Jacobs, 1994; Foerster 2006; Othman et al, 2017). These formulae were used in order to calculate the mean score and determine the percentage of the respondents' perceptions on the scope of study, accordingly, based on the closed-ended questions asked in Table 4 and 5.

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i$$

or

$$A = \frac{X1 + X2 + X3 + X4 + ... + Xn}{n} \tag{1}$$

A = represents the arithmetic mean;

$\sum$ = summation symbol; is the addition of a sequence of numbers; the result is their sum or total;

X = value given per subject;

n = total number of subjects involved; and

ai.= value given per subject

Sources. Medhi, 1992; Jacobs, 1994; Foerster 2006; Othman et al, 2017

According to Othman et al., (2017), the Equation (1) is further simplified to Equation (2) for better understanding of its application.

$$A = \frac{Total\ value\ given\ for\ each\ category}{Total\ number\ of\ all\ categories\ involved} \tag{2}$$

Applying the Equation 2, the rating from each respondent was totalled in accordance with the questions asked for Sections A and B, and then divided by the total number of respondents which represent the total number of respondents in their respective groups; business personnel, academician and community, in order to obtain the mean score. The mean score of the feedbacks was then converted into percentage value. The same process was used for the rest of the questions asked, in each section.

3.5. Findings.

Figure 4 illustrates the percentages of perceptions on the impact of wave actions towards the national coastlines given by the respondents to each of the question. Based on the percentage values of all the questions, the responses from the respondents showing that the wave actions contribute more negative impacts than the positive impacts as many facilities were destroyed due to coastal erosion phenomenon such as houses, roads, stalls, recreational places and etc. which near to the shoreline. A huge loss incurred by community and business personnel around the erosion areas as their homes and business places were eroded by huge waves especially during monsoon season. Based on the surveys, the negative impacts were truly affecting their source of incomes and economy, business and social activities, safety, and the surrounding environment. People at the areas of erosion will expose to hazardous conditions as the areas are the open areas with unpredictable menace especially to kids. Any activities nearby would pose a danger that could cause loss of life.

Figure 5 shows the percentages of perceptions on the impact of existing wave breakers towards the coastal activities. This study case was conducted in order to evaluate the contribution of the current breakwater system on the coastal areas' activities, such as in providing tourists' attractions, business opportunities, commercial and social benefits, and also the capability of the system in protecting the shore from any erosion problem. The feedbacks from the respondents shown that the existing waves breaking system did give impact on the activities at

Table 3: Closed-ended question used in measuring the perception of the respondents.

Answers		Justification
Yes	Positive	Response if there is any existence of positive impact.
	Negative	Response if there is any existence of negative impact.
No		Response if there is no impact at all.

Source: Authors.

Table 4: Questions used in measuring the perception of the respondents on the impact of wave actions on national coastlines (Section B).

1. Does the wave action that eroding the shoreline give impacts on source of incomes and economy?
2. Does the wave action that eroding the shoreline give impacts on business activities at the area?
3. Does the wave action that eroding the shoreline give impacts on the housing areas and community life at the area?
4. Does the wave action that eroding the shoreline give impacts on safety aspect at the area of erosion?
5. Does the wave action that eroding the shoreline give impacts on the environment and ecosystem at the area of erosion?
6. Does the wave action that eroding the shoreline give impact on the recreational and social activities at the area of erosion?

Source: Authors.

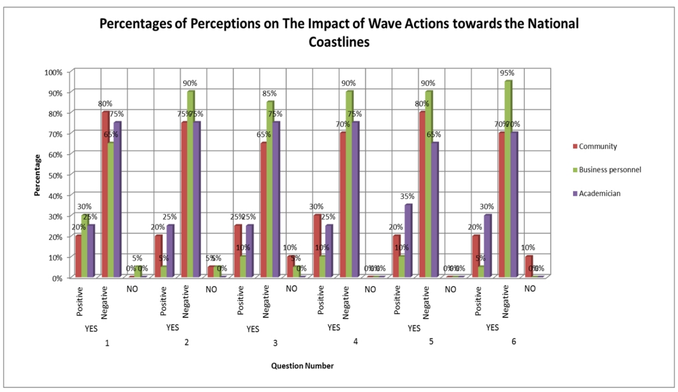
Table 5: Questions used in measuring the perceptions on the impact of existing wave breakers on coastal activities (Section C).

1.	Does the existing wave breaking system give impact on the activities at the coastal areas?
2.	Does the existing wave breaking system give impact on the business activities at the area of construction?
3.	Does the existing wave breaking system give impact in term of commercial aspect?
4.	Does the existing wave breaking system give impact towards the economic sector at the area of construction?
5.	Does the existing wave breaking system give impact in term of social aspect towards the local community?
6.	Does the existing wave breaking system give impact in term of usage of latest technological aspect?
7.	Does the existing wave breaking system give impact on the environment and ecosystem at the area of construction?
8.	Does the existing wave breaking system give impact on the aspect of attraction to the environment for tourism purpose especially at the area of construction?
9.	Does the existing wave breaking system give impact on the aspect of safety at the area of construction?
10.	Does the existing wave breaking system capable of effectively functioning and sustain for a long term period with minimal maintenance?

Source: Authors.

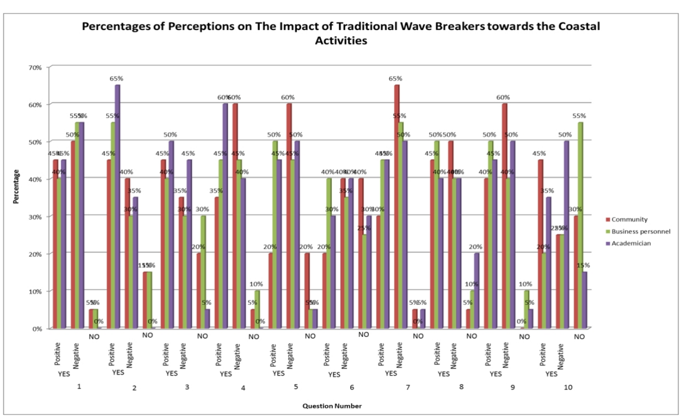
the coastal areas with more responses indicated the negative impact. Also, the existing waves breaking system were recorded to have more negative impacts toward the economic sector at the area of construction although responses recorded. Finally, it indicates that the existing waves breaking system gave more negative impacts on the social aspect toward the local community, the usage of latest technological aspect and also the environment and ecosystem at the area of construction which otherwise could liven up the atmosphere around the area of the breakwaters.

Figure 4: Percentages of perceptions on the impact of wave actions towards the national coastlines.



Source: Authors.

Figure 5: Percentages of perceptions on the impact of existing wave breakers towards the coastal activities.



Source: Authors.

However, some feedbacks from the respondents indicate that the existing waves breaking system also gave some positive impacts on the aspect of attraction to the environment for tourism purpose as the environment and condition of the eroded areas had been rebuilt and recovered if compared during the erosion was happening (refer to question number 8). Nevertheless, referring to question number 9, the safety aspect at the area of existing waves breaking system were still been concerned by the respondents as many negative impacts could happen as the areas have not received enough monitor and less visited by the public. Lastly, referring to question number 10, the existing waves breaking system were able to effectively function and sustain for a longer period with minimal maintenance yet still questionable as the feedbacks recorded were equivalent between positive impacts, negative impacts and no impacts. This may because of it is subjective as it depends on the strength of wave action at the particular areas and also the durability of the breakwater construction itself. However, based on the given feedbacks, majority of the respondents indicate that they had negative confident or no confident on the existing waves breaking system to be effectively functioning and sustaining the shoreline for a longer period of time with minimal maintenance as the erosion problem remains unresolved although huge investment had been injected to construct the breakwater system.

4. New Innovative Idea: Floating Vessel Breakwater System for Coastal and Tourism Sustainability.

Due to the huge impacts on environment and less commercialization of the existing breakwater system, therefore, this study intends to propose a new innovative idea in protecting the coastal areas from adverse erosion problem that leads to the coastal and tourism sustainability. This innovative idea is idealised based on the design of Palm Resort, Dubai where the resort construction pattern forms protection to its coastal areas (Figure 6). The idea induces an innovative concept by using the structure of the used vessels as the rampart to break the wave formation and thus, reduce coastal erosion problem. The proposed concept not only addressing the green technology concept, but also stimulate the commercial and social benefits to the area of development. The floating structure of the ship will be converted into permanent structure in which it will permanently attached to the ground by some of solid structures to ensure the strength of the whole structures in realising the coastal protection purpose.

In this study, Autodesk 3ds Max software tool has been used to develop a 3-dimension model of the coastal protection solution in order to provide proper visuals regarding the proposed innovation concept. Figures 7, 8, 9, 10, 11 and 12 represent the overall visuals of the innovation concept of coastal protection solution by re-using the out-of-service vessels. Figures 7, 8, 9 and 10 illustrate that the innovative concept made on the used vessels where they were turned into permanent structures in order to enhance their capabilities to withstand and reduce the wave strength before the wave have a contact with the shore. As the added values to this concept, it is introduced by incorporating the green technology and 3R (reuse, recycle, and reduce) concept to maximize the long-term benefits of its application. Other than that, this concept is also introducing a maximum utilization of the structures in such way may bring benefit to society, economy and nation as a whole. The maximum utilization of the structures means that the ships' structures can be fully utilized with any compatible and attractive activities which may generate more profits to society, states, and nation as well as serve the tourists' attraction if it is commercialized. A variety of business activities could be operated within the area of development, such as accommodation services (i.e. hotel), cafeterias, recreational centres and shops as illustrated in Figures 11 and 12. All these activities may provide more job opportunities to the local communities and help to improve an isolated area into a developed area that can contribute more to the state and national economy.

Figure 6: The Proposed Idea of Innovative Concept.

Source: Authors.

Figure 7: Overall view of the innovation.

Source: Authors.

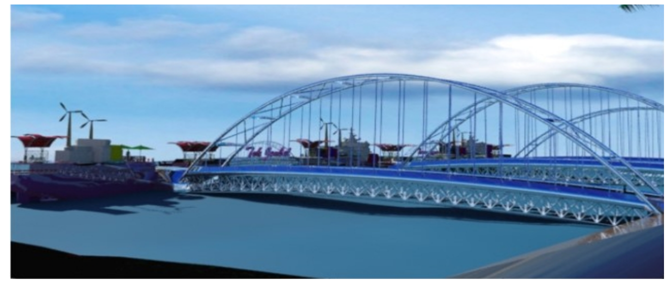
Figure 8: Under water view of the innovation.

Source: Authors.

Figure 9: Sea-view of the innovation.

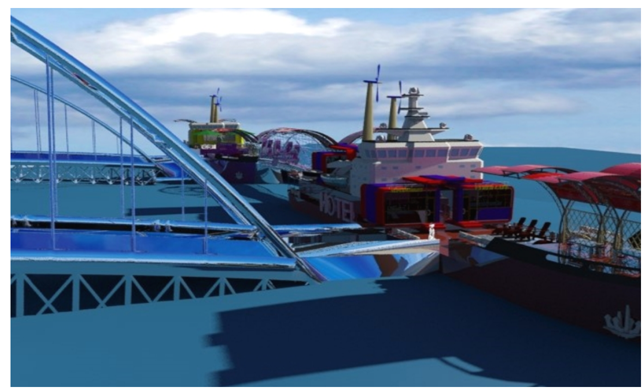
Source: Authors.

Figure 10: Sea-view of the innovation.



Source: Authors.

Figure 11: Sea-view of the innovation.



Source: Authors.

Figure 12: Sea-view of the innovation.

Source: Authors.

The application of this innovative concept is useful in many aspects, especially to the environment and local community. The brilliant use of this new breakwater system indicates that the costly facilities are no longer needed to be built which less in term of commercial and social aspects. Table 6 summarises the comparison between the existing system, which currently being used to protect most of the coastline in Malaysia, and the new coastal protection system, which is to be proposed.

The usefulness of this idea indicates that the "end-of-service" or "abandoned" vessels can be re-used rather than demolishing her structures for recycling and turning it into another forms of

Table 6: Comparison between existing and new breakwater system.

Impact factor	Existing breakwater system	New breakwater system
Economy	The area of businesses and economical point only concentrated at the ashore areas. Less commercial functions.	The area of businesses and economical point are expanded from ashore areas until the new breakwater facilities. Local economy can be served by introducing the hotel and food services, recreational zones, business centre etc. Improve tourism attractions. Provide long terms benefits to the state and national economy.
Social	Act as recreational areas for local community only.	Introducing various recreational and water-sports activities such as snorkelling, banana boating, parasailing, etc. around the water areas. Introducing attractive playground, sport areas and mini botanical garden on-board the ship. The facilities will opened more job opportunities for the local community to do businesses.
Technology	Low technology used.	Make use of green technology amenities (i.e. solar panel, wind mill etc.) to generate power supply for the facilities operation.
Environment	Establish long-term ecological hazards. Huge damages of ecosystem due to the construction. No attraction to the environment.	Reduce the impacts on ecosystem during the construction and encourage replanting of the coral areas to restore the harmony ecosystem. Create an attractive environment with colourful facilities along the shorelines. Increase attractions of the local community and tourism industry.
Safety	Less safety as it encourages more abandoned areas.	More safety as it reduces the impacts of huge wave actions beyond the facility area. More safety features are developed to monitor the water activities around the areas.

Source: Authors.

items which demands huge capital cost of the processes. This innovative idea may reduce abandoned and usage of old vessels as this may encourage the ship-owners to use more seaworthy vessels in their shipping businesses. This project may support the effort of protecting marine ecosystem as the green concept and alternative energy power are proposed. Also, the commercialization potential of this concept may benefits not only the developers, but also the local community, the state and the nation, in terms of its capabilities of generating economic and business point through introduction of shops, food stalls, hotels and water sports activities. By reusing the structure of vessels, the unique spaces on-board can be utilized to do a variety of businesses and provide attractions for tourism industry. Less capital cost required along with high profit can be generated. The designs of the system also vary which is depending on the creativity of developers in order to provide attractions of their facilities.

The usage of floating structures like ships can be utilized in constructing effective and attractive designs of the structure to have more spaces where the business activities can be held. The utmost advantage of using vessels' structures is that the uniqueness can be beamed at the night time when creatively decorated with colourful lights for grabbing the attraction of tourists. Therefore, this project is quite unique as the benefits not only cover in reducing the coastal erosion problems, but it may generate a variety of benefits not only to the environment, but also to the economic and social functions, along with safety benefits.

Conclusion.

The continuity of the coastal erosion problem reflects that there is no effective solution that able to sustain the shoreline areas from the impacts of strong wave action. The existing breakwater is viewed as not able to work effective in certain areas and the erosion remains occurred. Besides, there is not much benefits gained by the community with the construction of the existing breakwaters, plus it destroys most of the natural resources and environment near the shoreline areas. As existing breakwaters at the shore becomes inadequate to address the increase in number of erosion areas every year, this study has been conducted to determine the perception of the community toward the existing breakwater system including business personnel, academician and local community using questionnaires and interview sessions. An innovative model of a breakwater system with 3R concept is presented in this study as a possible solution to the problem. It is expected that the use and further development of this innovative system would give significant benefit to the investors, shipping companies, governments and society in terms of the economy, environmental, technological, operational, and safety benefits. Also, the new breakwater system allows the community to increase their household incomes by promoting new job and business opportunities at the facilities.

The contribution of this study is an innovative model of coastal protection system incorporating with both commercial and social benefits to ensure the coastal and tourism sustainability. Also, a variety of benefits can be offered to the local community such as job opportunities and encourage them to do businesses on the developed facilities. As a limitation, this study is just delivering the idea of innovative concept to overcome the erosion problem issue and it is not dealing with technical engineering part. Further studies can be conducted using the Cost and Benefits Analysis (CBA), engineering model design and technical test in order to determine the applicability, reliability as well as effectiveness of this innovation concept. Finally, this study is workable to be developed in order to ensure the sustainability of coastal areas and tourism activity.

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