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Sustaining Anti-Littering Behaviour within Coastal and Marine Environments: Through the Macro-Micro Level Lenses

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Abstract— Being regarded as a problem of global dimensions, marine litter has been a growing concern that affects human beings, wildlife and the economic health of coastal communities to varying degrees. Due to its involvement with human behavior, marine littering has been regarded as a cultural matter encompassing macro and micro level aspects. At the micro or individual level, behavior and behavioral motivation of an individual are driven by perception of that person while at the macro or societal level, aspects including policies and legislations influence behavior. This paper investigates marine littering through the macro-micro level lenses in order to analyze and recommend how anti-littering behavior can be improved and sustained. Using Coleman's model of micro-macro relations, research questions are formulated and investigated through a social survey. Results showed important differences in perceptions among participating groups and to address key issues, potential actions are proposed along with a framework to sustain anti-littering behavior.

Keywords—Marine Litter and Littering; Macro-Micro Level Study; Perception; Coastal User Groups; Anti-Littering Behavior; Sustainability;

1. INTRODUCTION

With no marine spaces left untouched by human actions (Halpern, et al., 2012), amplified and diversified human activities on these areas have triggered alterations on oceanic life, habitats and landscapes (Atkins, et al., 2011; Mani-Peres, et al., 2016). Essentially linked to human actions, marine litter has been a ubiquitously growing concern to the coastal and marine environment (Campbell, et al., 2014). Being part of the broader problem of waste management, marine litter or debris has been defined as “any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment” (UNEP, 2005). Marine debris has been regarded as a problem of global dimensions that adversely affects human beings, wildlife as well as the economic health of coastal communities to varying degrees (Oosterhuis, et al., 2014; UNEP, 2005). From a human safety and health perspective, beach visitors could be harmed by broken glasses, fish lines and hooks, while swimmers and divers could get entangled in submerged or floating debris while also being exposed to harmful bacteria found in contaminated water (Sheavly & Register, 2007). With regards to the marine environment and wildlife, entanglement and ingestion have been considered as significant problems of litter,

which could also cause damage and death risks to marine animals (Ryan, et al., 2009; Gregory, 2009; Tomas, et al., 2002; Lazar & Gračan, 2011). Plastic bags and bottle caps were identified as the most hazardous marine debris to wildlife in addition to fishing nets and gear (Hardesty, et al., 2015; Laist, 1987). Moreover, marine litter causes the wearing of the sea bed and leads to the accumulation of toxic waste substances that negatively impact the flora and fauna of the sea (Schlining, et al., 2013). Furthermore, marine littering is known to cause destruction or alteration of habitats, thus further impacting marine life (European Commission, 2011). Aesthetically, debris makes beaches unattractive, thereby discouraging coastal users from performing their activities and from visiting such areas (Sheavly & Register, 2007). Consequently, since coastal communities often depend on the revenue generated by seaside businesses, marine litter could potentially reduce number of visitors to the coastal area thus causing adverse economic impacts (Mouat, et al., 2010).

At the grass-root level, marine debris originate from two principal sources, namely, ocean-borne waste disposed within the sea and terrestrial waste sourcing from coastal users (Rees & Pond, 1995; Whiting, 1998). Ocean-borne waste sources from merchant ships, fishing vessels and pleasure crafts, among others, whereas terrestrial waste originates mainly from recreational visitors, beach-goers and landfills (Coe & Rogers, 2012; Davenport & Davenport, 2006; Strand, et al., 2015). Among these two sources, terrestrial waste from coastal users has been considered as most significant whereby accounting for up to 80% of global marine pollution (GESAMP, 1991). This source of litter mainly accounts for shore-based disposed solid waste, inappropriate or illegal dumping of domestic and waste dumps which are blown into water or carried by creeks, rivers, drains and sewers following human activities on the coastal areas (Sheavly, 2005; UNEP, 2011). Having slow degradation rates also lead to accumulation of such debris in the ocean thus further negatively impacting the marine environment (Barnes, et al., 2009; Ioakeimidis, et al., 2014). The principal reasons for terrestrial litter to end up as marine debris have been attributed to human behavior, actions and activities at sea (Campbell, et al., 2014; Derraik, 2002; Sheavly & Register, 2007; Cheshire, et al., 2009; Oosterhuis, et al., 2014).

Due to its involvement with human behavior, marine littering has been regarded as a cultural matter (Golik &

Gertner, 1992). Generally, culture is connected to the core values and norms of individuals at the micro level while also being strongly linked to the society at macro level (Erez & Gati, 2004; Bandura, 1986). In other words, marine debris related issues encompass macro-micro level aspects from a sociological perspective. At the micro level, human behavior was identified as a critical factor that is fundamentally linked to awareness, perception, attitude, level of concern about this environmental issue, in addition to motivations to engage in solutions (Hartley, et al., 2015; Rees & Pond, 1995). Among these factors, understanding perceptions on marine litter and littering has been considered among the foremost steps towards a sustainable approach to cleaner marine environments (Hartley, et al., 2015). Even though much literature is available regarding the behavioral dimensions of environmental concerns (Gardner & Stern, 2002; Schultz, et al., 2011), limited work has been done to address perceptions (Santos, et al., 2005). On the other hand, at macro or societal level, different aspects including policies and legislations influence behavior. This paper investigates marine littering through the macro-micro level lenses in order to analyze and recommend how anti-littering behavior can be improved and sustained to eventually target a litter-free marine environment. The findings presented in this study is intended to aid policy makers in understanding macro-micro level factors pertaining to marine litter in addition to potential actions towards sustaining anti-littering behavior.

2. RESEARCH FRAMEWORK

A recognized approach to investigate macro-micro level issues involves the use of Coleman's model of micro-macro relations (Coleman, 1986; Coleman, 1994). This model is regarded as one of the most popular theoretical diagrams in sociology and was conceptualized to explain how micro-level action is linked to macro level structures and vice versa. In this model, the macro-level encompasses large social entities or groups whereas the micro-level comprises individuals acting out of their own states of agency along with their interactions with other individuals (Little, 2012). Although this model has been extensively used in studies related to sociology (Hedstrom & Swedberg, 1998), organizational literatures (Minbaeva, et al., 2007; Felin & Foss, 2006) and information systems (Markus & Robey, 1988; Melville, 2010), among other research areas, it is yet to be used to investigate issues related to marine littering. Since aspects pertaining to marine litter encompass both macro and micro level parameters, Coleman's model of micro-macro relations was used as basis for the research framework in this study while also providing a means to frame the research questions.

As discussed earlier, since human behavior, actions and activities at sea are principal causes for terrestrial litter to end up as marine debris (Campbell, et al., 2014; Derraik, 2002; Sheavly & Register, 2007; Cheshire, et al., 2009; Oosterhuis, et al., 2014), a desired outcome of studies involving marine litter is unarguably to promote sustainable anti-littering behavior at both individual or micro level and societal or macro levels. As it has generally been established that the behavior of people is based on their perception of what the reality is (Dijksterhuis & Van Knippenberg, 1998), improving the perceptions of coastal

users could improve their anti-littering behavior. Using Coleman's model of micro-macro relations, four variables becomes important to study, namely the coastal society and behavior of social system at macro-level, and the perceptions about marine litter and anti-littering behavior at micro level. These variables are interconnected in the diagram given in Figure 1.

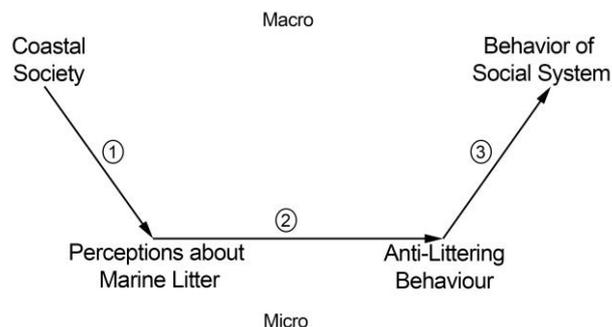


Figure 1 – Macro-Micro Level Model

Within the model shown in Figure 1, macro level is conventionally illustrated at the top while the micro level is depicted at the bottom. Interconnecting the identified variables establishes three fundamental links where the arrows in Figure 1 indicate possible pathways of causal influence. Creation of these links also forms different transitions in the structure namely, macro-micro (Link 1), micro-micro (Link 2) and micro-macro (Link 3). The identified variables and the established links are further discussed as follows.

2.1 Variable 1: Coastal Society

The coastal society in this study is regarded as the aggregate of users that have an influence on a particular coastal area. Generally, groups form an essential part of the society and perform important functions on the same entity (Stinchcombe & March, 1965). Even the society can be regarded as a large social group (Tajfel, 2010) and different groups are expected to have shared values which reflect the group culture (Bunderson & Sutcliffe, 2003; Edmondson, 2002). With regards to coastal user groups, limited literature is available on their categorization. A basic coastal user group classification is based on residency and types of activities exerted on a coastal area including resident, visitor and worker (Mikalsen & Jentoft, 2001; Tudor & Williams, 2006). In such classification, a coastal resident or inhabitant refers to a person who resides in that area. It has been estimated that 1.9 billion people reside closer than 100 km from the coast within areas less than 100 meters from above current sea level (Kummu, et al., 2016). This figure represents approximately 28% of the world's total population. Inhabitants of coastal zones can enjoy various benefits whilst being settled in such areas, including biophysical and climatic conditions together along with communication and navigation amenities (Kay & Alder, 2005; Wheeler, et al., 2012). The second category, namely visitor, refers to a person who visits coastal zone for a short period. Visitors can also be sub-classified as local or international. Local visitors here refer to people visiting a particular coastal

area, but living outside the same area but within same country. On the other hand, international visitors or tourists refer to people coming from an international destination to visit a particular coastal area during their stay. Both sub-categories of user visit coastal areas in order to make most of the activities including fishing, surfing, boating, beach-going or sun tanning. The final category, namely worker, relates to people doing a particular work in a coastal area. This includes hawkers, fishermen, tour-operators and shop owners, among others. Hawkers are more commonly seen on beaches to sell easily transportable merchandise to visitors whereas tour-operators derive an income by arranging tours. Fishermen derive their income by catching fishes and fishing-related litter is considered as an important contributor of ocean-borne litter (Edyvane, et al., 2004). A previous study showed that marine litter has had various impacts on fishing and these included reduced yield, damaged nets and time wasting due to regular needs for clearing debris from nets (Nash, 1992). The severity of these impacts also caused modifications in fishing behavior, notably avoidance of some fishing areas. Additionally, reduced number of visitors due to litter undoubtedly has an adverse impact on the income workers (Sheavly & Register, 2007).

2.2 Variable 2: Perceptions about Marine Litter

As discussed earlier, understanding the perception of users has been considered among the foremost steps to a more complete and sustainable approach towards anti-littering (Hartley, et al., 2015). From a psychological perspective, perception is defined as “*a set of internal sensational cognitive processes of the brain at the subconscious cognitive function layers that detects, relates, interprets and searches internal cognitive information in the mind*” (Wang, 2007). At the macro level, studies have demonstrated that group perceptions are influenced by various factors including entitativity, characteristics, goal and homogeneity, among others (Yzerbyt, et al., 2004). It has also been recognised that the perception of a group is influenced by some essential qualities of its members (Campbell, 1958; Spencer-Rodgers, et al., 2007). Additionally, the society also has an influence on the perception of individuals (Link 1) (Armstrong, 1996). At the micro-level, studies showed that this set of sensational cognitive processes is influenced by a number of factors principally related to the perceiver, the target being perceived and the situation in which the perception is made (Merleau-Ponty & Smith, 1996; Schneider, 1987). Among these factors, much work has been done regarding the perceiver and studies showed that perception is shaped or distorted by different characteristics including background, awareness, past experiences, attitudes, moods, motives, self-concepts, interests and expectations, among others (Zalkind & Costello, 1962; Jones & Davis, 1965). As for the target, influencing factors include novelty, size, background, proximity and similarity; as compared to time, environmental and social settings for the situation (Robbins & Judge, 2001).

In relation to marine litter, in the study conducted by Hartley et al. (2015) to investigate and baseline children’s understanding, attitudes and self-reported behaviors pertaining to marine litter, it was showed that the participants were quite

concerned about marine debris and did recognize a few of their causes and impacts. Another study investigated the perceptions of beach users with different socio-economic backgrounds (origin, educational level, sex, annual income, and time spent on beach) on solid litter pollution and results revealed that beach users rarely admit littering but blame other users in contaminating the beach (Santos, et al., 2005). Furthermore, the influence of non-resident workers on marine debris issues was investigated and results revealed that the same group litter at the same rate as tourists, permanent residents and visitors and that residency has an influence on awareness of marine litter (Campbell, et al., 2014). Even though the studies conducted provided insightful information, limited published literature is available on the perceptions of the identified coastal user groups in relation to aspects regarding marine litter.

2.3 Variable 3: Anti-Littering Behaviour

Anti-littering behavior encompasses the range of actions and mannerisms performed by coastal users to positively impact the coastal and marine environment relating to litter. In order to promote anti-littering behavior, previous research focused on the behavioral patterns pertaining to marine litter. In other words, it is important to understand littering behavior so that appropriate preventive actions can be taken (Kolodko, et al., 2016). For instance, studies showed that people are more likely to throw debris in littered and disordered environments as compared to a clean one; and are also less prone to litter after having observed someone picking up debris (Cialdini, 2003; Cialdini, et al., 1990; Schultz, et al., 2011; Keizer, et al., 2008). In terms of demographics, people of younger age groups are considered to be more likely to litter than older people (Durdan, et al., 1985; Finnie, 1973; Krauss, et al., 1978). Moreover, males have generally been considered to litter more than females (Meeker, 1997). Also, people living in rural environments are considered to litter more than those living in urban regions (Schultz, et al., 2011). Additionally, studies have revealed that educational level, religious conviction, marital status and income affect littering behaviors in general (Al-Khatib, et al., 2009; Eastman, et al., 2013; Santos, et al., 2005; Slavín, et al., 2012). Although all these factors have been correlated with littering behavior, it has commonly been established that the behavior of people is based on their perception (Link 2) of what the reality is (Dijksterhuis & Van Knippenberg, 1998). Behavior and the behavioral motivation of an individual are driven by his/her perception (Ajzen & Madden, 1986).

2.4 Variable 4: Behaviour of Social System

The final variable of the model studied is behavior of social system which relates to the operational aspects of the society and the natural environment (Melville, 2010). The behavior of the societal system is influenced by the interdependent actions of the actors who make up the system (Link 3) (Coleman, 1986). Studies have shown that social behavior can be automatically activated by features of the environment where the behavior of a person automatically increases the probability

of another individual or group to engage in that behavior (Bargh, et al., 1996; Chartrand & Bargh, 1999). As such, improved anti-littering behavior at micro level could positively impact the behavior of the social system at large (Link 3).

2.5 Research Questions

In the macro-micro model presented in Figure 1, literature confirmed that aspects of the coastal society have an influence on individual perceptions (link 1), which is in turn a driver of behavior (link 2). This driver may consequently improve the overall behavior of the social structure (link 3) (Bargh, et al., 1996; Chartrand & Bargh, 1999). While analyzing the first link, literature analysis showed that limited published literature is available on the perceptions of coastal user groups in relation to aspects regarding marine litter. This becomes important to investigate in order to identify key issues that need to be addressed so as to promote anti-littering behavior at both the micro and macro levels (links 2 and 3). Taking cognizance of this issue, three research questions have been formulated while also relating to the different links in the model presented in Figure 1. These questions are given in Table 1:

Research Question	Link
RQ1: How do the perceptions of coastal user groups differ regarding aspects of marine litter and what issues need attention among the differing perceptions?	1
RQ2: What actions could be taken in order to address the issues identified in RQ1 so as to promote anti-littering behavior from every group?	2
RQ3: What approach could be adopted in order to ensure sustainable anti-littering behavior of the social system based on findings of RQ2?	3

Table 1 - Summary of Research Questions

RQ1 seeks to investigate the perceptions of coastal users by co-relating with their classification within the society in terms of the previously discussed approach based on residency and types of activities exerted on a coastal area. Studying perceptions at the micro-level is expected to help in the identification of perception related issues that need to be addressed at the same level before determining potential actions that need to be taken so as to promote anti-littering behavior (RQ2). This investigation still relate to actions that need to be taken to influence micro-level perception improvement. To extend from micro towards macro level, RQ3 delves into the approach that could be used to sustainably promote sustainable anti-littering behavior. Due to limited availability of literature to answer RQ1 – RQ3, a social survey was conducted.

3. PERCEPTIONS OF COASTAL USER GROUPS REGARDING MARINE LITTER RELATED ASPECTS

The social survey was conducted in the coastal area of Grand-Baie (or Grand Bay). This coastal area is located in the north-west coastline of Mauritius with an area of 5.5 km² and consists of 12,111 inhabitants (Statistics Mauritius, 2014).

Grand-Baie was selected as coastal waters in Mauritius have been under threat due to eutrophication and wastes, which led to a reduced coverage of live corals in the coastal lagoons of Mauritius to 10-30% (Ramessur, 2013). Although being a popular touristic area of Mauritius, high levels of algae and cyanobacteria were detected in the waters at Grand Baie, which also has its reefs largely dead (DeGeorges, et al., 2010). Having undergone rapid development in the past, this coastal area has transformed itself from a typical fishing and agricultural village into a major tourist area of the island (Nazurally, 2014; Morpeth & Yan, 2015). As an international tourist destination, Grand Baie is well known for its high quality beaches, safe swimming facilities for some part of its lagoon and water based activities such as sailing, snorkeling, windsurfing, water skiing, use of pleasure crafts and travelling in a catamaran or glass bottom boat to admire the different aquatic species. Moreover, 19 out of the 107 hotels in Mauritius are located in Grand Baie and this coastal village is known for luxury shopping, nightlife and entertainment and fine-dining restaurants (Morpeth & Yan, 2015).

3.1 The Social Survey

As data collection instrument, a questionnaire was designed. This questionnaire was prepared with the aim to reduce researcher's bias as much as possible and sought perception of coastal users on the followings aspects related to marine debris and littering:

- Value of coastal area and the sea
- Severity of marine litter problem
- Constituents of marine litter
- Contributing factors that amplify marine litter
- The way litter reaches the sea
- Distribution of marine litter at sea
- User groups contribution to marine litter
- Associated threats of marine litter
- Actions to reduce marine debris
- Responsibility for reducing marine litter
- Mechanisms to improve perceptions on marine litter

For RQ1, the targeted audiences of the social survey were identified coastal user groups from literature, namely, inhabitants, workers (fishermen and hawkers) and visitors (consisting of tourists and local visitors). The non-probabilistic sampling technique of convenience was applied for the collection of suitable data. Respondents from these three categories were selected based on the ease of access and provision of valuable inputs. Before conducting the survey, a pilot study was carried out with 10 participants (two for each user profile) in order to test and verify questionnaire. The feedback obtained from the pilot study helped to fine-tune the questionnaire before large-scale execution.

Following the pilot phase, the survey was conducted during four weeks starting in April 2016 in order to target maximum participants during the summer period in Mauritius. Based on the non-probabilistic sampling technique of convenience, participants were recruited at four different anchor points in

Grand-Baie planned by the research team. At each anchor point, one specific coastal user group was targeted in order to better control the data collection process. When collecting data, a mixed approach was used including one to one interview and group interview, while also ensuring that groups remain of maximum of 3 participants. With every participant, the survey started with a brief introduction of the research followed by obtaining the consent of the respondent to participate in the study. Then, the participant was given time and assistance to fill-in the questionnaire, which was thoroughly checked after to ensure its validity. During the survey two important challenges were faced, namely, linguistic issues and obtaining the consent of participants. As the questionnaire was in a single language (English), several participants faced linguistic problems. These were mostly fishermen, participants aged above 60, and some tourists. As a solution, translation and assistance was provided to this group in order to ensure each question was properly understood and filled-in. Also, there were various cases where the targeted participants were busy in their activities and caused delays in the data collection process or did not give their consent for the survey. The remedy for this challenge was either to wait for the participant's availability (especially fishermen) or to seek other participants, respectively.

Following the survey, 335 successfully completed questionnaires were obtained for analysis and presentation of the outcomes. In terms of demographic details, 168 male and 167 female participated in this study although the distribution varied among the different coastal user groups, particularly, fishermen and hawkers. As for age distribution, hawkers had the highest average while local visitors had the lowest average. The demographic details of the respondents are given in Table 2 and results of the social survey are discussed next.

Coastal User Group	Total		Avg. Age (years)	Gender - Male		Female	
	Count	%		Count	%	Count	%
Inhabitants	134	40.0%	32.4	61	36.3%	73	43.7%
Visitors – Local	111	33.1%	30.6	49	29.2%	62	37.1%
Visitors – Tourists	54	16.1%	38.8	32	19.0%	22	13.2%
Workers – Fishermen	22	6.6%	42.5	17	10.1%	5	3.0%
Workers – Hawkets	14	4.2%	48.6	9	5.4%	5	3.0%
Total	335			168		167	

Table 2 - Demographic distribution of respondents

3.2 Value of Coastal Area and the Sea

In the survey, perceptions of coastal users on the value or importance of the coastal area and sea were sought to find out how valuable such areas are to them. For this, 9 responses were compiled from a previous survey (MARLISCO, 2013) namely for tourism and leisure, as a food source, for trade and shipping, for employment, as an energy source, for science and education, for aesthetics and scenery, for supporting plant biodiversity and as legacy to preserve for future generations.

Results showed that fishermen mostly valued the coastal area and the sea as food source from the sea. This was principally because fishermen are dependent upon the sea for a livelihood. Moreover, the same group gave lesser importance to the aesthetics and scenery of the coastal zones and sea since this aspect is not important for them as long as this group is able to derive enough catch for living. As for inhabitants, aesthetics and scenery of Grand-Baie along with food source were perceived as the most valuable aspects. It is believed that the aesthetics and scenery of coastal areas are priceless, peaceful and inspiring; while being the reason behind the relocation of a large number of people to the coasts (Beatley, et al., 2002; Marafa & Chau, 2016). Moreover, inhabitants perceived the sea as a rich source of fresh food which the same group claimed to enjoy (Huelsenbeck, 2012). On the contrary side, inhabitants perceived the sea as being of lesser importance as an energy source even though much work is being actively conducted in harnessing tidal energy (Allan, et al., 2011). Similar to inhabitants, tourists perceived aesthetics and scenery of the area along with food source as most valuable aspects. However, the same group perceived the coast and seas as being of least value with regards to supporting plant biodiversity, trade and shipping and as legacy to preserve for future generations. Hawkets perceived that the coastal area and sea are valuable for tourism and leisure as well as a source of food. Hawkets within the Grand Baie coastal area are highly dependent on tourism and leisure activities as means to retain customers, thus obtaining a decent income. Likewise, the same group is also dependent on resources obtained from the sea that are eventually sold for an income. Similar to inhabitants and tourists, local visitors perceived aesthetics and scenery of the coastal area and the sea as most valuable, in addition to a legacy to be preserved for future generations. As a responsibility towards the future generations and as per the theory of intergenerational justice, it is vital that the natural resources be preserved in such a way that they also can make the most of the coastal area and sea as the present generation (Tremmel, 2009). Overall, most coastal user groups perceived aesthetics and scenery of the coastal area and the sea as most valuable, while energy source being the least valuable. To sum up, results showed a varied perception among the groups. These results are depicted in Table 3 using a Likert-5 scale, where 5 shows that users strongly agree to the statement.

	Fishermen	Inhabitants	Hawkets	Local Visitors	Tourists
For tourism and leisure	4.5	4.3	5.0	4.2	4.9
As a food source	4.7	4.7	5.0	4.5	4.9
For trade and shipping	4.5	4.5	4.8	4.1	4.7
For employment	4.2	4.2	4.4	4.3	4.8
As an energy source	4.0	4.1	4.0	3.8	4.8
For science and education	4.5	4.3	4.0	4.1	4.8
For aesthetics and scenery	3.7	4.7	4.4	4.7	4.8
For supporting plant biodiversity	4.2	4.4	4.0	4.3	4.7
As legacy to preserve for future generations	4.2	4.3	4.4	4.7	4.7

Table 3 - Perception on Value of Coasts and Sea

3.3 Severity of Marine Litter Problem

Perceptions of respondents were obtained on the severity of marine litter as being a problem and the responses are summarized in Table 4. Surprisingly, among fishermen, inhabitants, hawkers as well as local visitors, there has been a common opinion that marine debris is problematic in other countries and not the case for Mauritius. Among the coastal user groups, tourists affirmed that since the ocean is vast, damages caused by marine litter are not at all significant. Furthermore, it is to be highlighted that once more fishermen, inhabitants, hawkers as well as local visitors mutually agree that marine litter is not an important environmental and economic issue. Hence, it can be deduced that the participating coastal users of the island were not well aware of the severity of the adverse environmental and economic impacts that marine litter may have both in the short and longer terms. The results are given in Table 4, using same scale as in the previous section:

	Fishermen	Inhabitants	Hawkers	Local Visitors	Tourists
The sea is so vast that marine debris does not have any negative impact	4.0	3.6	2.5	3.5	4.3
Marine litter is not at all a threat for the present generation but rather for the future one	3.4	3.0	2.2	3.0	3.2
Marine litter is not problematic for my country but could be for other countries	4.5	3.9	3.8	4.0	3.9
Marine debris is an important environmental and economic issue	1.1	2.2	2.0	2.0	2.7
Coastal communities are not impacted by marine litter	3.9	3.1	2.4	3.8	3.3
Marine litter is increasing both on the coasts and at sea	2.3	2.3	2.4	2.5	2.5
Research does not clearly demonstrate that marine litter is problematic for a society	3.3	3.2	3.6	3.5	2.6
Locals are carefree about marine litter	2.3	2.8	2.8	2.8	2.9

Table 4 - Perceptions on Severity of Marine Litter Problem

3.4 Constituents of Marine Litter

Perception of the respondents was also sought on the materials that marine litter consists of and responses were metal, plastic, glass, paper, cloth, fishing waste and organic materials (MARLISCO, 2013). According to the participants, plastic materials were highlighted as the major constituent of marine litter. 82.4% of the respondents agreed on this component, followed by 9.0% and 7.1% of participants who noticed mostly paper-based materials and organic matters respectively. As such, findings in this study align with literature and confirm the predominance of plastic debris as marine litter constituent (Hardesty, et al., 2015; Laist, 1987;

Derraik, 2002; Gregory, 2009). This major constituent is present almost everywhere from the coastlines, to the surface of the sea till the sea floors (Galvani, et al., 2015; Eriksen, et al., 2014). Among the rest, fishing waste was considered as the least noticed litter in this coastal area. This could be possibly due to the presence and strict regulations imposed by the fish landing station in the same area.

3.5 Contributing factors that amplify marine litter

The perceptions of the respondents were sought on the contributing factors that add up to marine litter. The factors included in the questionnaire were lack of consciousness during waste disposal, absence of bins, wastage of useful materials, omnipresence of plastics in every product, industries' way of doing business, poor/absence of enforcement of legislations, mishaps during shipment of products. It was found that 74.6 % of the coastal users believe that marine litter is on the verge of increasing and this included all the fishermen and hawkers who participated in the survey. This increase is possibly because a large proportion of the human population have the tendency of carelessly throwing waste either due to lack of awareness on the associated impacts or do not care for the protection of the environment (O'Hara, 1988; Santos, et al., 2005). Furthermore, 72.2% of the respondents affirmed that more and more people tend to make only single use of items and discard them off, possibly because of an increasing throw-away attitude of human beings (Reschovsky & Stone, 1994). This attitude of people relates to overconsumption which led to massive wastage and wrongful disposals which is very much encountered by the majority of the coastal users accounting to 77.3% of fishermen, 69.4% of inhabitants, 100% of hawkers, 62.2% of local visitors and 90.7% of tourists. Also, it is to be highlighted that because of a lack of bins in some parts of the coastal area, there is a significant increase in marine debris as reflected by 69.3% of the respondents. However, fishermen were not too agreeable to as only 50.0% of them are in favor of this potential contributing factor as compared to 63.4%, 100.0%, 68.5% and 85.2% of inhabitants, hawkers, local visitors and tourists respectively. Bins being placed at regular intervals within coastal areas would definitely be eye catching for a majority of people who wish to dispose their waste. Moreover, it can be deduced that 50.0% of the fishermen, 70.9% inhabitants, 100.0% hawkers, 54.1% local visitors and 90.7% tourists who have provided their views in this study, i.e. accounting to an overall 68.4 % of the respondents feel that there is a lack of adequate legal and enforcement systems that entail to additional marine litter. Poor or absence of enforcement of appropriate legislations and protocols only lead to aggravating the marine litter issue. Enforcement needs to be ensured at the level of the district council as well as by the authorities to ensure that waste is properly disposed. It has been proven that adequate legislations and fines indeed lead to a decline in the amount of litter that reaches the coastal areas and sea (Newman, et al., 2013). Additionally, 63.9% of the coastal users stated that marine litter is increasing because plastic is extensively being used in product wrapping and disposable items, among others. This causative influence is supported by 100.0% hawkers. As discussed earlier, plastics form part of the major constituents of marine litter throughout the world

accounting between 60 to 80%, representative of 8 million tons annually (Derraik, 2002; Gregory & Ryan, 1997; Amos, 2015). The overall breakdown is given in the pie chart in Figure 2.

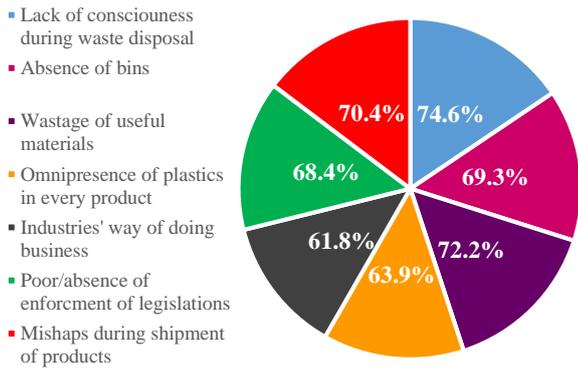


Figure 2 - Perceptions on Contributing Factors that Amplify Marine Litter

3.6 The Way Litter Reaches the Sea

From literature, the 5 main ways through which marine litter reaches the sea are from human activities on the beach, disposed waste in rivers, release of waste into the sea from boating, shipping and fishing activities, in addition to sewage overflows reaching the sea and waste blown from landfills (EEA, 2014). Among these ways, there is no landfill present in Grand Baie and that it is illegal to discharge sewage into drains and rivers within the island. Moreover, since there is no river linking to the Grand Baie seas, this source becomes irrelevant as well. The perception of the coastal user groups were sought regarding these sources and it was found that a significant number of tourists were not familiar to whether rivers and landfills are present in the region and how sewage is managed. Consequently, an average of 75.6% tourists gave neutral answers to these irrelevant sources to the region. Among the relevant sources, the coastal user groups perceived human activities on the beach as the most significant issue. In terms of statistics, 100% of fishermen and hawkers, 81.9% of local visitors, 76.8% of inhabitants and 75.9% of tourists perceive that a moderate to large amount of litter sources from human activities on the beach. As for release of waste into the sea from boating, shipping and fishing activities, perceptions were shared by 85.2% tourists, 78.6% hawkers, 77.3% of fishermen, 65.7% of inhabitants and 51.3% local visitors that moderate to large amount of litter emanate from this source.

3.7 Distribution of Marine Litter at sea

Perception of participants was sought on the distribution of marine litter in the coastal area. Among the four areas surveyed, namely, surface of coastal waters, surface of open oceans, below water surface and on the beach, all coast user groups were agreeable that the beach region was the area containing most of the litter. This finding also aligns with literature (GESAMP, 1991). Moreover, most user groups

besides hawkers also affirmed that there is a little amount of debris below water surface and these users came to know about this when undertaking water activities including swimming and snorkeling. Similarly, all coastal user groups mentioned that from time to time, little amount of waste is perceived on the surface of coastal waters during swimming and water activities. Likewise, fishermen and tourists perceived little to moderate amount of litter on the surface of open oceans away from the coast and out of the sight of land, notably during fishing or boating activities.

3.8 User Groups Contribution to Marine Litter

The perceptions of coastal user groups were sought on the most significant pollutant of the coastal area and the responses to this question included all the coastal user groups as given in Table 2. Results showed that participants rarely admitted of littering but rather blamed other users in contaminating the coastal area, as also highlighted in the study by Santos et al. (2005). According to 95% of the participating fishermen, inhabitants are the most significant pollutant of the coastal area. The same perception is shared by all other coastal user groups, but with slightly varying percentages. A previous study showed that inhabitants often tend to mishandle or inadvertently throw waste or even illegally dump all their litter within coastal areas and sea (Sheavly, 2005). Local visitors were found to be the second most important category to pollute the coastal area. The least polluting group was identified to be tourists. This could be explained by the fact that tourists that visit Mauritius are more environmentally conscious and are aware of the potential negative impacts that marine debris may have on the aesthetic aspect of the coastal area and sea. The results are summarised in Figure 3.

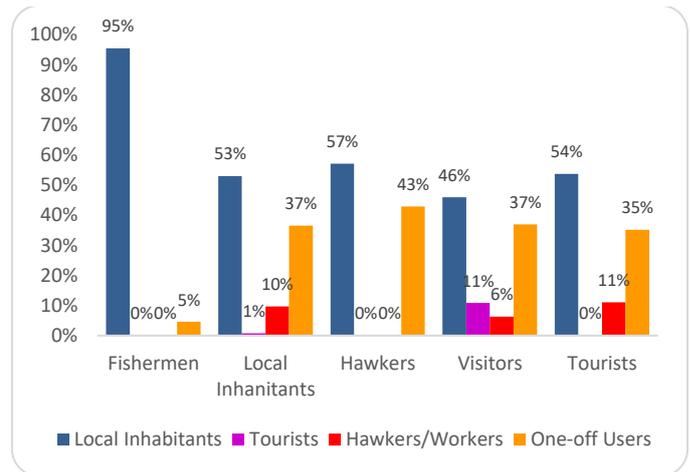


Figure 3 - Perception on User Groups Contribution to Marine Litter

3.9 Associated Threats of Marine Litter

As discussed earlier, marine litter is a threat to the marine environment, tourism, human health, fishing activities and aesthetics. In the survey, perception of the coastal users was sought on these threats. Results showed that the most

concerned coastal user group was tourists where all of them rated the identified threats as moderate to severe. Followed by tourists, hawkers gave similar ratings besides for human health where only 76.6% of them rated this problem as moderate to severe. This category of user found it challenging to establish the link between marine litter and human health. Fishermen were the third most concerned group who rated all threats moderate to severe besides tourism. Although this group was able to establish the link between marine litter and human health, 27.3% of fishermen did not consider debris as a moderate to severe threat to tourism. Further interviewing revealed that this sub-group of fishermen perceives the Grand-Baie beach of small area with limited activities, thus having reduced impact on tourism. Inhabitants were the second-least concerned coastal group where 85.1% of the group perceived the aesthetic appearance of the beach as the most significant one followed by the impacts of litter on the marine environment. Living permanently in the coastal area while also being among the most frequent visitors of the beach, many inhabitants mentioned to be more concerned by the aesthetic appearance of the coastal area, which is also a motivation for them to visit the beach regularly. The least concerned ones were local visitors and similar to inhabitants, this group was more concerned by the threats posed by marine littering to the aesthetic appearance of the beach. This group mentioned to visit the area for beach and water activities while debris could cause hindrance. Overall, the most significant threat was perceived to be the aesthetic appearance of the beach whilst the least important was alleged to be the threats that marine litter pose to human health.

3.10 Actions to Reduce Marine Debris

In the survey, four actions were proposed that can potentially diminish marine debris and these were to pick up litter seen in the sea, to use reusable products instead of disposables, to support government policies and legislations on marine litter and to ask people to pick up their debris when seen littering. Among these actions, picking up litter seen in the sea was perceived as the most difficult one followed by asking people to pick up their debris when seen littering, support government policies and legislations and use reusable products instead of disposables, respectively.

For residents of the coastal area, namely, inhabitants, fishermen and hawkers, the easiest action was perceived as the use reusable products instead of disposables. Many respondents supported this action as it was easier for them to carry reusable products (e.g. glasses and plates) when going to the beach, which is also in proximity of their residence. On the other hand, the three groups had varied perceptions with regards to the most difficult actions. For fishermen and hawkers, asking people to pick up their litter was perceived as the most difficult task. Due to their regular presence on the beach and coastal area, these coastal user groups revealed that asking people to pick up their litter might lead to conflicts, especially from beach-goers who are under the influence of alcohol. Consequently, conflicts could also impact their business activities and income. For local inhabitants, the most difficult action was perceived to be picking up litter in the sea. Further

interviews revealed that this group of coastal users found such action difficult due to safety reasons as debris might contain bacteria and chemicals. This perception was also shared by local visitors, whose easiest action was to support government policy and legislations on marine litter. The perspectives of tourists seemed different as compared to residents of the island. For this coastal user group, the most difficult action was perceived to be the use of reusable products rather than disposables. The mentioned reasons were that reusable products necessitates cleaning after use, are more expensive and would need to be discarded as well at the end of their trip. On the other hand, the easiest actions for this coastal user group were to support government policies and legislations by simply avoiding to litter, followed by picking up litter from the sea. This second action also highlights the cultural differences between local and foreign visitors with regards to marine litter. Moreover, the same group mentioned to be not so familiar to littering policies and penalties imposed by the government.

3.11 Responsibility for Reducing Marine Litter

Rather than being an individual responsibility, waste management should be a collective effort involving different stakeholders (Guerrero, et al., 2013). Based on an adapted list of key stakeholders consisting of general public, researchers, educational institutions, government and regulatory bodies, waste management organizations, environmental NGOs and media (Joseph, 2006), participants had to give their perceptions on the significance of the identified stakeholders on their responsibility to reduce marine litter. Results showed that all coastal user groups shared a common perception that the general public is the most important stakeholder in reducing marine litter. As also highlighted in literature, individuals have the opportunity to make the difference to the health of the marine environment by making the right choices (McKinley & Fletcher, 2012). In other words, in case the general public behaves in an environmental friendly manner, a significant percentage of debris will be reduced. On the other hand, researchers were perceived as the least important stakeholder in reducing marine litter all coastal user groups besides tourists. Further interviews showed that participants feel that researchers have limited interaction with the coastal area. Moreover, many participants mentioned to be unaware of studies conducted by researchers. However, tourists perceived that the media as the least important stakeholder since their direct focus is not marine littering and waste management. The results have been compiled in the stacked chart given in Figure 4.

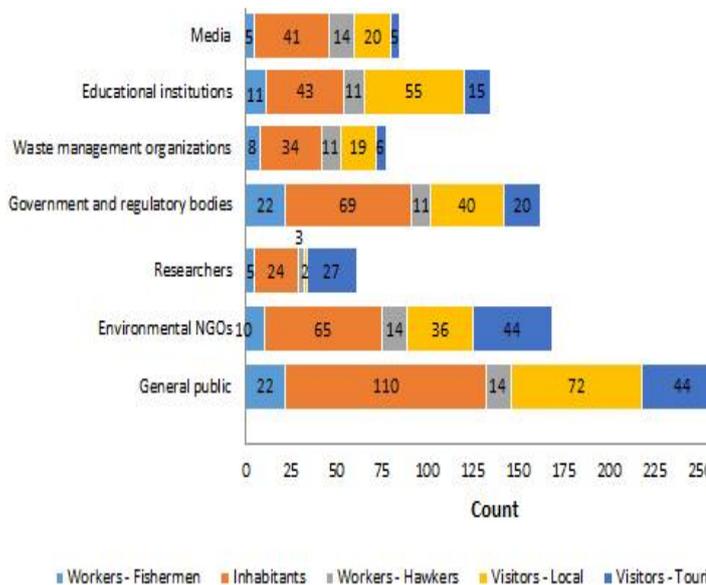


Figure 4 - Perceptions on the Responsibility to Reduce Debris

3.12 Mechanisms to Improve Awareness on Marine Litter

Additionally, the perception of coastal users was sought on the mechanism to improve the awareness on marine litter. The mechanisms proposed were television advertisements, radio advertisements, social networks and flyer distributions. The workers category, namely, fishermen and hawkers had a preference for the advertisements on television and radio. 68.2% of fishermen perceive that television is the most effective mechanism to improve awareness on marine litter as this category also feels that ads should be regular in order to keep reminding the general public about the issue. For the remaining fishermen, 27.3% perceived social networks to be effective as compared to 4.5% for radio. Hawkers, in turn, perceived radio as the most effective way as 57.4% of this category revealed to be tuned-in while selling their products on the beach. For the rest of the hawkers, 21.4% perceived social media and 21.4% of hawkers selected TV advertisements. Similar to fishermen, inhabitants perceived television ads as the most effective way to improve awareness on marine litter. 59% inhabitants selected this category as compared to 33.6% for social media and 7.5% for radio adverts. Local visitors and tourists perceived social media as the most effective means, represented by 64.9% and 46.3% respectively. For the rest of visitors, 21.6% selected television ads, 11.7% opted for radio ads and 1.8% nominated flyer distributions. The rest of tourists selected television and radio ads, represented by 42.6% and 11.1% respectively. Overall, although perceptions seemed to vary significantly among the different coastal user groups, social network was determined as the most effective mechanism by the majority of participants. Use of social media also highlights increasing dependence of human beings on information and communication technologies based tools (Bekaroo, et al., 2016), while also pinpointing its significance in raising awareness. Flyer distribution was also determined as the least effective mechanism in improving awareness as many participants mentioned to throw these away after sometimes

reading the message, which is later forgotten. The overall response distribution is given in the pie chart in Figure 5.

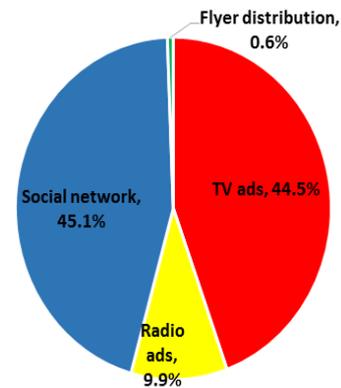


Figure 5 - Perceptions on Ways to Improve Awareness on Marine Litter

3.13 RQ1: Highlights on Key Differences in Perceptions

Based on the gathered information from the respondents' views, it could be deduced that depending on the role and needs of the coastal users, the value attached to the coasts and seas are divergent. This is obvious that individuals value these areas differently depending on different requirements either for sustaining a livelihood, peacefulness, recreation among others (Zalkind & Costello, 1962; Jones & Davis, 1965). Besides, fishermen, inhabitants, hawkers and local visitors highlighted marine litter as problematic in other countries and not in Mauritius. This perception of residents of the island seems different to compared to reality since marine litter has been reported as a concern¹ in Mauritius. Moreover, marine debris was not perceived as an important environmental and economic issue by the islanders. On the other hand, tourists mostly perceived that marine litter is not problematic as the ocean is so large that it can absorb the waste. As for the components of marine litter that prevail within the coastal areas and seas, plastic materials was perceived as the most commonly found debris within the coastal area. Other types of marine litter that could also be frequently noticed were paper-based materials and organic matters while the rarest one was waste materials emanated from fishing activities within the region of Grand Baie. Furthermore, coastal users were also aware that waste materials such as that aluminum cans, plastic bottles and bags and glass bottles have longer lifetime at sea, which is in coherence with literature. Among the contributing factors that amplify marine litter, lack of consciousness on behalf of people towards their environment was perceived as the most significant one followed by excessive use of disposables, principally by inhabitants and local visitors. According to all the coastal user groups, litter largely comes from land, notably from the beach and this finding is also in harmony with literature (GESAMP, 1991). With regards to the distribution of marine litter at sea, coastal users have a shared opinion that

¹ ION News (2014), #SeeingBlue: to raise awareness on protecting our seas! [online]. Accessed on: 20th Aug 2016, Available at: <http://ionnews.mu/seeingblue-raise-awareness-protecting-seas-1908/>

debris is mostly found on the beach as compared to other areas such as surface of coastal waters, surface of open oceans, below water surface and on the beach. Hawkers were the only user group who were persuaded that the amount of litter found below the surface of water is not at all significant while others have a differing point of view which have been witnessed during underwater activities. Moreover, there is consensus on the fact that from time to time marine debris are sighted on the surface of water. However, it is also important to highlight that fishermen and tourists perceived little to moderate amount of litter on the surface of open oceans outside the lagoon during their activities and this warrants further attention in order to reduce threats to wildlife, especially in the lagoon of Mauritius. In terms of contribution of other coastal user groups to marine litter, coastal users do not very much appreciate of taking the responsibility of littering and rather blame others for so doing as also highlighted in literature (Santos, et al., 2005). According to all the coastal user groups, inhabitants were considered as the most polluting users. The associated threats of marine litter were also investigated and the results show that the coastal users have divergent opinions. Tourists were those who mostly perceive marine litter as moderately to severely threatening. Among the various threats, the link between marine litter and human health was perceived as the least important by inhabitants, hawkers and local visitors. Although different actions could be taken by the coastal user groups to reduce marine litter, fishermen and hawkers found it difficult to ask people to pick up their litter. The highlighted reason was that such action might lead to conflicts, thereby adversely impacting their activities. Furthermore, inhabitants and local visitors perceived picking up litter on the beach and in the sea as a difficult action due to safety concerns. Moreover, tourists mentioned to be not so familiar to littering policies and penalties imposed by the government. With regards to responsibility for reducing marine litter, researchers were perceived as the least important stakeholder in reducing marine litter by inhabitants, workers and local visitors, although various studies are being undertaken globally in this topical area. Finally, among the mechanisms to improve awareness on marine litter, most coastal user groups highlighted social networks as being the most effective one in the current technology driven society.

Overall, with regards to RQ1, the social survey showed that perceptions of coastal user groups differ in most of the aspects investigated. This could be possibly due to the various factors that influence perceptions including group characteristics and entitativity, among others, although further analysis of these factors are beyond the scope of this paper. The highlights on the key differences in perceptions are summarized in Table 5:

Marine Litter Aspect	Issue Needing Attention	Most Concerned Group
Severity of Marine Litter Problem	Marine debris not well perceived as an important environmental and economic issue	<ul style="list-style-type: none"> Workers (both fishermen and hawkers) Local visitors Inhabitants

Severity of Marine Litter Problem	Marine litter perceived as problematic in other countries and not in Mauritius	<ul style="list-style-type: none"> Workers (both fishermen and hawkers) Local visitors Inhabitants
Severity of Marine Litter Problem	Marine litter is not problematic as the ocean is so large that it can absorb the waste.	<ul style="list-style-type: none"> Tourists
Contributing factors that amplify waste	Lack of consciousness on behalf of coastal users	<ul style="list-style-type: none"> Inhabitants Local visitors
Contributing factors that amplify waste	Misuse of materials still in good condition	<ul style="list-style-type: none"> Inhabitants Local visitors
Distribution of Marine Litter at sea	Knowledge on marine litter below water surface	<ul style="list-style-type: none"> Workers (hawkers in particular)
Distribution of Marine Litter at sea	Presence of little to moderate amount of litter on the surface of open oceans	<ul style="list-style-type: none"> Workers (hawkers) Local visitors Inhabitants
User Groups Contribution to Marine Litter	Inhabitants perceived as the most significant pollutant of the coastal area	<ul style="list-style-type: none"> Inhabitants
Associated threats of marine litter	Link between marine litter and human health	<ul style="list-style-type: none"> Inhabitant Hawkers Local visitors
Actions to Reduce Marine Debris	The difficulty in asking people to pick up their litter.	<ul style="list-style-type: none"> Fishermen Hawkers
Actions to Reduce Marine Debris	The difficulty in picking up litter on the beach and in the sea.	<ul style="list-style-type: none"> Inhabitants Local Visitors
Actions to Reduce Marine Debris	Familiarity to littering policies and penalties imposed by the government.	<ul style="list-style-type: none"> Tourists
Responsibility for Reducing Marine Litter	Reduced perceived role of researchers in the responsibility to reduce marine litter.	<ul style="list-style-type: none"> Inhabitants Workers (both Hawkets and Fishermen) Local visitors

Table 5 - Issues Needing Attention

4. RQ2: POTENTIAL ACTIONS TO ADDRESS ISSUES IDENTIFIED IN RQ1

In order to promote anti-littering behavior from every coastal user group, the issues identified in RQ1 (as in Table 5) need to be addressed. For these, a set of recommended actions

are given as follows to help in improving perceptions and to promote anti-littering behavior, as sought in RQ2.

- *Marine debris not well perceived as an important environmental and economic issue*
Outreach educational programmes and awareness campaigns on the significance of marine litter have shown to reduce or even eliminating the problem at grass-root level (Nolan, et al., 2009). The same approaches could be used to improve the perception of the coastal user groups.
- *Marine litter perceived as problematic in other countries and not in Mauritius*
This perception of residents of the island need to be aligned to what reality is as marine litter has been reported as a concern in Mauritius. For this, more aggressive sensitization campaigns are needed by utilizing different types of medium to propagate such information.
- *Marine litter is not problematic as the ocean is so large that it can absorb the waste*
As this perception concerns mostly tourists, engaging the same group in clean-up activities of beaches could help to raise awareness.
- *Lack of consciousness on behalf of coastal users*
Education for all age is a must in order to raise awareness among people to become environmentally responsible (Earll, et al., 2000). Visual illustrations through social networks and the help of media could be taken to sensitize on the negative impacts of marine litter. Moreover, appropriate display information on contraventions on beaches could deter littering.
- *Misuse of materials still in good condition*
The polluter pay principle could be introduced where users need to pay an additional fee when buying products equating the damage being done to the environment (Jang, et al., 2014). This solution could help inhabitants to better think before littering and the collected funds may be gathered for clean-up programmes of the sea. Additionally, education for all age is a must to raise awareness on how to increase lifetime of materials.
- *Presence of little to moderate amount of litter below water surface and on the surface of open oceans*
Within sensitization campaigns both issues could be given further attentions to showcase the impacts of litter on the flora and fauna of the sea and improve awareness of the concerned coastal user groups. Users finding litter below water surface and on the surface of open oceans could also report the problem to regulatory bodies so that further actions could be taken in the clean-up process. This could be facilitated by promoting use of mobile-applications and social media. Additionally, boat and catamaran owners and tour operators could help to implement mechanisms and enforce policies to ensure that visitors do not litter at sea during related activities. This could also be further backed by policies from regulatory bodies.
- *Inhabitants perceived as the most significant pollutant of the coastal area*
Existing policies could be reviewed and awareness campaigns could better focus on this coastal user group to showcase the threats of marine litter. Furthermore, studies have shown that involvement of community residents in clean-up activities does not only help to increase people's anti-littering motivation but also help to promote long-term reduction in littering (Roales-Nieto, 1988; Schultz, et al., 2011; Rees & Pond, 1995). Same activities could be conducted in the coastal area while involving inhabitants. Moreover, more effective monitoring techniques could be implemented within coastal areas involving the use of cameras and sensor-based systems to detect littering (Kako, et al., 2012). Furthermore, studies showed that distance to trash bins has been considered as a factor for littering behavior (Schultz, et al., 2011) and placing bins at regular intervals could help in improving this behavior (De Kort, et al., 2008). Also, proper enforcement of legislations and regulations pertaining to littering could be considered. Additionally, positive reinforcement (in the form of anti-littering rewards for cleanest coastal area) could be implemented as an effective means to reduce littering (Hartley, et al., 2015).
- *Link between marine litter and human health*
The concerned coastal user groups could be informed about the relationship between marine litter and human health through sensitization campaigns and social media, among other means.
- *The difficulty in asking people to pick up their litter*
If the worker category is finding it difficult to ask people to pick up their litter due to potential conflicts, the same group could be formed to initiate actions in picking up litter on the beach and in the sea in a safe manner. This action was found to be particularly helpful as it is human nature to imitate actions of people in their surroundings (Wagner, 2014).
- *The difficulty in picking up litter on the beach and in the sea*
Concerned coastal user groups could be sensitized on potential actions how to safely pick up litter. Moreover, signage could also be placed to inform coastal users to notify beach cleaners to help in the cleaning process. Reducing existing amount of litter within the area is considered as a surefire mechanism to diminish the rate of littering behavior (Casey & Lloyd, 1977; Huffman, et al., 1995).
- *Familiarity to littering policies and penalties imposed by the government*
For tourists to become more familiar to the policies and penalties imposed by the government, proper signage pertaining to littering fines must be well placed within the coastal areas. Moreover, it also recommended that hotels have a participative approach in reducing marine litter, for instance, management can provide handy information to tourists regarding marine littering management practices.

- *Reduced perceived role of researchers in the responsibility to reduce marine litter.*

This perception of inhabitants of the island could be improved by better showcasing research works conducted in the area of marine litter. For this, more effective knowledge dissemination platforms need to be used by researchers so that findings could be properly propagated. Research findings could also be made more accessible to the general population.

Overall, being regarded as a matter of culture, education, legislation and law enforcement have been identified as potential solutions to prevent marine litter from terrestrial sources (Golik & Gertner, 1992). This is also why recommendations for most of the issues discussed in this section relate to these solutions. Among, improving awareness was argued as the only guaranteed way to diminish the amount of debris reaching the sea and littering the shores (Rees & Pond, 1995), although a few previous studies showed that beach users have only basic understanding of marine litter in general (Hartley, et al., 2015; Santos, et al., 2005; GESAMP, 2015). Since coastal users are either directly or indirectly involved in the activities and behaviors contributing to marine debris, their awareness is a crucial factor to improve perceptions and help in the prevention and control of marine litter (Cheshire, et al., 2009; Steel, et al., 2005). Furthermore, being considered as a guide for actions that need to be taken to conserve coastal areas (Shi, et al., 2001; Beeharry, et al., 2014), policy and legislations are important parts of the recommendations discussed above. To better help in this endeavor, use of innovative technologies and mobile applications such as Marine LitterWatch² could be promoted that would give insightful information on techniques and existing policies.

5. SUSTAINING ANTI-LITTERING BEHAVIOUR: A REFLECTIVE FRAMEWORK

Taking cognizance of the marine litter related issues found during the social survey, waste management should be a collective effort involving all stakeholders (Guerrero, et al., 2013). In other words, efforts are needed at both micro and macro levels due to the close relationship between the two entities. On one hand, macro-level issues including social changes and policies influence perceptions at micro-level (Sternheimer, 2011) while on the other hand, the behavior of societal systems are influenced by interdependent actions of the actors who make up the system (Coleman, 1986). Due to the various issues that need to be addressed as revealed in RQ2, continuous improvement is needed to promote anti-littering behavior in the first instance. Once achieved, same needs to be sustained. However, there is a lack of published models and frameworks to guide this endeavor and that takes into consideration macro and micro level aspects.

As an innovative model, one based on the Plan-Do-Check-Act (PDCA) cycle could be adopted since continuous improvement

is needed towards sustaining anti-littering behavior. The PDCA model is a repetitive 4-stage continuous improvement model and has been utilized in different studies related to waste management (Matthews, 2003; Askarian, et al., 2010), although not directly considering macro and micro level aspects. As such, the PDCA cycle could be used as basis to extend the macro-micro model in Figure 1 into a model targeting litter-free coastal and marine environment through sustained anti-littering behavior from involved users. The proposed framework is given in Figure 6, consisting of three rings. The inner-most ring represents the targeted goal of the model whilst the middle-ring extends the micro-level parameters studied into a cycle based on findings of the social survey. The macro level is represented in the outer-most ring.

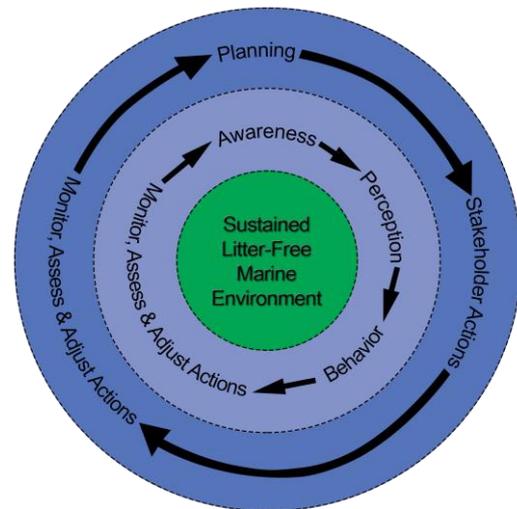


Figure 6 – Towards a Sustained Litter-Free Marine Environment

At the macro level, leaders of the society and social groups including governmental and non-governmental organizations, regulatory bodies, educational and research institutions, among others, should be influencing change needed towards achieving the goal. To start this, planning is essential in order to define the objectives and processes to achieve the expected target. This is followed by planning the actions to be taken by stakeholders in terms of resources and time-plan, among other factors. In the next phase called Stakeholder Actions in Figure 6, the plan developed in the first phase should be implemented. Examples of stakeholder actions at the macro-level would be to implement sensitization campaigns, policies and legislations and research, among other actions. It is also important to closely monitor, assess and implement corrective actions to ensure same are being implemented to effectively achieve the initially defined objective. Monitoring and assessment were found to be critical to ascertain that actions are coherent with principles of ecologically sustainable development with regards to marine litter (Ward, et al., 1998; Edyvane, et al., 2004). In case of deviations, corrective actions need to be taken early in order to eliminate non-conformities. Monitoring, assess and adjust actions could be implemented within a single phase or even in three different stages depending type and complexity of actions.

At the micro or individual level depicted in the middle circle in Figure 6, awareness has been argued as an essential factor

² European Environment Agency, Available at: http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch

needed for improvement of perceptions on marine litter and as a guaranteed mechanism to reduce debris reaching the sea and littering the shores (Cheshire, et al., 2009; Steel, et al., 2005). In other words, coastal users need to be aware of the adverse impacts of marine debris, and the mechanisms and practices that could be used in order to contribute towards prevention and control of marine litter. Furthermore, coastal users need to know the policies and legislations governing littering behavior and associated adverse consequences in violating them. As such, awareness precedes the studied micro-level links between perception and anti-littering behavior. Even at the micro-level, coastal users should be monitoring, assessing and adjusting their actions and contributions in reducing marine litter. Proper monitoring and assessment strategies and indicators are needed to understand awareness level and behavior so that corrective actions could be taken early. For awareness assessment, online quizzes on aspects related to marine litter and littering could be taken by individuals periodically. However, with regards to behavioral assessment, limited published literature is available on such techniques, which could be a barrier towards promoting anti-littering behavior at individual level.

6. CONCLUSIONS

This paper investigated marine littering through the macro-micro level lenses in order to analyze and recommend how anti-littering behavior can be improved and sustained to eventually target a litter-free marine environment. For this, Coleman's model of micro-macro relations was adapted and used as basis of the investigation. Using this model, four variables were studied, namely the coastal society and behavior of social system at macro-level and the perceptions about marine litter and anti-littering behavior at micro level. Analysis of the links between these variables revealed that behavior and behavioral motivation of an individual are driven by the perception of the person. Using this variable as basis in order to promote anti-littering behavior, three research questions were formulated. A social survey was conducted in the coastal area of Grand-Baie, Mauritius in order to help answering the formulated research questions. Results of the social survey showed that perceptions of coastal user groups differ in most of the aspects investigated and this could be possibly due to the various factors that influence perceptions including group characteristics and entitativity, among others. For the identified issues, a set of recommended actions were proposed so as to improve perceptions. Among these actions, education, legislation and law enforcement were identified as most significant ones. Overall, analyzing anti-littering behavior through the macro-micro level lenses did not only help to identify key variances in perceptions among coastal user groups, but also helped to recommend potential actions to address the identified issues before eventually proposing a reflective framework to sustain such behavior.

7. REFERENCES

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