Thesis for the Degree of Master of Business Administration

# An Economic Valuation of Reducing Marine Litter on Coastal Beaches in Sri Lanka


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# ABSTRACT

Sri Lanka is an island with a coastline of about 1620km, located in the Indian Ocean. Marine litter poses several threats to the coastal environment as well as to the economy. This study estimates the total economic value of marine litter reduction on the Sri Lankan coast by employing the One and One-Half Bound (OOHB) dichotomous choice contingent valuation (CV) method, which asks respondents to specify their willingness to pay (WTP) for the litter reduction. The CV surveys were undertaken through person-to-person interviews with 600 people in the western and southern provinces of Sri Lanka in November 2021. The payment vehicle of the scenario is an annual environmental tax for the next five years period. The respondents understood the CV questions well and appropriately responded to the hypothetical scenario explained in the CV questionnaire. Overall, 15.5% of the respondents had zero WTP, and the truncated mean annual WTP is estimated as 2,585 LKR ($12.93) per household. This value has a statistically good fit. The lower estimate of the population's WTP for the reduction of marine litter would be 3,944.06 million LKR ($19.72 million) per year and the higher estimate is 7,888.13 million LKR ($39.44 million) per year. The present value of mean WTP per household for five years period is 8,665.32 LKR at the discount rate of 15%. Accordingly, the aggregated lower estimate of the project is 13,221.11 million LKR ($66.11 million), and the higher estimate is 26,442.23 million LKR ($132.21 million). The analysis based on the responses suggests two possible reasons for the higher WTP. First, most of the respondents are more concerned and aware of marine litter issues as they reside in coastal areas, which affects WTP positively. The second reason is people's consciousness of the impacts of marine litter on the coastal tourism industry and the fishing industry. The findings of this study can be utilized for future policy planning regarding marine litter management, especially in western and southern provinces because western and southern coastal areas were identified as the highly polluted areas with marine litter.

## Acronyms and Abbreviations

CA – Cellulose Acetate

CE – Choice Experiment

CEO – Chief Executive Officer

CS – Compensating Surplus

CV – Compensating Variation

CVM – Contingent Valuation Method

DBDC – Double Bound Dichotomous Choice

DC – Dichotomous Choice

EEZ – Exclusive Economic Zone

EPS – Expanded Polystyrene

ES – Equivalent Surplus

EV – Equivalent Variation

GDP – Gross Domestic Production

HDPE – High-Density Polyethylene

kg – Kilogram

LKR – Sri Lankan Rupees

MEPA – Marine Environment Protection Authority

MMT – Million Metric Tonne

MT – Metric Tonne

NARA – National Aquatic Resources Research and Development Agency

NOAA – National Oceanic and Atmospheric Administration

OOHB – One and One Half Bound

PE – Polyethylene

PET – Polyethylene Terephthalate

PP – Polypropylene

ppd – Plastic per Day

PPE – Personal Protective Equipment

PS – Polystyrene

SBDC – Single Bound Dichotomous Choice

SMD - Submerged Marine Debris

UN – United Nations

UNEP – United Nations Environment Program

US – United States

WTA – Willingness-to-accept

WTP – Willingness-to-pay

# 1. Introduction

## 1.1 Background of the Study

Marine litter is defined by the American National Research Council (1975) as: ‘‘solid substances of human origin that are dumped into the sea or reach the sea through waterways or domestic and industrial outlets’’ (Alkalay et al., 2006). Marine litter has become a significant issue worldwide. It can be entered into oceans through land-based sources (which is the major source) and water-borne sources. According to Ballerini et al. (2018), as cited in Jambeck et al. (2015), it has been estimated that every year, an average of 8 million tons (4-12 MT) of land-based plastic waste enters the marine ecosystem and UNEP (2009), further explains that the plastic waste input to oceans from water-borne sources is are around 20% of the total loads found in the world's oceans. Besides, it is the most prominent pollutant that makes beaches aesthetically unattractive to visitors.

Sri Lanka is an island located in the Indian Ocean. It has a coastline of about 1620 km and Exclusive Economic Zone (EEZ) extends up to 200 nm. Sri Lanka’s ocean area is approximately 8 times larger than the land area. This coastal and marine area is one of the most treasurable resources of the country because it is rich in natural, environmental, cultural, and economic resources. The quality of Sri Lanka’s coastal zone has deteriorated to a great extent over the last few years as a result of marine litter which has been becoming an emerging problem for Sri Lanka in recent years, as a significant amount of marine litter has been accumulated on Sri Lankan beaches. The rapid development of tourism and other marine environment-related industries, five out of nine provinces of Sri Lanka with high population densities bordered by the coastal belt and being an island might be the major causes behind the marine debris piled in the coastal area of Sri Lanka. Island countries have intense effects of debris accumulation in marine environments because of their proximity to debris concentrating zones and gyres. Hence, island nations and their marine ecosystems are under severe threat (Lavers and Bond 2017; Monteiro et al. 2018, as cited in Mafaziya

et al., 2020). Sri Lanka is located at the center of international shipping lanes connecting east and west. Apart from the aforementioned reasons, several shipwrecks had taken place in the Sri Lankan coast very recently which cause the accumulation of the larger amount of marine litter along the coastal line. These incidents dragged the attention of residents towards the issues of marine litter and enhanced their awareness regarding marine litter. In terms of materials, marine litter mostly consists of packaging materials (55%), consumer products (25%), and fishing gear (20%) and 93 percent of these materials are plastic which is the greatest contributor to marine debris (Jang, et al., 2018). In this situation, only a handful of economic studies related to marine debris in Sri Lanka have been conducted until today.

## 1.2 Significance of the Study

Marine litter has several economic impacts, especially for an oceanic island like Sri Lanka which actively engages in fishing, tourism, and trading activities. Major sources of marine litter are inland litter flown through rivers and, solid and liquid wastes dump from industries and fishing vessels (Wickramaarachchi et al., 2010). The geographical location of beaches also plays an essential role in the amount of marine debris accumulation. Jang, et al. (2018) have identified the distance of urban cities or a river mouth from a beach, the persistence of a physical barrier, and the time of the monsoons as the contributory factors for plastic litter accumulation at Sri Lankan beaches. Fishing activities take place around the entire coast of Sri Lanka and fish consumption is the main source of animal protein for the Sri Lankan population. According to the National Aquatic Resources Research and Development Agency (NARA), there are 21 functioning fishery harbors and 58 anchorages throughout the coastal belt of the country. Even though there is a huge contribution from the fisheries industry to marine litter generation, marine litter also has a significant economic impact the on fisheries industry such as costs incurred from damages to or loss of fishing gear or hindrance of motors, cost of removing litter from fishing gear, removal of litter from harbors and marinas, cost of rescue services, etc.

According to the statistics of the Sri Lanka Tourism Development Authority (2019), the tourism industry is the third-largest foreign exchange earner in Sri Lanka. Most of the tourists from European countries visit Sri Lanka for coastal-related activities such as sea bathing, sunbathing, surfing, diving, whale watching, sea turtle watching, boat visits, etc. Marine litter makes beaches aesthetically unattractive and potentially hazardous for visitors. It discourages foreign and local visitors from visiting coastal areas. Many coastal communities in Sri Lanka depend on the income generated from coastal tourism, so the indirect economic cost of a littered beach can be huge. Coastal communities, municipalities, and volunteer organizations spend an enormous amount of time and money on efforts to limit marine litter on beaches. Removal efforts include daily sweeping of beaches and streets by municipalities, clinching garbage traps to canal outfalls, and monthly or annual volunteer beach cleanup days.

The economic costs of marine debris include the direct and indirect costs of damage as well as the cost that is inherently linked to the benefits from marine debris control as the implementation of policy options. Marine debris has been identified as an "avoidable cost" and managing it is cheaper than repairing damages to ecosystems and society. Externalities and economic losses of marine litter such as the costs of direct damage from marine debris to other users in the marine economy can be measured but, it requires more information on vectors and damage functions to measure the indirect damage, enabling physical damage to be valued. The second use of costs is for remediation. This remediation cost considers density dependence and the net benefits from cleanup (McIlgorm & Raubenheimer, 2018). Studies assessing the economic benefits of marine litter reduction are lacking, in spite of the availability of extensive amount of beach recreation related environmental economics literature in Sri Lanka. Hence, this study will be addressed this gap by estimating the willingness-to-pay (WTP) of Sri Lankan residents to the reduction of marine litter concentrations on coastal beaches.

## 1.3 Objectives of the Study

### 1.3.1. Primary Objective

Marine litter is not only harmful to the marine ecosystem but also to human health. Hence, there is a social demand from civil society and environmental organizations for appropriate measures by the government to reduce marine litter on the Sri Lankan coast. To prepare for appropriate countermeasures, it is important to estimate the environmental damage cost of marine litter in advance. Therefore, the main objective of this study is to estimate the willingness to pay values of residents in western and southern coastal districts for reducing marine litter on the coastal beaches in Sri Lanka, as quantitative information of the environmental damage cost of marine litter. This study only focuses on the economic value of beach litter reduction because a deep-sea marine litter of Sri Lanka has not yet been quantified appropriately. The results of this study provide options for decision-makers in financing marine litter reduction/management projects and future policy making. Also, decision-makers would benefit from possessing reliable estimates of economic values that country residents place on litter-free beaches. Estimates of these values were calculated using the one and one half bounded (OOHB) dichotomous choice contingent valuation technique. WTP data with zero observations which were collected through the WTP surveys have been analyzed using the Spike Model.

### 1.3.2. Secondary Objective

As responsible citizens of the country, people's willingness to volunteer for beach cleanup programs, how much time they would like to spend on such programs, and potential loss of income from volunteering for such programs are estimated.

## 1.4 Methods of the Study

The study focuses on marine litter on coastal beaches of Sri Lanka, which is a contemporary issue faced by Sri Lankan citizens the government. It attempts to evaluate the economic value of reducing marine litter in Sri Lankan beaches by employing the contingent valuation (CV) method, which asks people to indicate their willingness to pay (WTP) for the reduction.

The alignment of this study is as follows; initially, the theoretical and methodological premise of the research was established through a detailed literature survey of information analysis on marine litter and evaluation of the marine litter reduction. The study employed the most widely used and appropriate economic theories and approaches to do the economic evaluation. It is expected to utilize the analysis results and data in the policy planning and decision-making process regarding marine litter in Sri Lanka.

Second, for measuring the economic value of the reduction in marine litter in Sri Lanka, the study employed the existing valuation technique of contingent valuation method using the OOHB dichotomous choice questions based on a linear logistic probability model. The spike model has been used to deal with zero WTP response data in order to produce more empirical and systematic results. The OOHB dichotomous choice CV survey was undertaken with 600 households by a well-trained group of university undergraduates and experienced enumerators in a survey firm through person-to-person interviews during November, 2021.

## 1.5 Organization of the Study

The rest of this study is aligned in the following way;

Chapter 2 defines marine litter in a comprehensive way and indicates economical, ecological and social impacts of marine litter. Further it explains the current status of marine litter in Sri Lanka, including, marine litter types and quantities.

Chapter 3 elaborates the theoretical background and typology of total economic value and different methods of measuring economic value of non-market commodities. Further, it provides a comparison among single bound, double bound and, one and one half dichotomous choice methods.

Chapter 4 covers the construction of questionnaires; the method of survey and determining the sample size; the method of deriving the WTP from respondents; the payment vehicle, unit and period. It also presents descriptive statistics about the data set as well as evidence of the fast decay process in the data.

Chapter 5 estimated the economic value of reduction of marine litter on Sri Lankan coast using one and one half bound dichotomous choice contingent valuation question and the spike model. It also discusses the contingent valuation methodology applied in this study and the calculation of the willingness to pay for marine debris reduction.

The final chapter summaries the previous analyses, and provide a discussion with recommendations.

# 2. Marine Litter and Sri Lankan Status on Marine Litter

## 2.1 Introduction

UN Environment (2017) has defined the marine litter as “any persistent, manufactured or processed solid material that has been discarded, disposed of, abandoned in, or eventually reaches the marine or coastal environment”. Marine litter is a huge problem in coastal countries and a significant threat to the marine ecosystem. International Maritime Organisation (2018) has estimated that 15% of marine litter drifts on the surface of the ocean, 15% remains in the water pillars and 70% are on the seabed and according to Eriksen, et al. (2014), 5.25 million plastic particles with a total weight of 268,940 tonnes are currently drifting in the oceans.

Litter can be entered into the marine environment through both land-based sources and ocean-based sources. Galgani et al. (2015) has identified recreational use of coastal waters, general public waste, industrial sites, ports, unprotected landfills and dumps located near the shore, sewage overflow, accidental loss, and influx from extreme weather events have been identified as land-based sources of marine litter and, commercial vessels, ferries and liners, commercial and recreational fishing vessels, military and research fleets, cruise ships and offshore facilities such as platforms, rigs, and fish farms as ocean-based sources of marine litter. Different types of marine litter can be seen in the marine environment. The following list shows the main types of litter found in the marine environment:

- Plastics (fragments, sheets, bags, containers)
- Polystyrene (cups, packaging, buoys)
- Rubber (gloves, boots, tyres)
- Wood (construction timbers, pallets, fragments of both)
- Metals (drink cans, oil drums, aerosol containers, scrap)
- Sanitary or sewage-related debris (tampons, condoms, feces)

• Paper and cardboard

• Cloth (clothing, furnishings, shoes)

• Glass (bottles, light bulbs)

• Pottery/Ceramic

• Munitions (phosphorus flares)

(Fanshawe & Everard, 2002).

Table 2.1 shows major drivers or basic need of plastic, relevant economic sectors, specific activities that use plastics and estimated pressure produced per year.

Table 0.1: Drivers, economic sectors, activities and quantities of plastic marine litter

| **Driver, Basic Need** | **Economic Sector** | **Specific Activity** | **Estimated Quantities Produced Per Year** |
|---|---|---|---|
| Food security | Fisheries Aquaculture | Use of baskets buoys and lines, plastic net sheets, bags, ropes, and Expanded Polystyrene (EPS) floats | 640,000-705,000 tonnes |
| | Agriculture | Use of plastics for greenhouse construction, tunnel covering, shading and preventive nets, soil covering and solarization films, water supply, and drainage pipes, silage films, nets for pre and post-harvesting works, packaging containers and sacks, pots, strings, and ropes | 1,300,000 tonnes |
| Movement of goods and services | Transport | Wearing out of tyres in cars, planes, and paint used in road markings | 525,000 tonnes |
| Safety needs | Packaging | Use of single-use products to preserve foods | 15,600,000 tonnes |
| Shelter | Construction<br>Textile | Use of paint containing microplastics<br>Washing of synthetic fabrics | 1,400,000 tonnes<br>525,000 tonnes |
| Health/hygiene | Personal care product manufacturers<br>Pharmaceutical | Use of microbeads as exfoliants, cotton-bud stick, scrubs, toothpaste | 30,000 tonnes<br>No information |

| Driver, Basic Need | Economic Sector | Specific Activity | Estimated Quantities Produced Per Year |
|---|---|---|---|
| | product manufacturers | Single-use plastics such as syringes, masks, and rubber gloves | |
| Wellbeing | Tourism | Use of plastic products on beaches such single use plastics; cups, picnic forks, straws | 40% increase in marine litter during summer in the Mediterranean Region |
| Other | Pellets | Use of pellets as feedstock for making new plastics items such as plastic bags and clothes. | 4500 tonnes |
| Main drivers: food, safety needs, and shelter Total pressure 4.8-12.7 million tonnes of plastic in oceans annually | Main sectors Packaging, Agriculture, and construction | Main activities; use of single use products, mulching with plastics, painting of buildings, and other infrastructures | Total pressure 4.8-12.7 million tonnes of plastic in oceans annually |

Source: (Abalansa et al., 2020)

Many studies have evident that marine plastic litter is the most commonly found litter type in marine environments and the continuous production of plastic materials has been identified as a major cause for this issue. Total plastic production in the United States has increased from 2.9 million tons to 47.9 million tons in 1985 within 15 years (Robards et al., 1997, as cited in Fanshawe & Everard, 2002). It is difficult to quantitatively measure the marine litter distribution on beaches around the world. As mentioned by Galgani et al. (2015), beach litter data are derived from different approaches that consider different litter categories and are based on sampling on cross-sections of variable widths and lengths parallel or perpendicular to the shore. It is therefore difficult to quantitatively depict the distribution of beach litter. Also, Fanshawe & Everard (2002) emphasize that when measuring litter at any point in the marine environment, it is important to ensure that the litter is being measured at the actual sink or at an intermediate point in the path. However, some studies quantify the

marine litter quantities removed from the environment. Table 2.2 shows marine litter items take off from the global shoreline and waterways during the International Coastal Cleanup program in 2009.

Table 0.2: Mostly found marine litter items from the global coastline

| Rank | Litter Item | Count (Million) | Plastic Used |
|---|---|---|---|
| 1 | Cigarette filter | 2.19 | CA |
| 2 | Plastic bags | 1.13 | PE |
| 3 | Food wrapper/container | 0.94 | PE, PP |
| 4 | Caps and lids | 0.91 | PP and HDPE |
| 5 | Beverage bottles | 0.88 | PET |
| 6 | Cups, plates, and cutlery | 0.51 | PS |
| 7 | Glass bottles | 0.46 | - |
| 8 | Beverage cans | 0.46 | - |
| 9 | Straws stirrers | 0.41 | PE |
| 10 | Paper bags | 0.332 | - |

Source: (Andrady, 2015)

Despite being a small island, Sri Lanka ranks fifth among the top 20 countries that release mismanaged waste into the world's oceans; this debris mostly consists of plastics (Jambeck et al. 2015). Table 2.3 depicts the top 20 countries that release highest amount of mismanaged debris into the world's oceans.

Table 0.3: Highest ranking countries contributing to the marine debris into the world's oceans

| Rank | Country | Waste gen.rate (kg/ppd) | Mismanaged plastic waste (MMT/Year) | % of Total mismanaged plastic litter | Plastic marine litter (MMT/Year) |
|---|---|---|---|---|---|
| 1 | China | 1.10 | 8.82 | 27.7 | 1.32-3.53 |
| 2 | Indonesia | 0.52 | 3.22 | 10.1 | 0.48-1.29 |
| 3 | Philippines | 0.5 | 1.88 | 5.9 | 0.28-0.75 |
| 4 | Vietnam | 0.79 | 1.83 | 5.8 | 0.28-0.73 |
| 5 | Sri Lanka | 5.1 | 1.59 | 5.0 | 0.24-0.64 |
| 6 | Thailand | 1.2 | 1.03 | 3.2 | 0.15-0.41 |
| 7 | Egypt | 1.37 | 0.97 | 3.0 | 0.15-0.39 |
| 8 | Malaysia | 1.52 | 0.94 | 2.9 | 0.14-0.37 |
| 9 | Nigeria | 0.79 | 0.85 | 2.7 | 0.13-0.34 |
| 10 | Bangladesh | 0.43 | 0.79 | 2.5 | 0.12-0.31 |
| 11 | South Africa | 2.0 | 0.63 | 2.0 | 0.09-0.25 |
| 12 | India | 0.34 | 0.60 | 1.9 | 0.09-0.24 |
| 13 | Algeria | 1.2 | 0.52 | 1.6 | 0.08-0.21 |
| 14 | Turkey | 1.77 | 0.49 | 1.5 | 0.07-0.19 |
| 15 | Pakistan | 0.79 | 0.48 | 1.5 | 0.07-0.19 |
| 16 | Brazil | 1.03 | 0.47 | 1.5 | 0.07-0.19 |
| 17 | Burma | 0.44 | 0.46 | 1.4 | 0.07-0.18 |
| 18 | Morocco | 1.46 | 0.31 | 1.0 | 0.05-0.12 |
| 19 | North Korea | 0.6 | 0.30 | 1.0 | 0.05-0.12 |
| 20 | USA | 2.58 | 0.28 | 0.9 | 0.04-0.11 |

Source: Adapted from (Jambeck, et al., 2015).

The first International Coastal Cleanup event was conducted on the Texas coast, 35 years ago by Oceans Conservancy. Since then, Oceans Conservancy has noticed that the rise of single-use plastic production has dramatically changed the type and the amount of trash collected over time. They have developed the International Ocean

Trash Index which shows the amounts of the top ten most commonly found items at cleanup events. The CEO of Ocean Conservancy has stated that, with the COVID-19 pandemic, new types of plastics have now been found in beaches such as Personal Protective Equipment (PPE), including masks and gloves. Figure 2.1 depicts the number of most commonly found single-use plastic items in Asia-Pacific region, according to a survey of Oceans Conservancy.

There are several actions that can be implemented in national, regional and international level to manage marine litter. Banning of disposal items such as single use plastic items, imposing laws on waste management, environmental taxes, incentives and refunds can be seen as national level actions for marine litter management. International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78), the Convention for the Prevention of Marine Pollution by Dumping of Wastes and other Matter (the London Convention) and the convention on the transboundary movements of hazardous wastes and their disposal (the Basel Convention) are some of the international commitments for marine litter management.

| Location | kg | km | Number of Items | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cigarette Butts | Beverage Bottles (Plastic) | Food Wrappers | Other Trash | Bottle caps (Plastic) | Grocery Bags (Plastic) | Straws, Stirrers | Take out/ Away Containers (Plastic) | Beverage Cans | Beverage Bottles (Glass) |
| Australia | 3,308 | 185.7 | 5,555 | 1,608 | 8,826 | 208 | 20 | 465 | 1,912 | 48 | 1,836 | 1,432 |
| Bangladesh | 870 | 3.2 | 5,132 | 1,170 | 7,890 | 0 | 560 | 459 | 1,232 | 1,780 | 67 | 54 |
| Brunei | 1,297 | 112.1 | 108 | 2,816 | 293 | 444 | 400 | 346 | 126 | 315 | 239 | 173 |
| Canada | 35,569 | 1,530.3 | 75,541 | 6,195 | 18,470 | 530 | 10,316 | 6,920 | 4,098 | 2,029 | 8,562 | 2,807 |
| Chile | 21 | 0.7 | 991 | 10 | 111 | 99 | 48 | 41 | 29 | 14 | 11 | 9 |
| China | 21 | 0.4 | 4 | 3 | 4 | 3 | 5 | 5 | 5 | 4 | 1 | 4 |
| India | 1,727 | 4.8 | 145 | 64 | 160 | 11 | 276 | 37 | 36 | 65 | 12 | 15 |
| Indonesia | 27,792 | 182.9 | 13,026 | 4,870 | 7,321 | 4,246 | 2,855 | 4,435 | 4,457 | 2,739 | 990 | 1,324 |
| Japan | 8,595 | 78.5 | 4,774 | 4,746 | 3,670 | 304 | 4,194 | 1,721 | 1,102 | 3,946 | 2,255 | 1,546 |
| Malaysia | 16,413 | 309.2 | 23,797 | 30,291 | 13,858 | 7,426 | 10,008 | 9,730 | 7,090 | 5,643 | 4,333 | 2,932 |
| Maldives | 4 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N. Zealand | 54 | 0.8 | 0 | 7 | 35 | 27 | 2 | 8 | 6 | 5 | 4 | 6 |
| Peru | 232 | 4.9 | 115 | 241 | 169 | 81 | 131 | 189 | 27 | 32 | 69 | 105 |
| Philippines | 71,329 | 255.3 | 14,705 | 56,554 | 113,402 | 260,204 | 29,751 | 86,114 | 38,816 | 51,650 | 20,379 | 16,917 |
| Russia | 4,007 | 11.9 | 15 | 0 | 14 | 0 | 10 | 0 | 5 | 0 | 1 | 11 |
| Singapore | 1,224 | 68.6 | 1,282 | 62 | 299 | 259 | 202 | 109 | 275 | 96 | 35 | 42 |
| S. Korea | 80,901 | 258.1 | 16,991 | 3,567 | 3,724 | 16,942 | 2,230 | 5,758 | 1,699 | 2,046 | 2,810 | 2,237 |
| Sri Lanka | 23,819 | 91.5 | 2,895 | 27,400 | 13,132 | 0 | 5,781 | 7,990 | 2,793 | 1,489 | 2,316 | 9,770 |
| Thailand | 12,095 | 54.2 | 1,238 | 11,719 | 7,196 | 1,843 | 3,981 | 14,177 | 4,079 | 3,779 | 527 | 6,933 |
| US | 1,163,997 | 34,100 | 377,460 | 87,982 | 185,163 | 160,032 | 129,885 | 66,830 | 60,876 | 38,664 | 64,862 | 44,707 |
| Vietnam | 2,529 | 6.5 | 295 | 340 | 989 | 4 | 717 | 1,226 | 748 | 640 | 90 | 135 |

Figure 0.1: The amount of top ten most commonly found items on beaches in the Asia-Pacific region, 2020

Source: (Oceans Conservancy, 2021)

## 2.2 Ecological, Social and Economic Impacts of Marine Litter

There are several types of ecological, social, and economic impacts associated with marine litter. Litter in the marine environment causes a variety of adverse ecological consequences, including ingestion; smothering; entanglement; disturbance and removal of habitats through beach cleaning activities; transport of invasive species; and poisoning by decomposing products (Fanshawe & Everard, 2002).

Ecological impacts of marine litter are directly and indirectly related to social impacts as well. Marine litter can be ingested by marine biota, which can reduce the quality of fish catch. Marine litter can lead to loss of production in the fishing sector owing to the loss of potential fish catch due to loss or disposal of fishing gear, typically damage to fishing nets and vessels caused by entanglement or collision with marine debris (UN Environment, 2017). According to Galgani et al. (2019), the impact of marine litter and, in particular, microplastics and nanoplastics, on human health is still largely debated and more focused research needs to be carried out to properly address this issue.

There are a variety of potential economic losses related to marine debris, including impacts on commercial fisheries, impacts on shoreline property values, costs incurred by local governments and voluntary institutes/groups to remove and dispose of marine litter, and more general "existence" values reflecting the public's preference for a clean environment (English et al., 2019).

The economic impacts of marine litter can be categorized as direct economic impacts and indirect economic impacts. The direct impacts of marine litter include damages to fishing vessels and equipment, engine downtime due to cooling system damages and litter entangled in propellers, and contamination of fish caught with marine litter. Indirect impacts include loss of target species due to ghost fishing from abandoned, lost, or otherwise discarded fishing gear (ALDFG), although the total losses are unknown (SACEP, 2020). Further, marine litter has an impact on aesthetic value and scenic beauty of the coastal areas and effects on recreational activities. This will

decrease the number of visitors to coastal sites, which affects to reduce the revenue from the coastal tourism industry.

## 2.3 Current Status of Marine Litter in Sri Lanka

Sri Lanka ranks 5$^{th}$ among the top 20 countries ranked according to the quantity of mismanaged plastic marine debris. This reputation severely affects to the emerging tourism industry and the fisheries industry of the country. In Sri Lanka, inadequate municipal solid waste management practices are believed to be an important factor contributing to the accumulation of litter both on land and at sea. (Mafaziya et al., 2020). According to the Ministry of Mahaweli Development and Environment (2018), most of the waste dumps are open dumps, 4% of the dumping sites use bare land, and the rest are located in wetlands and wetlands directly or indirectly connected to the coast. In addition, garbage is dumped on beaches near residences of illegal immigrants and tourist destinations, and there is a problem of reckless dumping of solid waste in coastal areas.

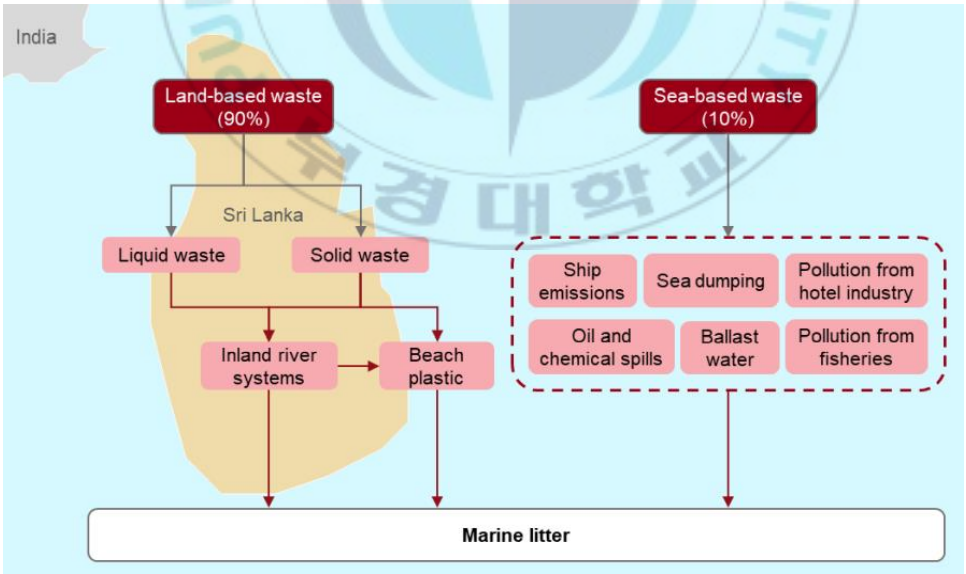



Figure 0.2: Marine Litter Pathways of Sri Lanka

Source: (Doerpinghaus et al., 2021)

The status of total marine debris in Sri Lanka has not been assessed to date. Plastic waste and its types are not being well monitored and it is necessary to understand the different types of marine litter to reduce their accumulation (Mafaziya et al., 2020). According to the Sri Lankan coastal cleanup data for five years (2008–2013), Gunasekara, et al. (2014) has revealed that around 75%of the marine litter is from recreational activities, and it includes bags (plastic and paper), balloons, beverage bottles (plastic, 2 L or less, and glass), beverage cans, caps, lids, clothing, shoes, eating utensils, cups, plates, food wrappers, containers, pull tabs, six-pack holders, shotgun shells, straws, stirrers, and toys.

Table 0.4: Amount of solid waste collected in municipalities in coastal districts

| **District** | **Gross Weight of Waste Collected per Day (Ton)** | **District Percentage (%)** |
|---|---|---|
| Puttalam | 97 | 3.4 |
| Gampaha | 313 | 11.0 |
| Colombo | 1257 | 44.3 |
| Kalutara | 93 | 3.2 |
| Galle | 103 | 3.6 |
| Matara | 68 | 2.4 |
| Hambantota | 28 | 1.0 |
| Ampara | 57 | 2.0 |
| Batticaloa | 119 | 4.2 |
| Trincomalee | 56 | 2.0 |
| Mullaitivu | 09 | 0.3 |
| Kilinochchi | 01 | 0.0 |
| Jaffna | 71 | 2.5 |

Source: (Ministry of Mahaweli Development and Environment, 2018)

Table 0.5: Marine debris types and their percentages on Sri Lankan beaches

| Marine Debris Type | Percentage (%) |
|---|---|
| Foreign debris | 0.9 |
| Packaging material | 55.1 |
| End-consumer products | 25.1 |
| Fishery-related debris | 10.5 |
| Wastes from other industries | 0.03 |

Source: (Mafaziya et al., 2020)

Table 0.6: Marine debris material types and their sizes along with percentages on Sri Lankan beaches

| Marine Debris Material Type | Large > 25mm (%) | 5-25mm (%) |
|---|---|---|
| Plastic | 93.3 | 98.7 |
| Metal | 2.0 | 0.0 |
| Glass and ceramics | 2.9 | 0.8 |
| Wood | 0.7 | 0.0 |
| Paper | 1.0 | 0.5 |
| Other material | 0.0 | 0.0 |

Source: (Jang, et al., 2018)

The marine debris collected in the Negombo area has been classified by type of material which includes, plastic bottles (45%), packaging material (25%), fishing items (20%), caps/lids (5%), and food wrappers/containers (5%). The marine debris collected in the Chilaw area has been classified by material type used, which includes plastic bottles (35%), packaging material (22%), fishing items (32%), caps/lids (6%), and food wrappers/containers (5%). The debris collected in the Bentota River is classified by material types, which include plastic bottles (32%), packaging material (29%), fishing items (11%), caps/lids (14%), and food wrappers/containers (14%). The debris collected from the ferry port at Horawala has been classified by material types and its composition includes plastic bottles (5%), packaging material (2%), fishing items

(2%), caps/lids (6%), and food wrappers/containers (5%) and plant leaves and fruits (80%). Beaches close to estuaries and cities, and beaches with barriers had more debris accumulation. The west- coast had a much higher macroscopic debris density due to strong currents. (Mendis & Amaratunga, 2020).

The highest density of large debris has been observed in Kudawella beach on the southern coast (38.8 items per $m^2$), followed by Back Bay on the east coast (23.2 items per $m^2$), and the highest density of small debris has been recorded in Mullaitivu (505 items per $m^2$), followed by Back Bay (487 items per $m^2$) in the east coast region (Jang et al., 2018). Compared to 2018, floating microplastics (FMP) in the Bar-Reef Marine Sanctuary (Northwest Coast) have been increased by 9.47%, while in Pigeon Island National Park (East Coast), floating microplastics have been increased by 5.94% (Weerakoon & Wimalasiri, 2020).

According to Jang et al. (2018), the mean density of 158/$m^2$ small litter items (5–25 mm) found in Sri Lanka is higher than the reported levels in other studies that have been conducted elsewhere in the world (Table 2.5). Viraj et al., (2019) showed that all the categories of plastics were seen in significantly higher levels in Bentota beach than that of other beaches at p=0.05, and Rekawa and Ussangoda beaches had a significantly lower abundance of plastics due to the limited number of population in the area and conservation of the Rekawa beach for turtles. Their study has further revealed that studied beaches are dominated by fibers (37%) and fragments (36%), and the beach usage for different activities such as recreational and fishing were identified as the major contributing factors for the abundance, distribution, and composition of plastics in studied areas.

Table 0.7: Quantities of marine litter along the coast of Sri Lanka and the beach typology

| Beach name | Large debris (>25mm) | | Small debris (5–25 mm) | | Beach typology | | | |
|---|---|---|---|---|---|---|---|---|
| | Number | Weight (gram/$m^{-2}$) | Number | Weight (gram/$m^{-2}$) | Near a river mouth | Near a city | With barriers | On the East coast |
| 1-Deduru Oya | 4.2±4.3 | 142 ± 101 | 60 ± 42 | 4.0 ± 4.8 | YES | YES | NO | NO |
| 2-Udappu | 0.7 ± 0.2 | 17 ± 12 | 12 ± 11 | 1.8 ± 1.2 | NO | NO | NO | NO |
| 3-Kudawa | 0.1 ± 0.0 | 5 ± 7 | 13 ± 23 | 1.6 ± 2.8 | NO | NO | NO | NO |
| 4-Wilpattu | 0.9 ± 0.6 | 5 ± 2 | 83 ± 55 | 1.6 ± 1.0 | NO | NO | NO | NO |
| 5-Urumale | 0.3 ± 0.5 | 29 ± 49 | 15 ± 19 | 2.1 ± 2.9 | NO | NO | NO | NO |
| 6-Iluppaikkadavai | 0.2 ± 0.2 | 1 ± 1 | 15 ± 16 | 0.1 ± 0.2 | NO | NO | NO | NO |
| 7-Mulankavil | 0.3 ± 0.2 | 14 ± 13 | 9 ± 8 | 0.6 ± 0.7 | NO | NO | NO | NO |
| 8-Casuarina | 0.4 ± 0.1 | 2 ± 2 | 59 ± 32 | 7.4 ± 7.0 | NO | YES | YES | NO |
| 9-Sri Sangamitta | 0.3 ± 0.0 | 3 ± 2.6 | 47 ± 5 | 19.1 ± 13.5 | NO | YES | NO | NO |
| 10-Mullativu | 0.5 ± 0.1 | 5 ± 2.5 | 505 ± 463 | 26.8 ± 29.5 | NO | NO | NO | YES |
| 11-Alampil | 1.9 ± 1.3 | 27 ± 21 | 460 ± 100 | 34.4 ± 14.5 | NO | NO | NO | YES |
| 12-Pankulam Aru | 6.5 ± 5.0 | 40 ± 56 | 419 ± 224 | 48.7 ± 32 | YES | YES | YES | YES |
| 13-Back Bay | 23.2 ± 16.1 | 721 ± 539 | 487 ± 242 | 44.1 ± 24.2 | YES | YES | YES | YES |
| 14-Sallitivu Island | 0.6 ± 0.5 | 6 ± 4 | 220 ± 97 | 18.0 ± 9.1 | NO | NO | NO | YES |
| 15-Thalankudah | 2.2 ± 0.6 | 18 ± 5 | 267 ± 56 | 36.4 ± 6.5 | YES | NO | YES | YES |

| Beach name | Large debris (>25mm) | | Small debris (5–25 mm) | | Beach typology | | | |
|---|---|---|---|---|---|---|---|---|
| | Number | Weight (gram/$m^{-2}$) | Number | Weight (gram/$m^{-2}$) | Near a river mouth | Near a city | With barriers | On the East coast |
| 16-Kirinda | 0.4 ± 0.2 | 5 ± 6 | 77 ± 36 | 24.4 ± 4.6 | NO | NO | YES | NO |
| 17-Bundala | 0.2 ± 0.1 | 1 ± 0 | 48 ± 33 | 10.8 ± 8.4 | NO | NO | NO | NO |
| 18-Hambantota | 2.5 ± 3.7 | 8 ± 9 | 28 ± 17 | 0.7 ± 0.3 | YES | YES | YES | NO |
| 19-Kudawella | 38.8 ± 6.7 | 2,484 ± 221 | 124 ± 82 | 2.6 ± 0.7 | NO | YES | YES | NO |
| 20-Galle | 0.9 ± 0.5 | 58 ± 48 | 48 ± 28 | 3.6 ± 2.1 | YES | YES | NO | NO |
| 21-Kalutara | 2.9 ± 0.5 | 107 ± 96 | 223 ± 61 | 34.9 ± 19.0 | YES | YES | YES | NO |
| 22-Modara | 2.7 ± 1.7 | 159 ± 126 | 248 ± 56 | 84.3 ± 32.2 | YES | YES | YES | NO |
| Average | 4.1 ± 9.2 | 175 ± 538 | 158 ± 170 | 18.6 ± 21.6 | N/A | N/A | N/A | N/A |

Source: Adapted from (Jang, et al., 2018)

According to Mafaziya et al. (2020), the cleanup data were only for beaches and marine litter in deeper ocean parts of Sri Lanka has not yet been appropriately assessed. However, there are some studies that quantified the micro-plastic content in surface water in some coastal areas of Sri Lanka as micro-plastic is a novel topic and plastic is the dominant litter type in marine environments. Weerakoon et al. (2018) have found that, the micro-plastic contamination of Sri Lankan surface water is lower compared to some parts of the world. Further, they have mentioned that micro-plastic pollution is higher in the surface water near fishery harbors.

Table 0.8: A comparison of micro-plastic pollution of surface water

| Area | Number of particles/$m^3$ |
|---|---|
| Northwest Atlantic | 67 |
| Southern California | 8 |
| Northeast Atlantic | 2.46 |
| Southern San Francisco Bay | 2.0 |
| Sri Lanka (Colombo) | 0.85 |
| Sri Lanka (Beruwala) | 0.60 |
| Sri Lanka (Hikkaduwa) | 0.44 |
| Western Mediterranean (Central) | 0.15 |

Source: (Weerakoon et al., 2018)

Weerakoon et al. (2018), Athawuda et al. (2018), Sivaramanan & Kotagama (2018), Hettige et al. (2015), and Weerakoon et al. (2018) have revealed that beaches in western provinces, especially the Colombo area are highly polluted with microplastics. Sivaramanan & Kotagama (2018) have rated the beaches in the Colombo district according to the Clean Coast Index (CCI) developed by Alkalay et al. (2006). They have noticed that a significant amount of waste carried by the drainage canals which are accumulated at the beach or brought back by the ocean tides are remarkable in Kollupitiya, Bambalapitiya, Wellawatte and Dehiwala urban areas.

Table 0.9: Cleanliness of selected beaches in Colombo district over three weekends, according to the CCI

| Beach Name | Cleanliness | | |
|---|---|---|---|
| | 25.03.2017 | 01.04.2017 | 08.04.2017 |
| Wellawatte | Moderate | Dirty | Dirty |
| Bambalapitiya | Extremely dirty | Extremely dirty | Extremely dirty |
| Kollupitiya | Moderate | Moderate | Dirty |
| Galle face | Dirty | Dirty | Extremely dirty |
| Mattakkuliya | Moderate | Dirty | Extremely dirty |
| Dehiwala | Clean | Dirty | Extremely dirty |
| Mount Lavinia | Clean | Clean | Moderate |
| Ratmalana | Extremely dirty | Extremely dirty | Extremely dirty |
| Moratuwa | Dirty | Dirty | Extremely dirty |

Source: Adapted from Sivaramanan & Kotagama, 2018

Sri Lanka's unique location in the Indian Ocean also affects the accumulation of marine debris. Seychelles and India-Sri Lanka regions have been identified as possible sources of low wind debris rather than medium and high wind items (Duhec et al., 2015). Similarly, Sri Lanka is affected by beach particles from diverse source countries when the Northeast Monsoon Current (NMC) and the Southeast Monsoon Current (SMC) pass through it (Mheen et al., 2020).

## 2.4 Marine Debris Management Institutions and National Policies of Sri Lanka

The central government and local government agencies are responsible for waste management in Sri Lanka. The main central government regulatory bodies responsible for conserving the maritime zone and the coastal zone of Sri Lanka are, the Coast Conservation and Coastal Resources Management Department and the Marine Environment Protection Authority which are directly involved in the management and pollution abatement of the country’s marine and the coastal zone (Mafaziya et al., 2020).

National Policy on Solid Waste Management (2007), Coast Conservation Act, and the Marine Pollution Prevention Act is the national policy and two acts that are directly related to marine litter prevention. In addition to these several national-level strategies had been implemented from time to time, to prevent marine litter. Marine Pollution Prevention Act No. 35 of 2008 is a national regulation enforced to control, prevent, and manage marine environment pollution in Sri Lanka. The Marine Environment Protection Agency (MEPA) is the supreme political party established by the Sri Lankan government under the above act. MEPA is in charge of finding solutions to overcome pollution-related problems in the maritime region of Sri Lanka (Thushari & Senevirathna, 2020).

MEPA (2018) has identified the poor management of wastes by coastal residents and fishermen, lack of public awareness about the dangers of marine litter and how to prevent it, insufficient waste management in rivers and canals connected to oceans, and a shortage of collection and disposal facilities, as major reasons for the marine litter problem.

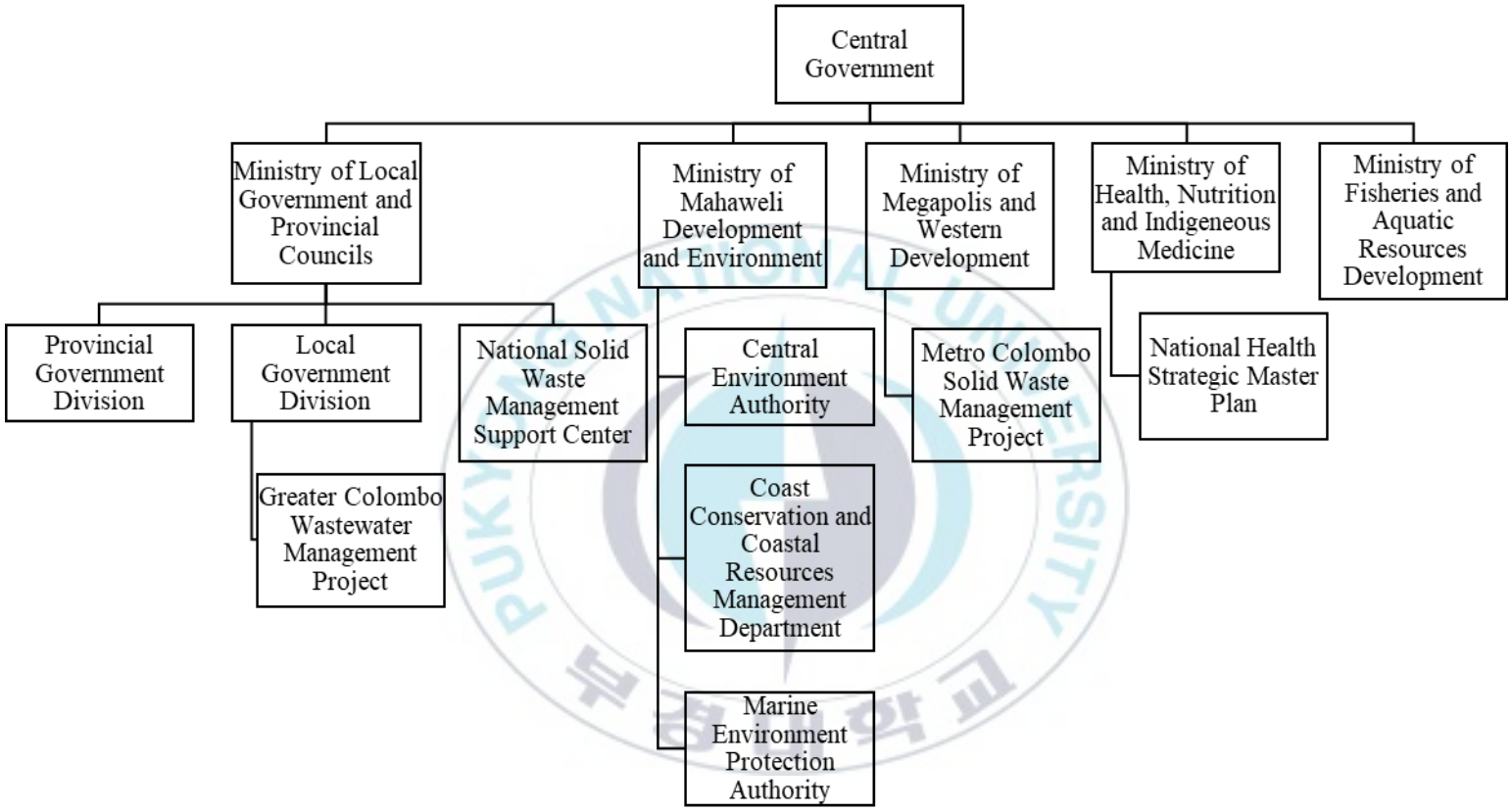



Figure 0.3: Structure of marine debris management institutions

Source: Adapted from Mafaziya et al., 2020

Like many other countries, Sri Lanka spends enormous money to remove and dispose of marine litter annually. 'Beach Caretaker Program' is one of those programs initiated in 2018 by MEPA, to maintain clean beaches around the country in a regular manner. It has covered four coastal areas (nearly 50km coastline) in Colombo and Gampaha districts continuously. International Coastal Cleanup program also marine litter removal program conducted in Sri Lanka. Table 0.10 shows the costs incurred to local government (Colombo, Gampaha, and Kalutara districts are under the Ministry of Local Governments) to remove and dispose of marine litter.

Table 0.10: Costs incurred to local government to remove and dispose of marine litter

| Year | Cost of the Program (LKR/Million) | |
|---|---|---|
| | Beach Caretaker Program | International Coastal Cleanup Program |
| 2018 | 1.419 | 3.285 |
| 2019 | 1.119 | 2.841 |
| 2020 | 2.827 | 3.697 |
| 2021 (up to September) | 1.879 | 1.800 |

Source: (MEPA, 2021)

Mafaziya et al. (2020) has further mentioned that, instead of occasional beach cleanups, continuous cleanup programs coupled with source reduction can significantly reduce marine debris pollution, and Sri Lanka has no proper marine-litter related database of an annual marine debris monitoring program that surveys the composition and amount of marine debris produced in different districts. Even though there are management institutions and legislations, a national level marine litter monitoring program is required to implement the existing regulations to overcome the marine litter problem of Sri Lanka.

# 3. Economic Theory for Measuring the Economic Value

## 3.1 Introduction

"Value" is an important concept to many individuals in different disciplines such as, financial, economic, and ecological sectors. The meaning of it may also be different according to the discipline it used. Ecologists define it as "that which is desirable or worthy of esteem for its own sake; thing or quality having intrinsic worth" and economists define it as "a fair or proper equivalent in money, commodities, etc." (Freeman et al., 2014). The economic concept of "value" is based on the well-being of individuals, which depends on the consumption and production of goods and services and the quantities and qualities of the good and service. In order to maximize the economic well-being of individuals, the governments should make changes to environmental and resource allocations only if the welfare benefit is higher than those given up by transferring resources and inputs from other uses.

The standard economic theory of measuring welfare changes is based on assumptions that people have well-defined preferences among alternative bundles of goods, people know their preferences, and that these preferences have the property of substitutability among the market and nonmarket goods making up the bundles (Freeman et al., 2014). Economists attempt to measure value based on preference set, utility function, and consumer surplus theories.

An individual is assumed to have a set of preferences over goods and services and, utility is an unobservable and continuous index of those preferences (Hanley et al., 1997). Economic surplus consists of consumer surplus and producer surplus. Consumer surplus is the excess of the price than the actual price that a consumer would be willing to pay for the good or service in the market. This can be a willingness to pay or a willingness to accept compensation measures. Producer surplus is the difference between the income received and the production cost of the goods.

The remaining of this chapter aligns as follows: a discussion regarding the total economic value in Section 3.2, a comparison between WTA and WTP concepts is in Section 3.3, a discussion on economic valuation including a review about contingent valuation method, dichotomous choice elicitation method including a disparity among each method is in Section 3.4, empirical literature review in Section 3.5 and Section 3.6 is the theoretical and conceptual framework of the study.

## 3.2 Total Economic Value

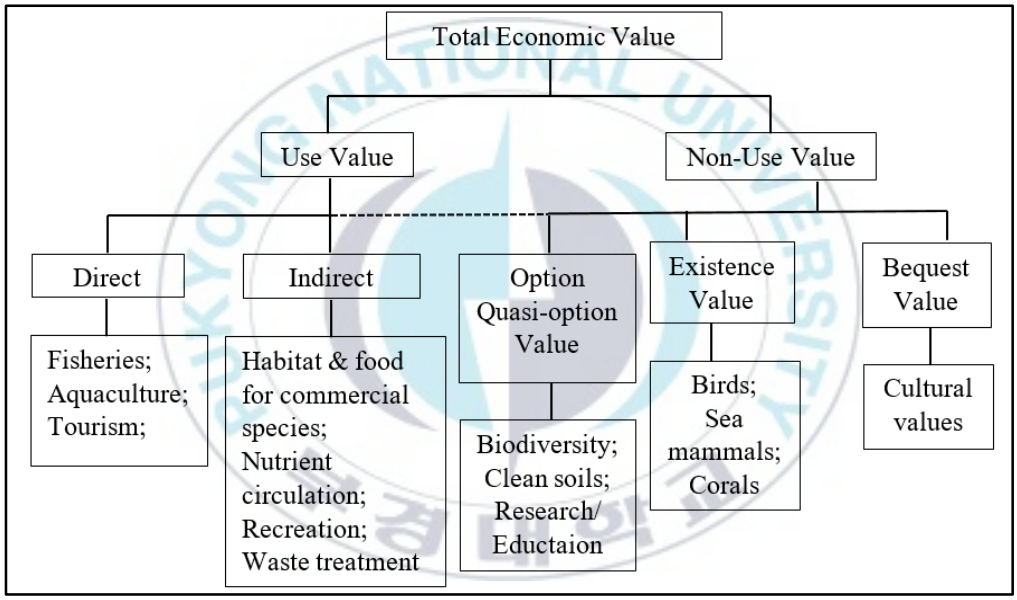



Figure 3.4: Typology of the total economic value of the marine environment
Source: Adapted from Aanesen et al., 2010

Economic value is the value that individuals put on economic goods based on the benefits derived from them. It is often estimated based on willingness to pay for a good, usually measured in monetary terms. Economists have divided the total economic value of benefits received from ecosystem services into two components as use-value and non-use value. Use value is a physically observable tangible benefit classified into two main categories as direct use value and indirect use value (Harris & Roach, 2018). Non-

use value occurs when a resource is not actually consumed in the process of experiencing it and it reflects people's willingness to pay to improve or conserve resources that they will never use (Tietenberg & Lewis, 2018).

Direct-use value can be obtained by making a deliberate decision to use a natural resource and values may derive either from the financial benefits that we obtain by extracting/ harvesting a resource or from the well-being that we obtain by physically interacting with a natural environment (Harris & Roach, 2018). Fisheries/ aquaculture, fish processing, and tourism are some examples of direct use values of the marine environment. Habitat and food for commercial species, nutrient circulation, and bioremediation of waste are some examples of indirect use values of the marine environment that support the direct use values but, are not found explicitly in markets (Aanesen et al., 2010).

Option value reflects the amount that people are willing to pay to preserve the environment for possible future use (Harris & Roach, 2018) and (Tietenberg & Lewis, 2018), while quasi-option value refers to the value of preserving a natural environment for increasing the knowledge of future generations therein, such as, research and education (Aanesen et al., 2010).

Bequest value is a type of non-use value, that an individual would willing to pay for a resource because he or she wishes it to be available for future generations, such as cultural values (Harris & Roach, 2018) and another type of non-use value is existence value which is measured as the willingness to pay for a resource to continue to exist even not concerned about its future use (Tietenberg & Lewis, 2018). All of these economic values are additive, as well as the total economic value of a natural resource may depend on the management scenario of that resource and some of these economic values may not be relevant for particular natural resources.

## 3.3 WTP and WTA Concepts

The value measures can be expressed in terms of either willingness to pay (WTP), or willingness to accept compensation (WTA) in terms of any good that the individual is willing to substitute for the good being valued (Freeman et al., 2014). WTP and WTA represent the two general measures of economic value for environmental service and WTA reflects an individual's economic valuation of improved environmental services, while WTA reflects an individual's willingness to accept compensation to allow the deterioration of the environmental service (Hanley et al., 1997).

Compensating variation (surplus) and equivalent variation (surplus) are two concepts relevant to WTP and WTA measures in the presence of price changes. The compensating variation (CV) is the amount required to compensate for the price increase in order to gain the same level of utility that an individual had before the price increase. For an environmental quality increase, the compensating variation is positive (WTP), while it is negative (WTA) for environmental quality decrease. Equivalent variation asks what change in income would require to gain the same level of utility that an individual had before the price increase. For an environmental quality increase, the equivalent variation is positive (WTA), while it is negative (WTP) for environmental quality decrease.

Table 3.1: The Relationship between Hicksian welfare measures and WTP or WTA

| **Properties** | **CS;CV** | **ES;EV** |
|---|---|---|
| Improvement (price decrease or quantity increase) | WTP | WTA |
| Deterioration (price increase or quantity decrease) | WTA | WTP |

As shown in Table 3.1, Hicksian equivalent surplus measure is the maximum WTP for a deterioration (price increase or quantity decrease) of an environmental service while the Hicksian compensating surplus measure indicates the minimum WTA value.

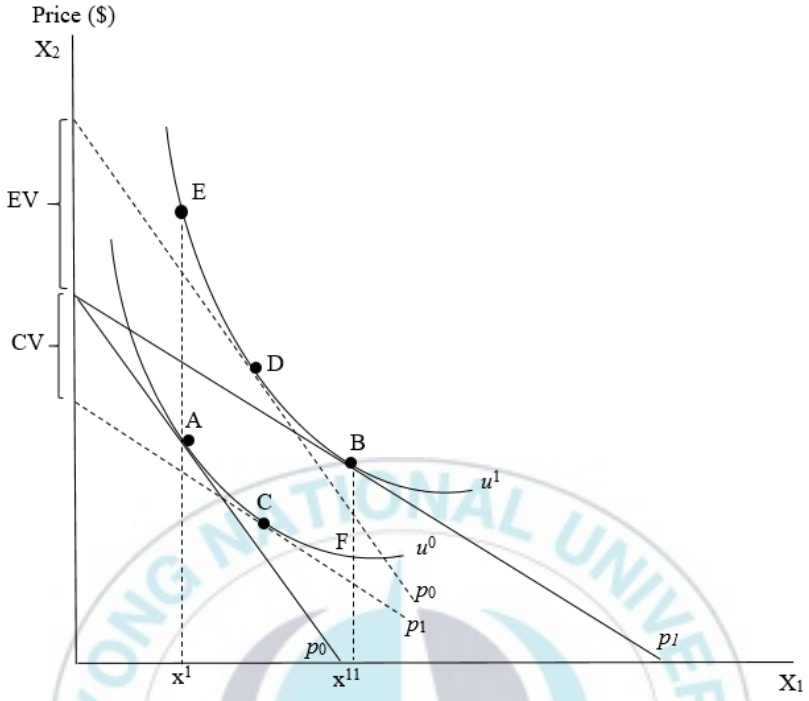



Figure 3.5: Four measures of welfare gain and loss from a price change

Source: Adapted from Freeman et al., 2014

In Figure 3.2 above, the vertical distance from point B to F shows the compensating surplus (CS) measure which is closely related to the CV measure and the vertical distance from A to E shows the equivalent surplus (ES).

WTP is one of the two standard and appropriate measures of economic value, in the situation where an agent needs to obtain a commodity (Carson R. T., 2000). Bateman et al. (2006) have stated three defining characteristics of an ideal WTP elicitation method: i) incentive compatibility; (ii) statistical efficiency; and (iii) procedural invariance. The DC elicitation method has had great use among economists since it was popularized by Hanemann (1984) and Hanemann et al. (1991) demonstrated the drastic improvement in the efficiency associated with the DC model. The single bound dichotomous choice (SBDC) method for extracting willingness to pay (WTP) responses in CV surveys has a prime disadvantage in terms of its low statistical efficiency even though it is an attractive method in terms of incentive compatibility.

Also, the SBDC model shows a significant bias for the parameter and WTP estimate (Kanninen, 1995). The double-bound dichotomous choice (DBDC) is an alternative approach to the SBDC method that provides improved statistical efficiency at the cost of compromised incentive compatibility and is vulnerable to higher response variances. The DBDC model also has a response bias, but Kanninen (1995) discovered that it does surprisingly better than SBDC. As a mean to reduce the likelihood of response bias to subsequent bids in multiple-bound descrete choice formats, such as DBDC models, while retaining most of the efficiency gains of the multiple-bound approach., Cooper et al. (2002) introduced the one and one-half bound (OOHB) approach which differs from the DBDC in several important aspects; it preserves incentive compatibility of responses while generating most of the efficiency gains as DBDC method, but the OOHB is also vulnerable to several anomalies (Bateman et al., 2004). Compared to the SBDC and DBDC methods, the OOHB DC method is identified as the most efficient and widely used CVM method over other DC elicitation methods.

## 3.4 Environmental Valuation

Environmental assets are natural resources such as clean air, water, forests, commercially exploitable fisheries, etc., in that they provide flows of services to people that are equally accessible and have no competition in their use. Many of these natural resources are not bought or sold in conventional markets. Hence, these environmental assets do not have market prices and the economic values of these assets may be different from their actual market value. Environmental valuation is assigning market values for these environmental goods and services.

An environmental valuation can satisfactorily cover only part of the field and has several important limitations. Environmental sciences relate to processes provide complex and not fully understandable scientific and physical data as well as, notions of environmental costs and benefits rest on concepts of sustainable development that need to be tested in operational conditions. Therefore, when selecting a credible and accurate environmental valuation method, the data requirements and availability,

intelligibility and plausibility should be considered. Plausibility is frequently overlooked. (Serrat, 2016).

### 3.4.1 Non-market Valuation

Non-market value can be defined as the economic value of goods or services which are not traded in the conventional marketplace, as no marketplace exists. Boyer & Polasky (2004) has stated that non-market valuation emerged from the desire to consider natural environment in the decision-making process, and they further mentioned that economists and other stakeholders have made an effort to give a monetary value for the services provided by the natural environment, also to the other commodities that there is no physical market but nonetheless have value. Non-market valuation techniques are generally categorized into two main categories as, the Revealed Preference (RP) method and the Stated Preference (SP) method as shown in Figure 3.6.

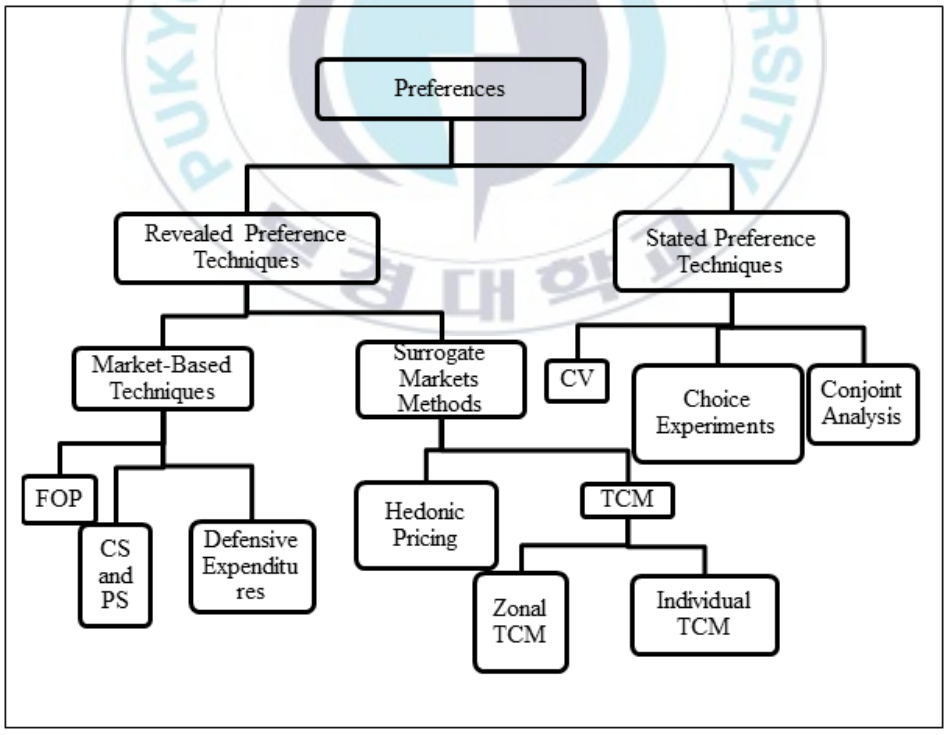



Figure 3.6: Classification of non-market evaluation techniques

Source: (Baker & Ruting, 2014)

The revealed preference method involves determining whether revealed value of the commodity is greater or less than the offered price (the entrance and transportation costs) because these methods are based on actual behavior reflecting utility maximization subject to constraints. In general, analysts need to make assumptions about preferences because of the information limitations provided by respondents' data. So that, models can be estimated with such data. As a result of this, values from revealed preference methods are subjected to limitations (Freeman et al., 2014).

The stated preference method uses an individual's stated behavior in a hypothetical situation to evaluate the value of a non-market good. This method includes a variety of approaches such as contingent valuation method (CVM), conjoint analysis, and choice experiments. CVM is the most commonly used approach in many applications (Alpizar et al., 2001). The old methods of stated preference techniques have been directly questioned people about the values they place on environmental services by creating, in effect, a hypothetical market. These forms of stated preference techniques are commonly referred to as contingent valuation techniques because the responses are contingent upon the specific conditions laid out in the hypothetical market (Freeman et al., 2014).

The main distinguishing feature between these two methods is the type of data utilized for value estimations. Stated preference methods depend on data from well-designed survey questions that ask people what choices they would make regarding substitutions of an environmental commodity (intended behavior). Revealed preference methods depend on data that reveal people's actual selections (revealed behavior) (Boyle, 2010).

However, the economic value of a change in environmental quality relies not only upon the economic and biological parameters of the model, but also on the institutional arrangements for ownership or public management of the resource (Freeman et al., 2014).

### 3.4.2 Contingent Valuation Method

Hanemann et al. (1991) has interpreted the Contingent Valuation Method (CVM) as one of the standard methods for assessing resources that cannot be traded in the conventional market, such as wildlife, recreation, and environmental quality. It is a stated preference non-market valuation method based on questionnaires. More than fifty years ago, Ciriacy-Wantrup (1947, 1952) recommended that "appropriately constructed interviews" could be utilize to obtain information about people's desires for non-market commodities. After that statement, the contingent valuation (CV) method has become the most widely used approach for obtaining willingness to pay (WTP) values for an assortment of environmental and other non-market public goods (Carson, 2007, as cited in Bateman et al., 2009).

Contingent valuation surveys are carried out as face-to-face interviews, email surveys, and telephone interviews. Hanemann (1994) stated that, till the mid-1980s, the bulk of contingent valuation studies applied some style of an open-ended questions such as: "What is the most you would be willing to pay for...?" Thereafter, the majority of key contingent valuation surveys have applied closed-ended questions such as: "If it cost $x, would you be willing to pay this amount?" or "If it cost $x, would you vote for this?" CVM uses survey instruments to obtain an individual's WTP for or willingness to accept (WTA) the change in environmental quality (Hoyos & Mariel, 2013).

Even though CVM is the most accepted environmental evaluation method, it has many problems.

i. Validity of responses – Due to the hypothetical nature of the contingent valuation survey questions that were used to collect the data, there may be confusion whether the answers received would be the same one that a person could get if markets existed.
ii. Strategic bias - This bias arises when respondents act strategically by providing an valuation that they wish to achieve a particular outcome rather than providing their true valuation.

iii. Starting point bias - In a bidding game, when the interviewer's initial evaluation is systematically related to the final bid reported by the respondent, this is called a starting point bias, which can be reduced through pilot surveys to establish a possible starting point.

iv. Information bias - Information bias occurs when respondents may be unfamiliar with, or may not have knowledge of, the scenario presented to them.

v. Payment vehicle bias - Payment vehicle bias occurs when WTP relies on the choice of payment method.

vi. Additional problems in developing countries - Many developing countries do not have an official listing of residents at the village level. Hence, the sample used in CVM surveys may not be random, so responses may not be representative. Furthermore, the entire community may be aware of the study because the village is so small. Due to this reason the researcher might receive similar answers for the survey questions. Another major problem commonly encountered in developing countries is that women tend to respond to the questions in an acceptable manner to their husbands, in the presence of their husbands during the survey. (Honu, 2007).

According to Hanemann (1994), the purpose of designing a contingent valuation study is to capture the pursuit of value, but to formulate it around a particular product that is plausible and meaningful and, if the scenario of presenting the product may not be real, the key is to make it look real to respondents. The obtained values of a CVM study are dependent on the information provided in the questionnaire. Hence, it is the main concern when designing a CVM questionnaire. The details provided in the questionnaire survey should be uniform with empirical and expert knowledge and, comprehensible to an average citizen who has little or zero knowledge about the good in valuation. Therefore, a considerable amount of time and effort should be allocated for questionnaire designing in a contingent valuation study.

Most acceptable contingent valuation surveys contain the following: (a) an introduction about the general context for the decision to be made; (b) a detailed description of the

non-market commodity to be offered to the respondent; (c) the institutional setting in which the commodity will be provided; (d) the payment vehicle; (e) a method by which the survey elicits the respondent's preferences with respect to the commodity; (f) debriefing questions about why respondents answered certain questions the way that they did; and (g) a set of questions regarding respondents' characteristics including attitudes and demographic information (Carson, 2000). Hoyos & Mariel (2013) has stated that CV surveys can directly obtain monetary (Hicksian) measures of well-being associated with discontinuous changes in environmental product offerings by substituting one product for another or marginally substituting other attributes of an existing product. The National Oceanic and Atmospheric Administration (NOAA) panel concluded that the contingent valuation studies can produce estimates reliable enough to be the starting point for administrative and judicial processes. Further, it mentioned that if the respondents are familiar with the assessed commodity, and use professional surveyors for the interviews, the validity and the accuracy of contingent valuation studies can be improved (Arrow, et al., 1993).

### 3.4.3 Dichotomous Choice (DC) Method

The Dichotomous Choice (DC) method is the most popular elicitation format today, even though there are many CV methods in practice. The DC format (also known as a referendum or closed-ended) has been gained considerable acceptance among economists and researchers because of its incentive compatibility (i.e. if the respondents WTP is greater than the presented bid, s/he will answer "yes" and otherwise "no") and its substantial simplification of the cognitive task faced by respondents (Hoyos & Mariel, 2013). In DC approach, respondents are questioned whether they are willing to pay $X to enjoy the benefits of a particular environmental commodity. The answer should be "yes" or "no". According to Honu (2007), it is evident that WTP cannot be derived directly from the DC method. WTP is derived through special statistical or econometric methods as there is no change in the amount of $X faced by each respondent. This approach is claimed to imitate what happens in real market conditions in which a consumer is quoted a price for a product (the price at

which the consumer accepts the product and buys it, or the consumer rejects the product and does not buy it). Hanemann et al. (1991) has stated that the statistical efficiency of conventional DC contingent valuation studies can be improved by questioning each respondent a second DC question which relies on the answer to the first question – if the first answer is “yes”, the second bid is slightly larger than the first bid. On the other hand, if the first answer is “no”, the second bid value is slightly smaller. They have further said that this "double-bounded" approach proved to be more effective than the traditional "single-bounded" approach

The double-bound (DB) contingent valuation method (CVM) has the advantage of being more efficient in estimating welfare benefits than the single-bound (SB) discrete-choice CVM, but some of the answers to the second bid value may not match with the answers to the first bid value, which is a disadvantage of the DB format. As a means to reduce the likelihood of response bias to subsequent bids in multiple-bound discrete choice formats such as DB models, while retaining most of the efficiency gains of the multiple-bound approach, the one-and-one-half-bound (OOHB) approach was introduced to further improve the practical applications presented (Cooper et al., 2001). The OOHB format circumvents the surprises linked with the subsequent question of the DB format, but the presence of this second question breaches the conventional incentive compatibility criterion explained in the Gibbard-Satterthwaite theorem. This introduces the potential for OOHB respondents to strategically misrepresent their preferences (Bateman et al., 2009).

Further, Cooper et al. (2001) proposed the OOHB format that the respondent is presented with a range, [ $B_i^-, B_i^+$], where $B_i^- < B_i^+$. *A* is the presented bid value. The method is as follows; If the lower price, $B_i^-$, is chosen at random as the starting bid, the three possible responses would be (No), (Yes, No) and (Yes, Yes). The corresponding response probabilities would be $\pi_i^N$, $\pi_i^{YN}$, $\pi_i^{YY}$. If the higher price, $B_i^+$, is randomly chosen as the starting bid, the possible responses are (Yes), (No, Yes) and (No, No) and, the corresponding response probabilities of $\pi_i^Y$, $\pi_i^{NY}$, $\pi_i^{NN}$ are as follows;

$$\pi_i^N = \pi_i^{NN} = \mathrm{P_r}\{C_i \leq B_i^-\} = G(B_i^-;\theta) \quad \text{Equation 3.1}$$

$$\pi_i^{YN} = \pi_i^{NY} = P_r\{B_i^- \leq Ci \leq B_i^+\} = G(B_i^+;\theta) - G(B_i^-;\theta) \quad \text{Equation 3.2}$$

$$\pi_i^{YY} = \pi_i^Y = \mathrm{P_r}\{C_i \geq B_i^+\} = 1 - G(B_i^+;\theta) \quad \text{Equation 3.3}$$

If the starting bid is $B_i^-$ and the response is (No) or if the starting bid is $B_i^+$ and the response is (No, No), then let $d_i^N = 1$; otherwise 0. If the starting bid is $B_i^-$ and the response is (Yes, No) or if the starting bid is $B_i^+$ and the response is (No, Yes), le$d_i^{YN} =$ 1t; otherwise 0. If the starting bid is $B_i^-$ and the answer is (Yes, Yes) or the first bid is $B_i^+$ and the response as (Yes), let $d_i^Y = 1$, and 0 otherwise. Finally, the log-likelihood function for the responses to a CV survey using the OOHB format is as follows;

$$ln\, L^{OOHB}(\theta) = \sum_{i=1}^{N}\{d_i^Y\, ln\,[1-G(B_i^+;\theta)] + d_i^{YN}\, ln\,[G(B_i^+;\theta - G(B_i^-;\theta)] + d_i^N\, ln\,[G(B_i^-;\theta)]\} \quad \text{Equation 3.4}$$

The median WTP (denoted as $C^*$) can be obtained by solving for $C^*$ in the below equation;

$$G_c(C^*) = 0.5 \quad \text{Equation 3.5}$$

If WTP is greater than or equal to zero, the truncated mean WTP (denoted as $C^{++}$) is;

$$C^{++} = \int_0^\infty [1 - (G_c(A)]\, dA = (1/b)\ln[1+\exp(a)] \quad \text{Equation 3.6}$$

Where *a* is the constant and *b* is the coefficient of bid.

In a linear logistic model, the overall mean and median WTP can be measured as follows;

$C^+ = C^* = a/b$ (7) Equation 3.7

In DC contingent valuation surveys, it is common to have respondents who would reject paying for the hypothetical market. Therefore, it is useful to have a model that allows zero WTP responses. Hence, Kristrom (1997) introduced the two versions of spike model which allows zero responses without compromising the analysis in any way. First, the sample is essentially partitioned into respondents with zero WTP and positive WTP. The second version of the model aims at splitting the respondents into three different categories: those who dislike the project (the "losers"), those who are indifferent, and those who find that the project is welfare-improving ("the winners").The spike model uses two valuation questions by default to identify zero responses: asks whether or not the individual would like to contribute at all to the project or the other offers price *A*. The distribution of WTP in the extended spike model is as follows;

$F_{wtp}(A) = H_{wtp}(A)$ if $A<0$

$p_-$ if $A \rightarrow 0^-$

$p_+$ if $A \rightarrow 0^+$

$G_{wtp}(A)$ if $A>0$

Where, $H_{wtp}(A)$ describes those with a negative WTP and $G_{wtp}(A)$ describes those with a positive WTP. The proportion of zeroes is given by $p_- - p_+$.

The mean can be calculated by

$E(WTP) = \int_0^\infty 1 - F_{wtp}(A)\, dA - \int_\infty^0 F_{wtp}(A)\, dA$ Equation 3.8

The discontinuity at zero does not matter; it contributes zero to the integral. The median is obtained by solving for $A^+$ in the following equation;

$F_{wtp}(A^+) = 0.5$ Equation 3.9

## 3.5 Empirical Literature Review

The main goal of this empirical analysis is to explore how environmentalists and economists value the litter impact on coastal areas around the world. Impacts of marine litter can have either direct or indirect costs to the economies. Direct economic costs of marine litter stem from damage to an industry or economic activity, such as the costs of vessel break down due to marine litter entanglement on a vessel propeller and these costs can be readily measured. Marine creatures that consume marine litter and contaminate the food chain is an example of the indirect cost of marine litter and it cannot be easily measured. Non-market values of marine litter can be estimated when there are non-market values such as scenic values, or the values placed on the marine environment, or marine activities by people who do not necessarily access them (APEC, 2008).

Over the past years, it has been proven that CV is the most popular valuation tool among economists when it comes to the valuation of non-marketed commodities since it relies on stated preference techniques. Towards that end, this technique has been widely used by environmental economists and researchers in the past decades to value a variety of non-marketed commodities. Although a great attention has been paid to beach recreation in the environmental economics literature, studies evaluating the economic benefits of marine litter reduction efforts are lacking (Leggett, et al., 2017).

The limited literature regarding the evaluation of marine litter reduction includes Jin et al. (2020) which is an economic valuation of the reduction of marine litter by employing contingent valuation (CV), that asks people to indicate their willingness to pay (WTP) for the reduction. A dichotomous choice CV survey has been conducted by a professional survey firm through one-on-one interviews with 1,000 households. 37.9% of respondents had stated zero WTP, and the household's annual WTP was estimated at an average of 5523 won (USD 4.92). The WTP of the population for the reduction was 110.3 billion won ($99.75 million) per year for the next five years. The economic effects of SMD have been summarized in three ways. First, tourism revenue is decreasing due to marine environmental pollution caused by SMD. Second, there are

economic damages that occur to fishermen. The third effect of SMD is the national economic loss from transboundary pollution. Stratified random sampling has been performed using strata. The median WTP obtained in this study was zero and the mean WTP was estimated to be positive. The mode WTP has not been calculated because it has been used DC WTP question. It has been found that the reduction is socially beneficial since its value outweighs the costs associated with the reduction.

Brouwer et al. (2017) conducted the first study to evaluate the social costs of marine litter washed ashore and litter left by beachgoers on different European coasts. Three identical surveys, including a discrete choice experiment, have been executed at six coastal areas along various European coastlines. These social costs are driven by public awareness of the impact of the beach litter experience and the willingness of beach visitors to contribute several hours a year to activities such as volunteering to clean up beach litter, as well as increased entry fees or local taxes. The calculated WTP welfare measures linked with beach littering were used in this study as indicators of the social costs involved.

Smith et al. (1996) had the first attempt to measure the importance of controlling marine debris as an aesthetic characteristic of beaches and coastal area. The contingent valuation method has been used to estimate the economic value people would pay to control marine debris on recreational beaches in New Jersey and North Carolina. The Weibull survival model was assumed to treat for and against votes as defining censoring points for an unknown willingness to pay a distribution of votes. The study findings suggest that: (1) people to differentiate situations with different amounts of debris when describing using color photography. (2) the pilot survey implies measures of people's willingness to pay (WTP) for litter control are consistent with scope test in that larger WTP is associated with programs that address situations for more severe background levels of litter, and (3) Local beach setups seem to influence how people interpreted the plans to describe beach conditions without the proposed control programs.

Loyola et al. (2019) have used a stated preference questionnaire to estimate the economic value of Galapagos National Park's recreational attributes. The selected five attributes of the park for this study were endangered species, the prevalence of garbage, site infrastructure, air quality, and entrance fees. As per the results of this study, tourists place the highest willingness to pay values on increased protection of animal species (US$26.9) and garbage reduction (US$111.2).

Balance et al. (2000) have estimated the deterrent effect of marine litter on beach users and the consequent effect on the regional economy. An interview survey has been employed to determine the importance of beach cleanliness to local and non-local beach users. Especially by foreign tourists have stated cleanliness at the most important factor in influencing choice of the beach. Almost half of the Cape Metropolitan Region respondents were prepared to spend more than seven times the average trip cost to visit clean beaches. Furthermore, this study has found that, up to 97% of the value of these beaches could be lost by a drop in standards of cleanliness. The travel cost method has been employed to estimate the recreational value of selected beaches in the Cape Peninsula, South Africa.

King (2018), in his study, has conducted a cost-benefit analysis to assess the cost and benefits of recovering marine plastics from the environment. He has found that none of the marine plastic recovering methods are profitable even though there is a range of uses exist for recovered marine plastics, but, he has further found that while not financially viable, the plastic recovering scheme is found to be economically viable given the significant damages from marine plastics on the marine economy.

The study administered by Loomis & Santiago (2013), compares the economic values of increasing beach water clarity and eliminating trash on beaches, derived from CV method and Choice Experiments (CE). The results of this study show the economic value of increasing beach water clarity per visitor per day has been estimated at $54 ($39–73 CI) using CVM, while CE estimated $51 ($34–70 CI). Eliminating trash on beaches has been estimated at $103 ($83–131 CI) using CVM, while it has been estimated as $98 ($77–126 CI) per visitor day using CE. Comparing the benefit

estimates of the two methods, the CVM and CE 90% confidence intervals overlap and represent statistically equivalent values.

Leggett, et al., (2017) has used the random utility maximization (RUM) travel cost model to describe beach trips by residents of Orange County, CA. In this study, it was mentioned that coastal communities and volunteer groups spend significant time and money on efforts to limit marine debris on beaches highlighting the potential magnitude of impacts. RUM has been used to evaluate the economic benefits linked with several hypotheses for marine litter reduction. This study has addressed the gap by estimating the potential benefits for beach visitors from reduced concentrations of marine litter, focusing on Orange County, CA. The estimated seasonal per capita benefit linked with a 25% marine litter reduction on all beaches in the selected set is $12.91 (total benefit of $29.5 million in 2013 dollars), with estimated seasonal benefit per capita of $20.36 associated with hypothetical improvements that may be associated with full implementation of the Los Angeles River Waste (total profit of $46.5 million).

Table 3.2: Summary of the estimated WTP values for the removal/ reduction of marine litter

| **Authors** | **Method** | **Observations** | **Payment Style** | **Bids (USD)** | **Mean WTP (USD)** |
|---|---|---|---|---|---|
| (Jin, Kwon, & Yoo, 2020) | CVM (OOHB) | 1000 households | Tax over the next five years | 1-3, 2-4, 3-5, 4-7, 5-9, 7-11, 9-14 | 4.9/year/ household |
| (Choi & Lee, 2018) | CVM (OOHB) | 400 households | Tax | 1-3, 2-4, 3-5, 4-7, 5-6, 5-7, 6-8, 7-9 | 2.59/year/ household |
| (Abate, et al., 2019) | CVM (SBDC) | 1804 households | Tax | 58.5, 175.6, 316, 515, 819 | 642/year/ household |
| (Monserrate & Ruano, 2020) | CVM (SBDC) | 1000 | Donation for a program | 0.25, 0.5, 1, 3, 5, 10 | 2.59/annually |
| (Shen, Mao, Xie, & Li, 2019) | CVM (Probit) CEM | 805 | Entrance fee | 0-0.29, 0.3-0.59, 0.6-0.89, 0.9-1.18, 1.18 - Above | 1.08 – 1.4 |

| Authors | Method | Observations | Payment Style | Bids (USD) | Mean WTP (USD) |
|---|---|---|---|---|---|
| (Loomis & Santiago, 2013) | CVM<br>CEM | 214<br>213 | Additional trip cost | - | 98-103 |
| (Smith, Zhang, & Palmquist, 1996) | CVM | 693 | Local tax/entrance fee | - | 21.38-72.18 |
| (Brouwer, Hadzhiyska, Ioakeimidis, & Ouderdorp, 2017) | DCE | 650 | Entrance fee | 0.59, 1.17, 2.91, 5.85 | 0.78 – Greece, 9.64 – Bulgaria, 2.4 Netherland visitor/year |
| (Loyola, Wang, & Kang, 2019) | DCE | 1585 | Fee for entering the national park | 100, 125, 150, 175, 200 | 111.2 per visit |
| (Khedr, et al., 2020) | DCE | 1000 | Additional waste management fee | 5.85, 11.7, 23.4, 40.95, 58.5 | 1% more on top of their current waste management fee |

## 3.6 Conceptual and Theoretical Framework

As mentioned earlier in the preceding paragraphs, non-market valuation techniques are usually classified into two categories, namely revealed preference and stated preference methods. In this section, the emphasis is rather placed on the stated preference method since it is the major technique of this research. Therefore, a review of the concepts and theories related to the stated preference technique will be necessary.

Stated preference contingent valuation methods are widely accepted and most popular non-market valuation technique among economists because it requires people to directly report their willingness to pay (WTP) to acquire a particular commodity or their willingness to accept (WTA) to give up a commodity, rather than infer them from observed behavior in regular markets. However, a quality study requires a careful attention to the method and even a good study design requires to identify the barriers of each approach and the assumptions made. This study is based on the OOHB DC

contingent valuation method which is a stated preference technique and the researcher considers these considerations carefully to administrate the study result.

OOHB model has many advantages than using other contingent valuation methods like single bound DC method and DBDC method for non-market valuation. Although the OOHB model uses fewer information than the double-bounded (DB) approach, the efficiency gains from moving from single-boundary to OOHB account for a large portion of the efficiency gains associated with moving from single-boundary to DB. When analyzing the survey data, OOHB estimates are more consistent and more efficient for subsequent data than DB estimates (Cooper et al., 2001). Therefore, OOHB DC method was chosen as the valuation technique of this study.

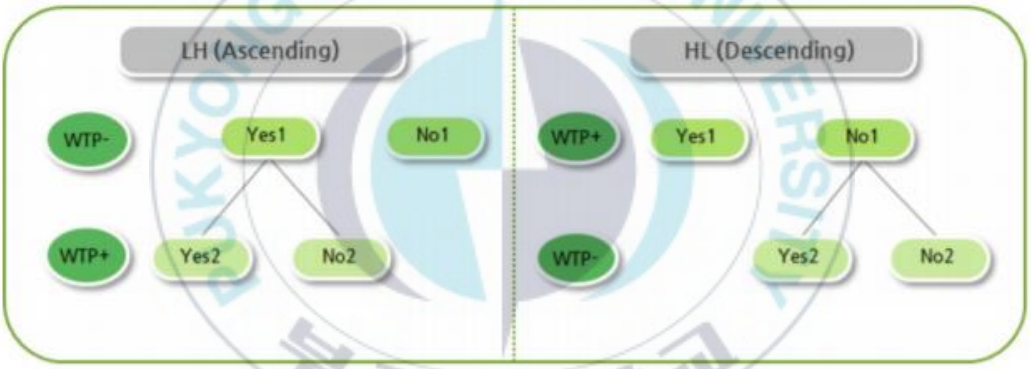



Figure 3.7: Questionnaire type of 1.5 bound dichotomous choice model
Source: (Kim et al., 2014)

# 4. Survey and Data Analysis for Respondents' Preference

## 4.1 Introduction

Open-ended questions, bidding game questions, payment card questions and dichotomous choice (DC) questions are the four main methods used in literature for eliciting WTP. The DC method has been used in this study as the WTP elicitation method because DC question method has been employed in most recent literature and as explained in the previous chapter, it has many merits over other methods.

Figure 4.1 shows the overall framework of the survey using CVM. Since CVM surveys influence finding respondents' behavior rather than preferences, it is important how non-market goods/services that are not being evaluated are combined with market types, payment vehicle, methods of elicitation, and survey methods. This study produces various results by analyzing the survey data collected from 600 respondents, including respondents' perception on marine litter reduction, level of awareness on marine litter issue in Sri Lanka, willingness to participate in voluntary beach cleanup programs, and time spent on cleanup activities, etc.

This chapter is aligned as follows: Section 2 elaborates the questionnaire designing including an evaluation of the validity and reliability of CVM survey designs. Section 3 describes the sampling and survey method of the study. Section 4 discusses the WTP elicitation method and the payment vehicle. Section 5 includes a data analysis and discussion of survey findings, leaving the question of economic valuation to a later chapter.

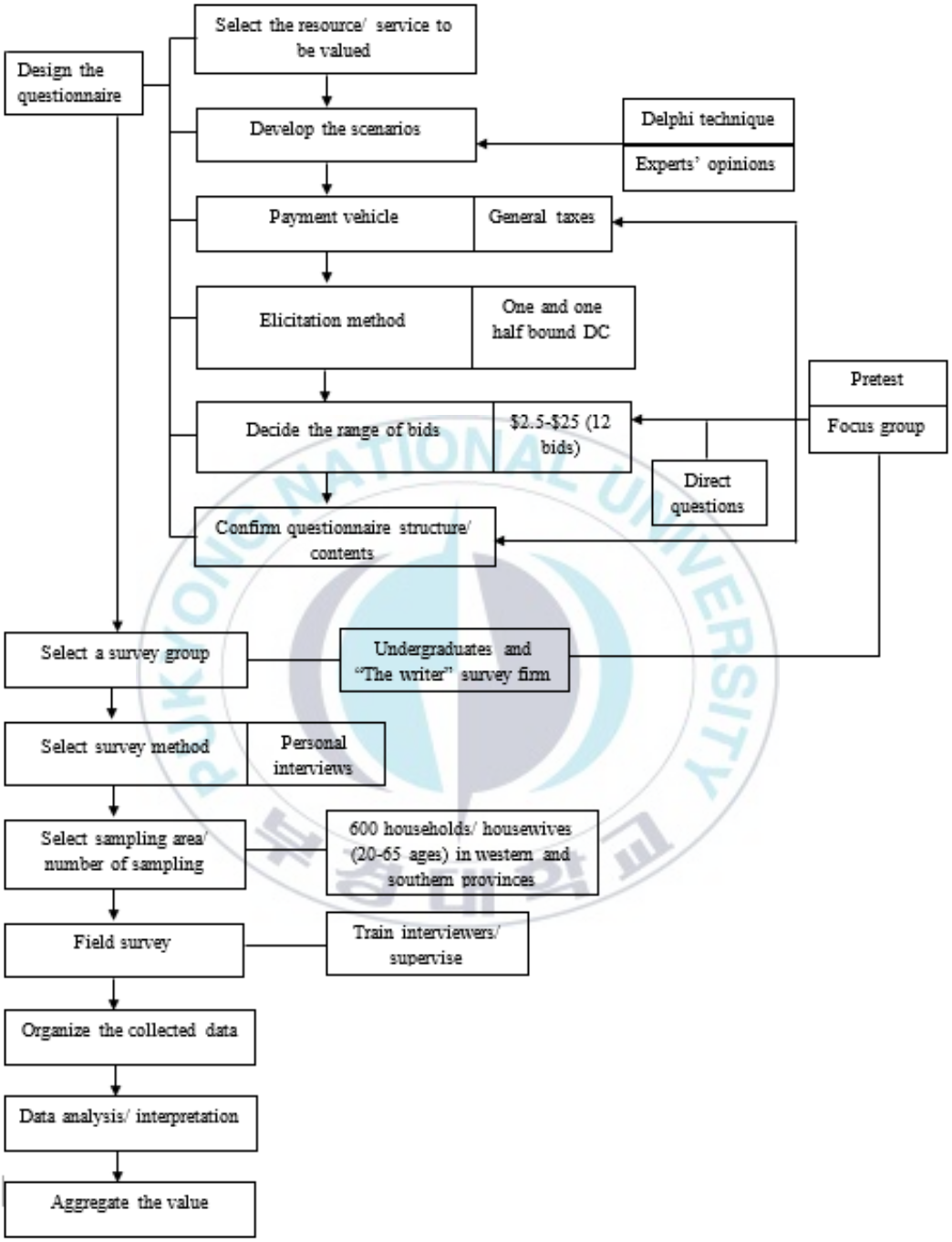



Figure 0.8: The survey framework using CVM

## 4.2 Questionnaire Design

The CV questionnaire should be well-made with great effort. In order to conduct an actual field survey with a well-made CV questionnaire, the survey method should be determined as the first step. This study adopted OOHB DC question method and the questionnaires were designed accordingly. Questionnaires were set without private questions such as respondent's name, home address, contact number, etc.

The technique of using value statements of a survey as a measure of WTP has critics. The obvious concern is validity which refers to the degree to which the CVM evaluation correctly indicates the 'true' value of the environmental resource/ service under investigation (Bateman & Turner, 1992). CVM generally focused on validity rather than reliability (Loomis, 1989). Mitchell & Carson (1989) identified three categories of validity testing: content validity, criterion validity, and construct validity. Content validity measures whether the estimated WTP can be accurately and fully correspond to the environmental resource/ service under investigation. Criterion validity compares the CVM estimates with the 'true' value (the criterion) of the non-market good. Construct validity investigates whether the measures produced by CVM relate to other measures as predicted by theory, and this has two categories as theoretical validity and convergent validity (Bateman & Turner, 1992). Further, when respondents have knowledge about, experience with, and well-formed attitudes toward the good, they are more likely to assign higher economic values as well as contingent values are more likely to be valid (Heberlein et al., 2005).

Reliability refers to the consistency and repeatability of CVM estimates (Bateman & Turner, 1992). Reliability test in a CVM study is important for designing suitable experiments to check the validity of CVM by determining what an individual's "true" willingness to pay would be if a real market existed (Loomis, 1989). Reliability can be evaluated by comparing the test-retest correlations and by assessing the stability of the willingness to pay functions themselves (Loomis, 1990).

The questionnaires of the study were designed in September 2021. Two separate questionnaires were developed for lower-bound and upper-bound WTP questions. Both questionnaires consisted of three main sections with 22 questions. There are five questions at the beginning of the questionnaire to select suitable respondents for the survey (respondent selection questions). The first section focused on the residents' perception of marine litter reduction of Sri Lanka's beaches. This section began with an introduction to general information about marine litter with a view card. That would give them a full understanding of the current situation of marine litter in Sri Lanka. It was followed by series of questions related to the knowledge on marine litter, willingness to volunteer for beach cleanup programs, beach visiting pattern and purpose, marine litter impact on the residents' beach experience and their attitude toward marine litter reduction. The second section is the most important part of the survey and it was mainly about residents' willingness to pay for marine litter reduction. There is a view card with two pictures that one of those shows a beach with litter (Base Condition) and the other picture shows a very clear and clean beach without marine litter (Condition A). The third section comprised of socio-economic questions which sought to ascertain the socio-economic status of respondents. This part included some relatively easy questions such as, level of education, employment status, annual household income and average annual household spend.

The pre-test surveys and focus group interviews were conducted in early October. 36 sample households were selected for the pre-test surveys and focus group interviews. During the focus group interviews, respondents were asked if they are willing to pay an environmental tax for the next 10 years if the beach condition improved to 'Condition A' (hypothetical). Most of the respondents stated that since the government policies and strategies are revised every 5 year time, it is more appropriate if it is a tax for the next 5 year time. Further, they have stated that the questions in the questionnaire are understandable and none of the questions make them inconvenient to answer. Six sets of two bids were determined for pre-test survey. These bid values were assumed based on a previous WTP study on wetland conservation in Sri Lanka which has used

the same WTP elicitation method. The bid values used for the pre-test survey were; (100;300), (200;400), (300;500), (400;600), (550;750), (700;1,000) (in LKR)[1]. The first value of each set of bids is the lower bid and the second value is the higher bid. However, almost all the respondents interviewed for the pre-test survey had higher WTP values than the bid values. Therefore, considering the responses for pre-test survey, the bid values were revised for the final survey.

After making adjustments to the questionnaire according to the responses received during the pre-test and focus group interviews, the survey was carried out during November, 2021. The determined bid values for the final survey are; (500; 1,700), (1,100; 2,300), (1,700; 2,900), (2,300; 3,500), (3,000; 4,200), (3,800; 5,000) (in LKR). The total number of sampled respondents were divided into two groups. In the first group, respondents were questioned whether they were desired to pay the lower amount. If the respondent answered "yes", then the higher bid value was presented. Otherwise, the survey ended. In the next group of respondents, they were questioned whether they were desired to pay the higher bid value. If the respondent answered "yes", the survey ended; if not, they were questioned one more time to know whether they were desired to pay the lower bid value. If the respondent answered "yes", then s/he was asked about their maximum willingness to pay value for the marine litter reduction. The respondents who responded "no-no" or "no" were asked a follow-up question, whether or not they were willing to pay a single LKR for marine litter reduction. In addition to that, those who were not willing to pay any amount were questioned as to the reason they had for voting against an environmental tax.

Since respondents have to express their choice in an unfamiliar market, they should be well informed about the resource being valued in the hypothetical scenario. However, some difficulties were experienced with the residents, especially those who did not understand the objective behind the surveys. The copies of the questionnaire were made

[1] US $1 is approximately equal to 200 LKR (Sri Lankan Rupees) in 2021.

available in Sinhala and English as majority of the population is comfortably communicating in Sinhala.

## 4.3 Sampling and Survey Method

This study limits the sampling area to western and southern provinces of Sri Lanka which includes six coastal districts: Gampaha, Colombo, Kalutara, Galle, Matara, and Hambantota (Figure 4.2 - marked in red dots). The two major reasons of selecting this sample area are, over 40% of the total household population is living in these six coastal districts (Central Bank of Sri Lanka, 2019) and most of the studies on marine litter quantification in Sri Lanka (Athawuda et al., 2018; Hettige et al., 2015; Jang, et al., 2018; Sivaramanan & Kotagama, 2018; Weerakoon et al., 2018; Samaranayake et al., 2018) evidenced that western and southern coast are highly polluted with small and large marine litter. In addition to that, more than 50% share of the gross domestic production (GDP) is generated in this selected area (Central Bank of Sri Lanka, 2019), evidently, most of the manufacturing and service industries located in Colombo and other districts in the western and southern province, more than 50% of the total marine fish catch has been recorded from these coastal districts (Ministry of Fisheries, 2020) and over 60% of tourist hotels are also located along the western and southern coast (Sri Lanka Tourism Development Authority, 2019) which means that western and southern coastal districts have the highest income generation from coastal tourism.

The Stratified Random Sampling method is the sampling technique used in this study. This technique is a probabilistic sampling method, consists of dividing the entire population under study into smaller sub-groups known as strata. The stratum variable considered in this study was districts and an individual (household in this study) can only belong to a stratum. The sample size of each stratum was proportional to the household population of each stratum. The targeted sample size for this study was 600 households. Thus, the optimal sample size of Gampaha was 166 observations, 167 for Colombo, 88 for Kalutara, 77 for Galle, 59 for Matara and 43 for Hambantota. The survey team randomly selected households from each stratum. This study excluded people under 20 or over 65 years of age who may lack the ability of economic decision

making can have a significant impact on the analysis result (Jin et al., 2020). To improve the reliability of data, heads of the households or spouses who are capable of making financial decision of the household were interviewed. A team of well-trained undergraduates of Sabaragamuwa University of Sri Lanka, and 5 of the experienced interview experts of "The writer" survey firm were selected to conduct the interviews. Due to the COVID 19 pandemic some of the interviews were conducted via online platforms such as, Zoom and Google Hangout. A total of 600 questionnaires were completed effectively.

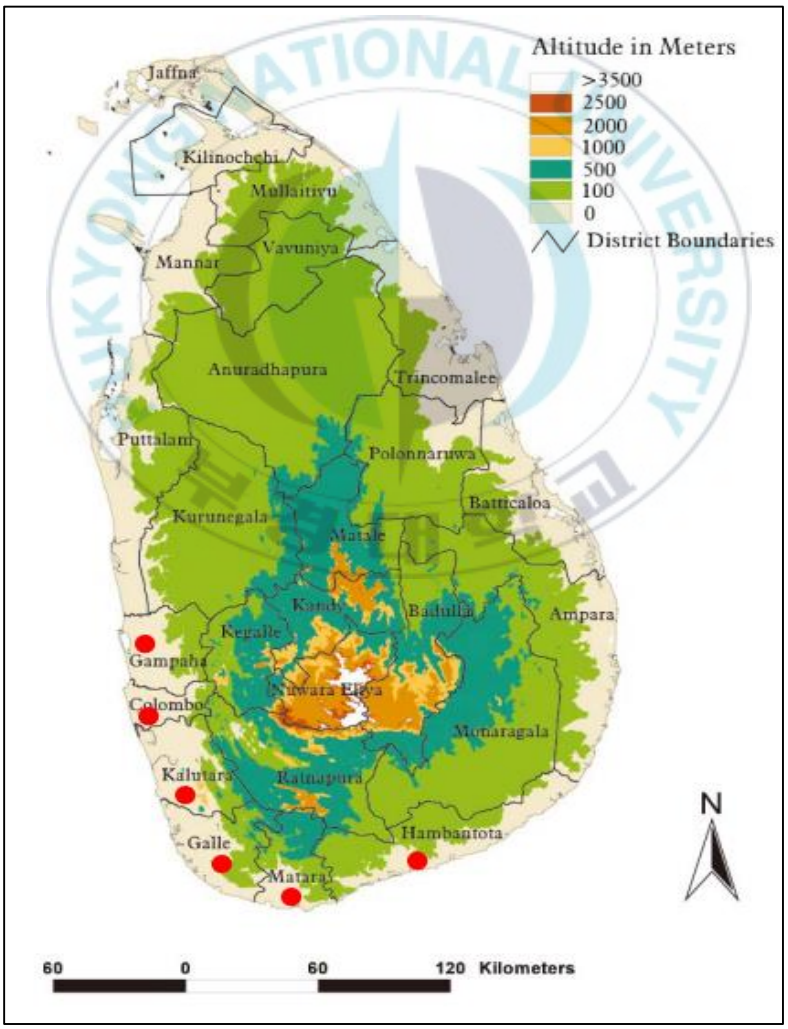



Figure 0.9: The Map of Sample Area

This study used face-to-face interviews as many CV studies have used this method as a more reliable approach. In addition to that, interviewers can clearly explain the hypothetical market to interviewees, so that, interviewees may have enough information to determine if they are willing to pay for the proposed hypothetical market. The respondents were informed that they were participating in an academic research at the beginning of the interview and only the residents who expressed their willingness to support the research were selected for the survey.

## 4.4 WTP Elicitation Method

The DC model has had great use among economists since it was popularized by Hanemann (1984). The single bound (SB) dichotomous choice technique for eliciting willingness to pay (WTP) responses in contingent valuation surveys has a major drawback in terms of its low statistical efficiency even though it is an attractive method in terms of incentive compatibility. DBDC is an alternative approach that provides improved statistical efficiency at the cost of compromised incentive compatibility, and vulnerable higher response variances. The one-and-one-half-bound (OOHB) dichotomous choice method is an innovative elicitation method introduced by Cooper et al. (2002), differs from the DBDC in a number of important aspects; it preserves incentive compatibility of responses while generating most of the efficiency gains as DBDC method, but the OOHB is highly vulnerable to a number of anomalies (Bateman et al., 2004). Hanemann et al. (1991) demonstrated the drastic improvement in the efficiency associated with the DC model. As explained in the previous chapters, the OOHB DC method is the most efficient and widely used CVM method over other DC methods. Hence, the elicitation method employed in this study is the OOHB DC method.

Since the total sample size of the study is 600 households, lower-bound questionnaires were given to 300 households and upper-bound questionnaires were given to other 300 households. Six questionnaires with lower-bound bids (500, 1100, 1700, 2300, 3000, 3800) and six questionnaires with upper-bound bids (1700, 2300, 2900, 3500, 4200,

5000) (in LKR) were used in this study. The results of the pre-test for focus groups were used to refine the range of bid amounts for the OOHB DC WTP questions. The lower-bound and upper-bound questionnaire formats are depicted in Figure 4.3. The respondent is presented with a range of bids [$B\ i^{-}$ , $Bi^{+}$], where $B\ i^{-} < Bi^{+}$. One of these two prices is selected randomly and the respondent is asked whether s/he would be desired to pay that amount. The second WTP question is asked only if the response for the first question is compatible with the first price. If the lowest price, $B\ i^{-}$ is randomly asked as the starting bid, the responses would be (no), (yes, no), and (yes, yes). If the highest price, $Bi^{+}$ is asked as the starting bid, the responses would be (yes), (no, yes), and (no, no) (Cooper et al., 2002).

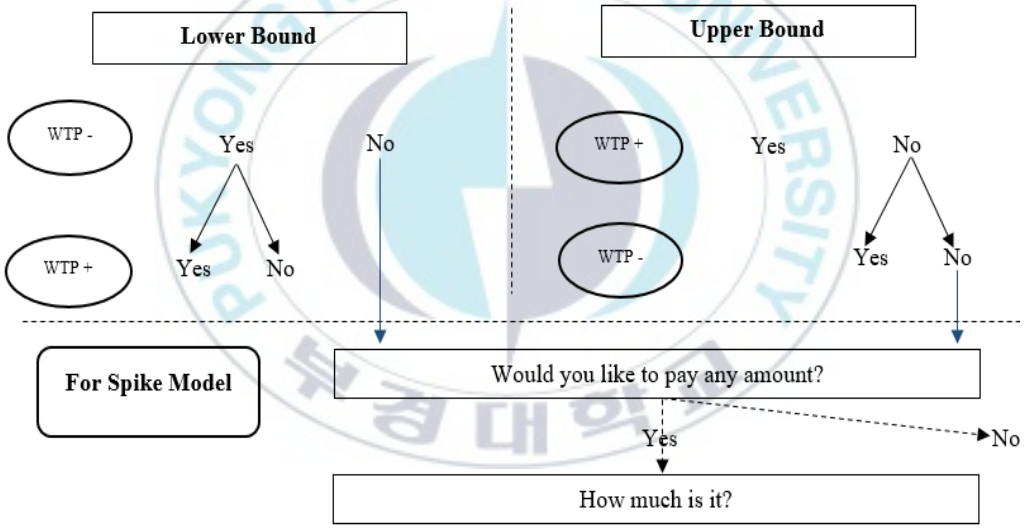



Figure 0.10: Bidding tree for OOHB DC and Spike experiments

## 4.5 Payment Vehicle

Utility bills, entrance fees, taxes and increased prices are the common types of payment vehicles used in most CVM studies. Participants in the focus group interviews mentioned that they would prefer for an annual environmental tax since the people feel more obliged for a tax and it is very realistic than other payment types. Also, it is more realistic to use as a financial source for government policy implementation. Therefore, the payment vehicle used for this study is an environmental tax. Sri Lanka introduced environmental taxes by the Environmental Conservation Levy Act No.26 of 2008 as another strategy to reach the sustainable development.

Environmental tax has a plausible connection with the marine litter removal programs because it is the main source of payment for the project implementation costs. The WTP question was: "Would your household be willing to pay the given amount as an environmental tax, each year for five year time for a marine litter removal program to have a litter-free marine environment around the country? If you would not pay, the program would not be implemented and the marine litter will not be removed from the coastal areas".

## 4.6 Data Analysis for Respondents' Preferences

The questionnaire format consisted of three main sections; (i) respondents' perception on marine litter reduction, (ii) WTP question to reduce marine litter in Sri Lanka, (iii) socio-economic questions. Before starting the questionnaire there are five questions at the beginning of the questionnaire to select appropriate respondents. It includes the questions regarding the gender, born year (only respondents born between 1956 and 2001 were surveyed), whether s/he is head of the household or his spouse (unless they were not subjected to the survey), whether they have monthly income (if not, the survey was ended) and finally the residential area the respondent currently lives in (if a respondent is living outside the six coastal districts selected for this study, the survey was discontinued). The complete questionnaire, including view cards, is provided in Appendix A.

#### 4.6.1. Socio-economic Characteristics of Respondents

The findings of this survey provide in-depth details for policy-makers of Sri Lanka regarding how people in different socio-economic backgrounds, ponder about the value of reducing marine litter in coastal environment in Sri Lanka. Users of this study will find the perception of Sri Lankan people towards marine litter reduction, the most common reasons that they want to protect the marine environment at a cost, and this provides cost-effective means for making benchmarking policies and practices for the policy planners in Sri Lanka.

Overall, 49% of the respondents were men. The survey was aimed at assessing the opinions of people aged from 20 to 65 and focusing on the head of the household or his spouse. 41% of the respondents were in their 30's showing the highest age group participating in the survey. 23.5% of the respondents were in their 40's, 20.2% of the respondents were in their 50's, 9.3% of respondents were in their 20's and 6% of respondents were in their 60's (Figure 4.4). More than half of the respondents (54%) were heads of households.

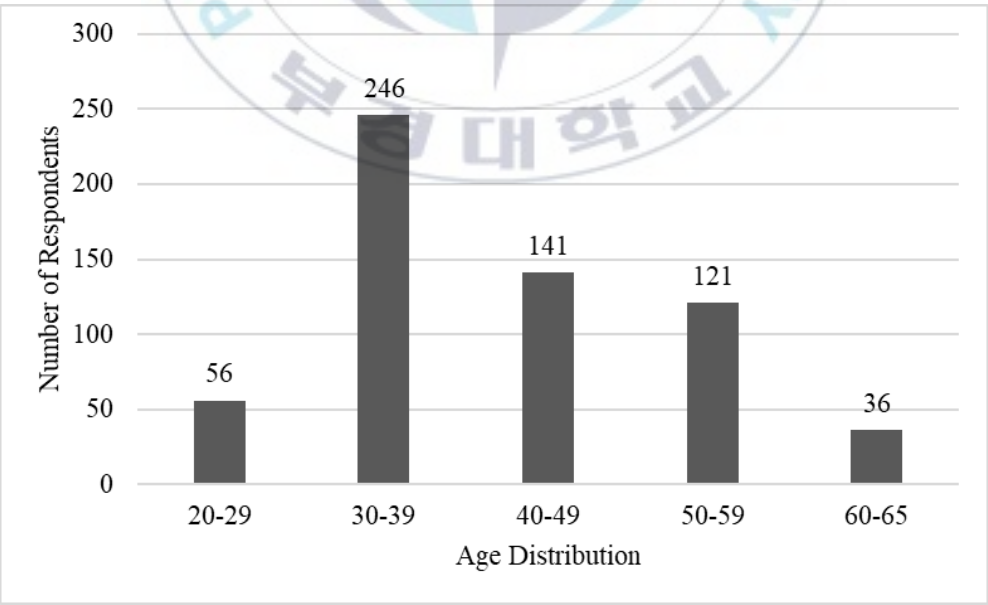



Figure 0.11: The age distribution of respondents

Only the respondents who have a monthly income were considered for the survey as the people who do not have a monthly income have no ability to make economic decisions. 27.8% of respondents were residing in the Colombo district, 27.7% were in Gampaha, 14.7% were in Kalutara, 12.8% were in Galle, 9.8% were in Matara and 7.2% were in Hambantota district. These percentages were based on the distribution of household population in each district.

The majority of the respondents (38.5%) were employed in private sector companies (Figure 4.5). 24.7% were government servants, 15.8% were self-employed, 11.5% were housewives, 5.7% were retired people, 3.5% were employed people in various fields such as brokers, and only 0.3% of respondents were unemployed.

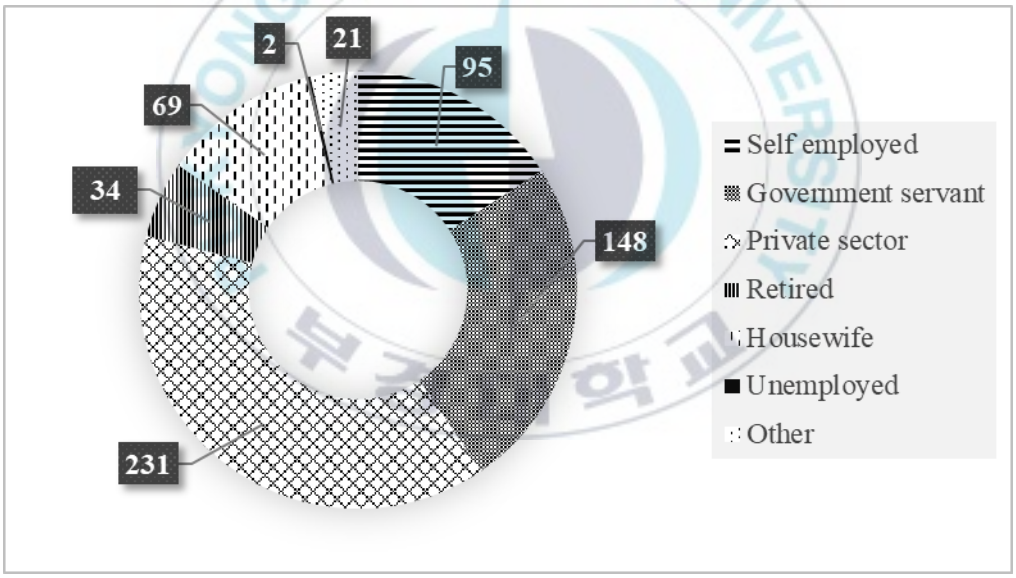



Figure 0.12: Types of respondents' jobs

The majority of the respondents had a higher educational background where 31.2% had collegiate education, 30.2% had a university degree, and 5.7% had a Master/Ph.D. qualification (Figure 4.6).

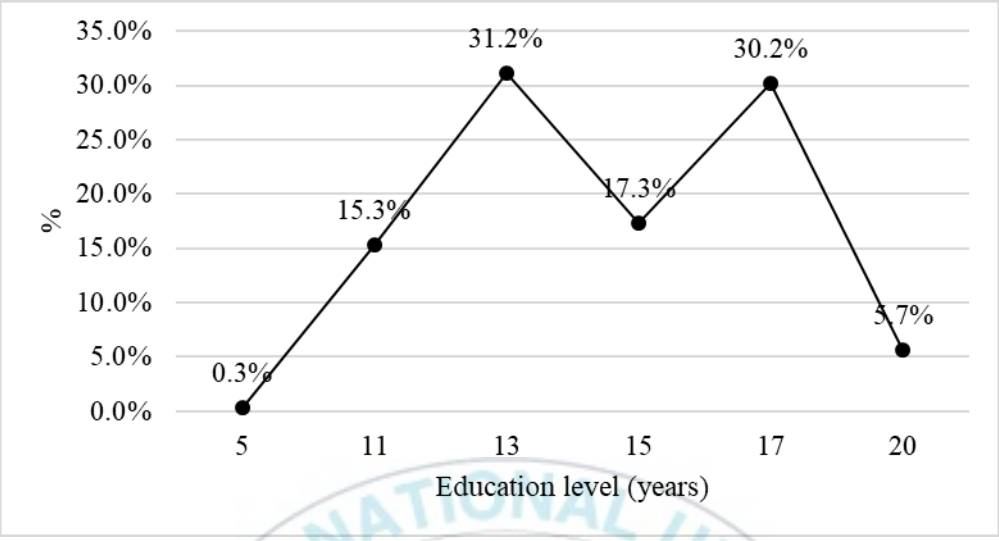



Figure 0.13: Education levels of respondents

41.5% of respondents' annual income was ranging between $3900-9600. Those with annual income less than $900 were 1.8%, and the other edge of the income spectrum of earnings for greater than $9600 was 19.2%. Table 4.1 shows detail distribution of annual income of the respondents.

Table 0.11: The annual income distribution of respondents

| Annual Income | Frequency | Ratio (%) |
|---|---|---|
| Less than $900 | 11 | 1.8% |
| $900-1800 | 51 | 8.5% |
| $1800-2700 | 70 | 11.7% |
| $2700-3900 | 104 | 17.3% |
| $3900-9600 | 249 | 41.5% |
| More than $9600 | 115 | 19.2% |
| **Total** | 600 | 100% |

More of the respondents spent on average $2375-8500 annually for their day-to-day requirements including recreational and other leisure activities which include 20.3%

expend $2375-3430, 38.8% expend $3430-8500, and 18.8% expend more than $8500 annually (Figure 4.7).

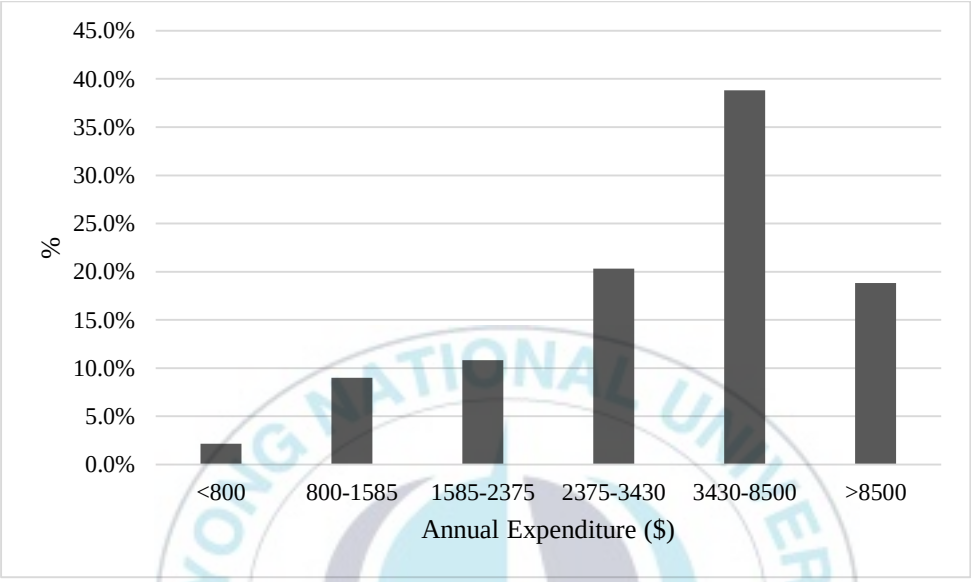



Figure 0.14: Annual Expenditure of Respondents

### 4.6.2. Residents' Perception on Marine Litter Reduction

The general knowledge of respondents about the marine litter issue in Sri Lanka is on an average level. The results show that 42% of respondents had little knowledge and 41% had average knowledge about it (Figure 4.8). From 600 sample of respondents, majority (36.5%) was visiting a beach 1-2 times a year. 13.8% of respondents had no experience in visiting a beach during last two years (2019 and 2020), out of which 50.6% were Gampaha district residents. Only 7.3% of respondents have visited a beach more than 2 times a month and majority (38.6%) of them are Galle district residents (Table 0.12). Approximately 80% of the respondents stated that there was at least a little annoyance with marine litter when they visited the beach and only 6.5% of respondents stated that there was no annoyance at all from the marine litter, out of which 61.5% of them are not frequent visitors to the beach (less than 2 visits per year) (Figure 0.16).

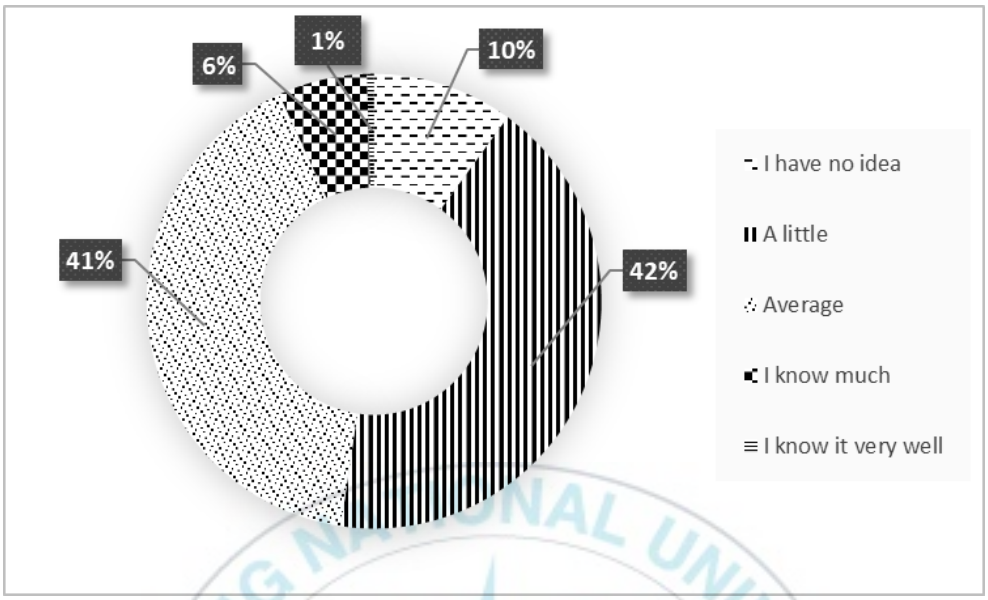



Figure 0.15: Awareness on Marine Litter

Table 0.12: The frequencies of visiting a beach

| Visit Plan | Frequency | Ratio (%) |
|---|---|---|
| No experience in visiting a beach | 83 | 13.8% |
| Once every 2 years | 98 | 16.3% |
| 1-2 times a year | 219 | 36.5% |
| 1-2 times in 6 months | 110 | 18.3% |
| 1-2 times a month | 46 | 7.7% |
| More than 2 times a month | 44 | 7.3% |
| **Total** | **600** | **100%** |

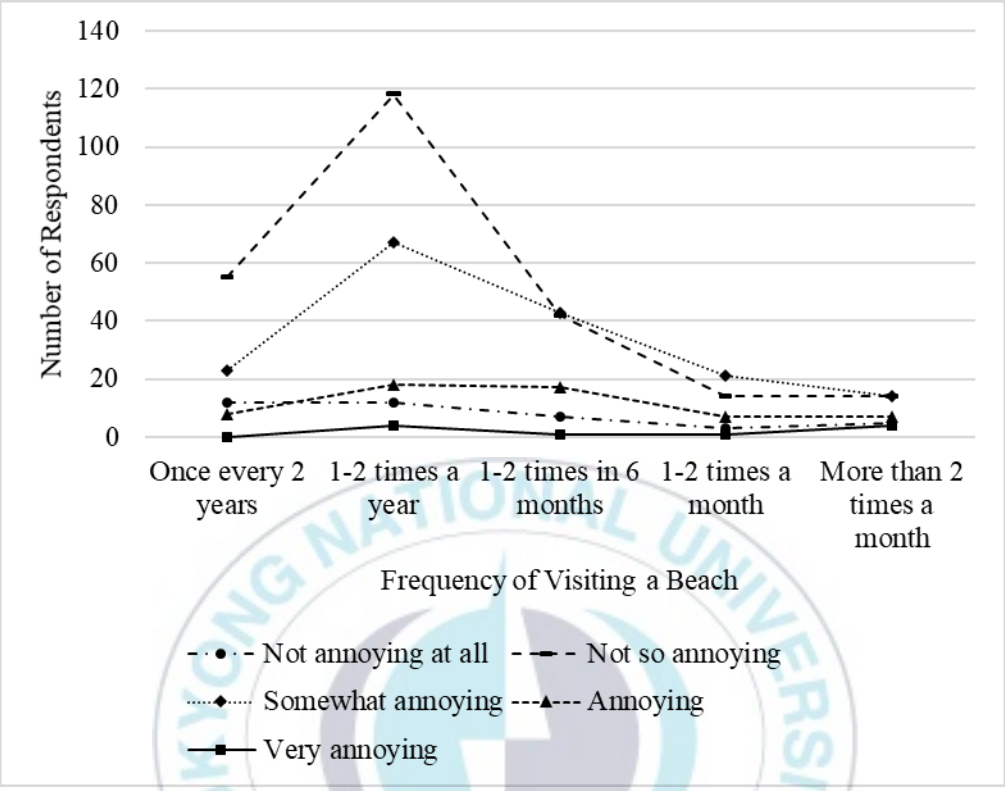



Figure 0.16: Frequency of visiting a beach and level of annoyance

More than half of the respondents in the sample (65.2%) stated that they would like to voluntarily participate in beach clean-up programs. They have specified the amount of time that they would like to spend on such programs during a month. If we assume that a person works 8 hours per day and there are 261 working days per year, the potential loss of income from volunteering for beach cleanup programs is 265,603 LKR ($1,328) per month for a 600 sample of respondents, which was calculated based on their income details and the time they would like to spend for clean-up programs.

### 4.6.3. Importance of Marine Litter Reduction

Respondents were provided with several statements regarding the importance of marine litter reduction and thereafter, their attitudes and general views on marine litter reduction were assessed as shown in Table 4.3.

The responses were rated and analyzed with a 5-point Likert Scale. Given eight statements have not been gone over more than 2.0 on average indicating that respondents acknowledge the importance of marine litter reduction for the environment, the livelihood of fishermen, and local residents of Sri Lanka. The analysis results show a surprising fact that the respondents have recognized marine litter reduction as an important fact for the development of the tourism industry in Sri Lanka. Further, many of the respondents have stated that marine litter reduction is extremely important to conserve marine organisms including endangered animals and plants.

Table 0.13: Respondents' attitude towards marine litter reduction

| Statement | Number of Respondents | | | | | Mid Point | S.D. |
|---|---|---|---|---|---|---|---|
| | SA | MA | A | MD | SD | | |
| Marine litter reduction is important for fishermen to get a quality fish harvest | 356 | 209 | 32 | 2 | 1 | 1.471667 | 0.629702 |
| Marine litter reduction is necessary for people to enjoy recreations or leisure such as fishing, sea bathing, walking, relaxing on the beach, etc. | 396 | 167 | 33 | 2 | 2 | 1.411667 | 0.642562 |
| Marine litter reduction is very important for Sri Lanka's coastal tourism industry | 442 | 138 | 18 | 1 | 1 | 1.301667 | 0.548786 |
| Marine litter reduction is necessary for me and my family to spend time leisurely in the future | 330 | 207 | 58 | 4 | 1 | 1.565 | 0.707065 |
| Marine litter reduction is necessary to conserve the marine ecosystem for my children and my descendants to spend time leisurely in the future | 345 | 192 | 59 | 3 | 1 | 1.538333 | 0.70429 |
| Marine litter reduction is important to conserve marine organisms including endangered animals and plants. | 418 | 161 | 18 | 1 | 2 | 1.346667 | 0.580561 |
| Even if no one visits the marine environment, reduction of marine litter is important | 356 | 171 | 65 | 7 | 1 | 1.543333 | 0.745463 |
| Unless marine litter is reduced, it will be a severe threat to marine life, human beings, as well as to the Sri Lankan economy. | 409 | 144 | 35 | 7 | 5 | 1.425 | 0.729334 |

*Note:* SA-Strongly Agree, MA- Moderately Agree, A- Agree, MD- Moderately Disagree, SD- Strongly Disagree, S.D.- Standard Deviation. In the 5-point Likert Scale, SA, MA, A, MD, and SD have the scales of 1, 2, 3, 4, and 5 respectively.

### 4.6.4. Actions to Reduce Marine Litter

Respondents were been aware of the economical and ecological importance of the marine environment to achieve sustainable development, measures/ actions to reduce marine litter, and the high cost of these actions. Thus, 507 respondents (84.5%) of the sample expressed their WTP for an annual environmental tax, and the other 93 respondents (15.5%) were not willing to pay even a single cent despite recognition of the importance of marine litter reduction in Sri Lanka (see Table 0.14).

A primary concern when measuring WTP in a CVM study is how to deal with protest zero bids which are No-No-No and No_No responses to the WTP questions. Desvousges et al. (1987) have discovered using the probit model that the probability of zero bids decreases with education, risk of exposure, and increases with greater knowledge of the issue, as findings of their experiment to discover the determinants of non-zero bids and Musser et al. (1990) have discovered using the logit model that respondents with higher education levels, age, and income were less likely to register protest zero bids and believes by the respondent that the development is “good”, it decreases the probability of a protest zero bid (Halstead et al., 1992). The reasons for respondents’ unwillingness to pay an environmental tax for marine litter reduction are listed in Table 0.14.

38.7% (36 respondents) have given a valid reason which is the inability to pay higher a tax rate. Other 61.3% (57 respondents) indicated invalid reasons. 43 respondents (46.2%) believe that the cost must be covered using the existing taxes, 11 respondents (11.8%) stated that the people who litter on the marine environment should pay for the damage and 2 respondents (2.2%) mentioned that this issue is not a problem for them to consider.

Table 0.14: Reasons for not willing to pay a tax for marine litter reduction

| Reason | Number of Respondents | Percentage of Respondents | Validity of the Bid | Rank |
|---|---|---|---|---|
| The cost is too high for my household to afford | 36 | 38.7% | **Valid** | 2 |
| Polluters should pay | 11 | 11.8% | Invalid | 3 |
| The cost must be covered using taxes already paid | 43 | 46.2% | Invalid | 1 |
| Not enough information is given | 1 | 1.1% | Invalid | 5 |
| I am not interested in this issue | 0 | 0.0% | Invalid | - |
| This issue is not a priority | 2 | 2.2% | Invalid | 4 |
| The government is already spending for this field too much | 0 | 0.0% | Invalid | - |
| Total | 93 | 100% | | |

On the flip side, the reason for bearing an extra burden was explained by the respondents who expressed their willingness to pay for the marine litter reduction. (Table 4.5). 32% of them (162 respondents) considered the marine litter reduction as a legacy for future generations. 154 respondents (30.4%) contemplated the protection of the scenic beauty of Sri Lankan beaches, and 23.3% (118 respondents) considered the environmental tax as a better approach for pollution prevention.

Table 0.15: Reasons for WTP for marine litter reduction

| Reason | Number of Respondents | % of Respondents | Rank |
|---|---|---|---|
| For recreations | 4 | 0.8% | 7 |
| For future visits and uses | 15 | 3.0% | 5 |
| For future generations | 162 | 32.0% | 1 |
| For protecting the scenic beauty of Sri Lanka's beaches | 154 | 30.4% | 2 |
| For avoiding pollution | 118 | 23.3% | 3 |
| For ensuring the quality of the fish catch | 11 | 2.2% | 6 |
| For protecting marine wildlife | 39 | 7.7% | 4 |
| Other | 4 | 0.8% | 7 |
| Total | 507 | 100% | |

# 5. The Measurement of the Economic Value of Marine Litter Reduction

## 5.1 Introduction

Marine litter is an environmental problem worldwide as well as it is a significant threat to the Sri Lankan marine environment. A strong motivation for marine litter reduction, however, exists since the benefit of marine litter reduction is immense for the protection of marine wildlife which indirectly affects the development of the emerging tourism industry of the country. This chapter applies a CV method to estimate the economic value of marine litter reduction on the Sri Lankan coast.

Carson et al. (1999) addressed six issues in measuring the total value which is frequently promoted as criticisms of contingent valuation. They are, (i) commodity definition: the difficulty of portraying the commodity in the survey in a way in which respondents can grasp its relevant attributes, (ii) the influence of various instruments in terms of project delivery and payment on the value of goods, (iii) resource familiarity: CV respondents cannot give meaningful values for unfamiliar goods, (iv) arguing that passive use value is only a concern in the case of irreversible changes to unique resources, (v) how to deal with substitutes in valuation analysis, and (vi) incentive compatibility structures of contingent valuation questions. Most of these problems can be solved by using a high-quality CV survey method. This study used the face-to-face interview method to collect the data and the CV elicitation method is the OOHB DC method. A total of 658 personal interviews were conducted during November and December 2021.

## 5.2 Estimates of the Economic Value

### 5.2.1. Econometric Model for Analyzing the WTP Responses

In the OOHB model, two sets of bid amounts are set up in advance: a lower bid amount ($B^L$) and an upper bid amount ($B^U$). The lower-bound bid values were first presented to the half of the respondents of the sample, and other half was asked about the WTP for upper-bound values. There are six possible responses for the upper-bound and lower-bound WTP questions;

- Possible responses for lower-bound ($B^L$) WTP questions
  i. If the response is 'no', $WTP \leq B^L$
  ii. If the response is 'yes-no', $B^L < WTP \leq B^U$
  iii. If the response is 'yes-yes', $B^U < WTP$

- Possible responses for lower-bound ($B^L$) WTP questions
  i. If the response is 'no-no', $WTP \leq B^L$
  ii. If the response is 'no-yes', $B^L < WTP \leq B^U$
  iii. If the response is 'yes', $B^U < WTP$

In practice, there are respondents who do not want to place any value on preserving natural resources. In this study, there are 93 zero responses to the WTP question. In order to handle this issue and make full use of the information given by the respondents, the spike model was used to analyze the data, considering that some respondents would not be willing to pay for the marine litter reduction projects. Therefore, this study used the conventional linear logistic model as well as the OOHB spike model to analyze the data. To identify respondents with zero WTP, the interviewer asked an additional question to know whether they were willing to pay anything or nothing. Therefore, there are eight possible responses in a spike model;

- Possible responses for lower-bound ($B^L$) WTP questions
  - i. If the response is 'no_no', WTP = 0
  - ii. If the response is 'no_yes', $0 < WTP \leq B^L$
  - iii. If the response is 'yes-no', $B^L < WTP \leq B^U$
  - iv. If the response is 'yes-yes', $B^U < WTP$

- Possible responses for upper-bound ($B^U$) WTP questions
  - iv. If the response is 'no-no-no', WTP = 0
  - v. If the response is 'no-no-yes', $0 < WTP \leq B^L$
  - vi. If the response is 'no-yes', $B^L < WTP \leq B^U$
  - vii. If the response is 'yes', $B^U < WTP$

Using the linear logistic function often used in econometrics literature, the cumulative distribution of WTP ($cd_{WTP}$) can be specified as;

$$cd_{WTP}(B;Ø_1, Ø_2) = \begin{cases} [1+\exp(Ø_1 - Ø_2 B)]^{-1} & \text{if } B > 0 \\ [1+\exp(Ø_1)]^{-1} & \text{if } B = 0 \\ 0 & \text{if } B < 0 \end{cases}$$

where $Ø_1$ and $Ø_2$ are parameters to be estimated.

The spike is the probability that WTP is zero. Hence, $[1+\exp(Ø_1)]^{-1}$ indicates the spike. The mean WTP of the spike model is derived as $(1/ Ø_2) \ln [1+\exp(Ø_1)]$. Average WTP estimates are typically used for policy analysis or evaluation. Therefore, it is required to calculate and present a confidence interval (CI) to contemplate the uncertainties that may arise during the estimation of mean WTP (Kim et al., 2020).

### 5.2.2. WTP Responses

The size of sample size is an important fact in a CV study. The general rule of sample size is that "larger CV samples reduce the uncertainty about WTP (reduce the standard error of mean WTP) and increase the accuracy of estimates" (Vaugha & Darling, 2000). The sample size was defined using the following equation with a 95 percent confidence interval;

$\hat{x} = \bar{x} \pm (t_{0.05}) \frac{\sqrt{\sigma}}{\eta}$ (Equation 0.6) where,

$\hat{x}$ - Estimated value of the population mean

$\bar{x}$ - Average WTP calculated from the sample

$t_{0.05}$ - Value of *t* at 95% confidence level[2]

σ - Standard deviation[3]

$\eta$ - Sample size

The data obtained from the pre-test survey was utilized to calculate the sample size. Although larger sample sizes are appropriate for better estimations, it is important to keep the sample size at a suitable level in order to minimize the survey cost. The suitable size of the sample was determined as approximately 595 with 95% confidence interval level and a sample error of 7.5%. The survey yielded 658 usable interviews, and enumerators were rated 58 of them as poor quality. Therefore, the findings of the survey are based on the review of the responses of 600 households.

Table 0.16 represents the distribution of responses to the valuation questions, showing the total number of households who stated that they would be willing to pay for the marine litter reduction program at each bid level, ranging from 500 to 5,000 LKR. If the respondent said 'yes' to the initial lower-bound bid value of the WTP, then s/he was asked the second WTP question by adding 500LKR to the initial bid value. On the contrary, if s/he said 'no' to the initial bid, there were no further questions regarding bid values. If the respondent said 'no' to the initial upper-bound bid value of the WTP, then s/he was asked the second WTP question by subtracting 500LKR to the initial bid value. On the contrary, if s/he said 'yes' to the initial bid, there were no more questions regarding bid values. In the column of 'YY', 48% (24 respondents) of the 500 LKR sample respondents stated 'yes' and 'yes' to the two WTP questions, implying that their WTP for the program is 1,700 LKR or higher value. The other half of the

[2] *t*-value at 95% confidence interval is 1.96

[3] $\frac{\sqrt{\sigma}}{\eta}$ = standard error which is assumed as 135 in this study.

respondents (26 respondents) in ‘YN’ column, stated ‘yes’ to 500 LKR and ‘no’ to 1,700 LKR. The respondents who said ‘yes’ to the initial upper-bound bid are in the ‘Y’ column, and if they said ‘no’ to the first bid value (i.e. 1,700 LKR) but, ‘yes’ to the second bid value (i.e. 500 LKR), those were accounted in the column ‘NY’. Note that the number of ‘yes’ responses drops, roughly, when the bid values increase. The number of ‘no’ responses to the 1,100 LKR lower-bound bid is 10. 7 respondents in the 2,300 LKR sample stated ‘no’ and ‘no’ the two WTP questions, and 7 respondents said ‘no’ and ‘yes’ to the same two questions. Therefore, it can be concluded that the percentage of ‘no’ responses for the 1,100-2,300 LKR bid range is 48% (24 respondents out of 50 respondents sample). 84 respondents said ‘no’ to the initial bid of lower-bound survey but, they were willing to pay some amount lower than the bid value asked by the interviewer (shown in ‘N_Y’ column), while 41 respondents were stating that they would not be willing to pay a single cent (shown in ‘N_N’ column). Similarly, for the upper-bound WTP questions, 64 respondents had ‘no-no’ response to the suggested bid values but, they were willing to pay some amount, while 52 respondents were rejecting to pay a single cent for the program. The spike model, therefore, seems to be the ideally suited model for estimating WTP in this ‘zero’ response samples, since a considerable proportion of the sample population (40.2%) has zero WTP responses.

Table 0.16: Distribution of responses to presented bid range

| Amount (LKR) | | Sample Size | | No.of Responses if $BID^L$ is Presented First | | | | No.of Responses if $BID^U$ is Presented First | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | N | | | | NN | |
| $BID^L$ | $BID^U$ | $BID^L$ | $BID^U$ | YY | YN | N_Y | N_N | Y | NY | NNY | NNN |
| 500 | 1700 | 50 | 50 | 24 | 26 | 0 | 0 | 32 | 10 | 2 | 6 |
| 1100 | 2300 | 50 | 50 | 12 | 28 | 9 | 1 | 36 | 7 | 7 | 0 |
| 1700 | 2900 | 50 | 50 | 17 | 18 | 7 | 8 | 31 | 5 | 4 | 10 |
| 2300 | 3500 | 50 | 50 | 5 | 14 | 18 | 13 | 28 | 2 | 13 | 7 |
| 3000 | 4200 | 50 | 50 | 8 | 11 | 21 | 10 | 10 | 4 | 21 | 15 |
| 3800 | 5000 | 50 | 50 | 7 | 5 | 29 | 9 | 16 | 3 | 17 | 14 |
| Total | | 300 | 300 | 73 | 102 | 84 | 41 | 153 | 31 | 64 | 52 |

*Note:* $BID^L$ indicates lower-bound bid values and $BID^U$ indicates upper-bound bid values. If the respondent's response for the initial lower-bound bid was 'no' but, s/he was willing to pay some amount, those are responses indicated by 'N_Y', and if the respondent's response for the initial lower-bound bid was 'no' and also rejected to pay a single cent, those are responses indicated by 'N_N'. YY, YN, Y, NY, NN, NNY, and NNN indicate 'Yes-Yes', 'Yes-No', 'Yes', 'No-Yes', 'No-No', 'No-No-Yes', and 'No-No-No', respectively.

### 5.2.3. Estimation Results

The conventional linear logistic model and the spike model were used for the estimation of the results. This estimation was done by using the TSP (Time Series Processor, 1996) statistical package. Table 0.17 outlines the estimation results of the OOHB DC conventional linear model without covariates. The estimated overall mean or median is 2,499 LKR, and the standard error is 102.

Table 0.17: Estimation results for conventional OOHB DC model without covariates

| **Variables** | **Linear Logistic** |
|---|---|
| **Constant (a)** | **2.062541** |
| *t*-value; *p*-value | (11.00289; .000)** |
| **BID (b)** | **0.825246** |
| *t*-value; *p*-value | (14.28643 ; .000)** |
| No.of observations | 600 |
| Log-likelihood | -587.3422 |
| Wald statistic | 223.8004 |
| **Overall Mean and Median WTP** | **2499** |
| Standard error | 102 |
| *t*-value; *p*-value | (24.50284; 000)** |
| 95% confidence interval | 2285˛ 2697 |
| **Truncated Mean WTP** | **2644** |
| Standard error | 86 |
| *t*-value; *p*-value | (30.57913; 000)** |
| 95% confidence interval | 2641˛2786 |

The calculated *t*-value is 24.50 which means that the overall mean WTP is significantly different from zero. Therefore, the hypothesis that the overall mean is statistically different from zero can be rejected. The truncated mean WTP is statistically significant at the 1% level. The two parameters used in the conventional linear logistic model without covariates are $b_0$ and $-b_1$. The starting values of these parameters were set as 0.2 and 0.3. The 95% confidence interval for overall mean and median WTP was estimated by replicating the $b_0$ and $-b_1$ 5,000 times.

### 5.2.4. WTP Estimates

Table 5.3 shows a comparison of mean and median WTP estimates of the conventional linear logistic model and the spike model with covariates and without covariates. The truncated mean WTP of the conventional model and the spike model without covariates is 2,644 LKR. The mean WTP of the conventional model with covariates is 2,613 LKR while it is 2,585 LKR in the spike model. All the values have a statistically good fit. The conventional model has a standard error of 86 without covariates and 83 with covariates and the *t*-value of 30.58 and 31.36. The standard error of the spike model without covariates is 97 and it is 92 in the spike model with covariates, and the *t*-values are 27.36 and 28.00 respectively.

The overall mean and the median in the conventional model without covariates is 2,499 LKR while it is 2,419 LKR in the spike model. The median with covariates in the conventional model is 2,513 LKR while it is 2,417 LKR in the spike model. Similarly, as the mean, all the parameters in the conventional model and spike model are statistically significant at 1% level. The spike is calculated as 14.12% which is somewhat close to the observed fraction of people who declined to pay an environmental tax for marine litter reduction (15.5%).

Table 0.18: Annual WTP in linear logistic and spike model

| WTP | Conventional Linear Model | | Spike Linear Model | |
|---|---|---|---|---|
| | **without covariates** | **with covariates** | **without covariates** | **with covariates** |
| **Truncated Mean WTP** | **2644** | **2613** | **2644** | **2585** |
| 95% confidence interval | 2641˛2786 | (2592˛2676) | (2461˛2837) | (2124˛3087) |
| Standard error | 86 | 83 | 97 | 92 |
| Wald statistic | 935.08323 | 983.7429 | 748.9011 | 784.4984 |
| *t*-value; *p*-value | (30.57913; 000)** | (31.36468 ; 000)** | (27.36606; 000)** | (28.00890; 000)** |
| **Overall Mean and Median WTP** | **2499** | **2513** | **2419** | **2417** |
| 95% confidence interval | 2285˛ 2697 | (2318˛2697) | (2202˛2630) | (1871˛2962) |
| Standard error | 102 | 93 | 109 | 100 |
| Wald statistic | 600.3894 | 722.3572 | 495.4545 | 578.95119 |
| *t*-value; *p*-value | (24.50284; 000)** | (26.87670; 000)** | (22.25881; 000)** | (24.06140; 000)** |

*Note:* Confidence intervals were calculated by using the Monte Carlo simulation method with 5,000 computations. **means statistical significance at the 1% level

It is necessary to assess the theoretical validity or internal consistency of a CV study. The CV data is collected through interviewing selected respondents. Therefore, it is necessary to examine the impact of respondents' characteristics on the probability of 'yes' responses to the amounts presented in the survey. Hence, the statistical significance of covariates related to the respondents' characteristics was considered. The variables, definitions, and statistics are shown in Table *0.19.*

Table 0.19: Definition and statistical information of the variables used for covariates

| Variable | Definition | Average | Standard Deviation |
|---|---|---|---|
| Income | Annual household total income after tax (Unit: 1,000 LKR) | 1,121.4 | 558.39 |
| Awareness | The respondents' knowledge on the marine litter issue in Sri Lanka (1 = I have no idea; 2 = A little; 3 = Average; 4 = I know much; 5= I know it very well) | 2.45 | 0.778 |
| Visit_plan | How often do the respondents visit a beach (1 = No experience in visiting a beach; 2 = Once every 2 years; 3 = 1-2 times a year; 4 = 1-2 times in 6 months; 5 = 1-2 times a month; 6 = More than 2 times a month) | 3.1167 | 1.3624 |
| Age | Age of the respondent (Number of years) | 41.207 | 10.610 |

Table 5.5 indicates the estimation results. In summary, respondents accepted the hypothetical market and were willing to pay a substantial amount annually, on average, per household. This willingness varies according to the characteristics of respondents. All the variables are significant at the 5% level, except the ‘age’ variable. Age is statistically significant at the 10% level. The negative sign of the coefficient indicates that the variable has a negative correlation with the probability of responding ‘yes’ to the presented bid amount. If not, it suggests that it has a positive correlation. For example, the higher the bid value, then it is less likely to respond ‘yes’ to the offered bid. Also higher the income level of the respondent, it is more likely they to respond ‘yes’to the presented bid amount.

Table 0.20: Estimation results of spike model with covariates

| Variables | Coefficients (t-values) |
|---|---|
| Constant | -3.0109 (0.003)** |
| Bid | 17.8356 (0.000)** |
| Income | 1.7743 (0.076)* |
| Awareness | 6.7402 (0.000)** |
| Visit plan | 3.8533 (0.000)** |
| Age | 1.8888 (0.059)* |
| Spike | 0.1260 |
| Number of observations | 600 |
| Log-likelihood | -577.5131 |
| Wald statistic | 335.2831 |
| (p-value) | 0.0000 |

*Note:* ** and * means the statistical significance at the 5% level and 10% level respectively.

## 5.3 Aggregating Issues on WTP Estimates

The purpose of most environmental economic studies is to assess the aggregate damage from an environmental change or an aggregate cost for environmental quality improvement projects. This chapter calculates the aggregated WTP using the sample statistics explained in the previous sections. A key issue in expanding the sample statistics into the population is its representativeness.

Table 0.21 shows the level of representativeness of sample characteristics with the population. There is an extremely small difference in the percentages of males and females in the sample and the population. There are no differences between the district values in the sample and the population. However, it can be seen that the average annual household income of the sample is comparatively higher than the population. There

may be two causes for this discrepancy between two income values: (i) Population statistics were given for 2016, and the survey was conducted in 2021. Hence, there may be an increase in average annual household income during five year time, (ii) the average monthly household income in 2016 is 62,237 LKR which is an average of the monthly income values from urban, rural, and estate sector population (88,692; 58,137; 34,804 LKR respectively). The majority of the respondents in this sample were from urban areas. Further, the mean per month incomes of the six coastal districts selected for this study are comparatively higher than other districts in Sri Lanka. However, the average monthly income value of the sample (93,450 LKR) lies between the 95% confidence interval limits of the 2016 mean annual household income of the urban population (79,590~97,793 LKR) (Department of Census and Statistics, 2017). If the sample is broadly representative of the population characteristics, the sample statistics can be expanded to the population.

Table 0.21: Representativeness of sample characteristics

| **Variable** | **Sample[4]** | **Population[5]** |
|---|---|---|
| *Gender* | | |
| Female | 51% | 51.6% |
| Male | 49% | 48.4% |
| *District* | | |
| Gampaha | 27.7% | 27.7% |
| Colombo | 27.9% | 27.9% |
| Kalutara | 14.7% | 14.7% |
| Galle | 12.8% | 12.8% |
| Matara | 9.8% | 9.8% |
| Hambantota | 7.2% | 7.2% |
| Household income[6] | 1121400 | 746844 |

[4] The sample is 600 respondents.
[5] Data from the Department of Census and Statistics, Sri Lanka
[6] Means the average annual household income

The second major aggregation issue is mean or median controversy. This problem typically occur when there is a skewed distribution. In CVM studies, it skewed to the right because a large number of people are willing to pay smaller amounts of money and some are willing to pay larger amount of money. In that case, the median is much smaller than the mean (Harrison & Kriström, 1995). Hanemann (1984) argued in favor of the median, but Johansson et al. (1989) argued that the mean would be the preferred welfare measure because the median is inconsistent with the Pareto-efficiency while the mean is consistent with it. The median has an attractive statistical property which is robustness towards the tail behavior. The choice between the use of mean or median in welfare measures is a common argument in CVM studies. However, this study used the mean value for WTP aggregation.

With reference to the WTP estimates in Table 0.18, the annual mean WTP (truncated mean) in the spike model with covariates is 2,585 LKR per household. According to the Department of Census and Statistics (2021), it was estimated that Sri Lankan household population in 2021 as 5.1 million. The lower estimate of the expanded annual mean was calculated as follows;

$$\text{Expanded annual mean WTP} = (\text{Annual mean WTP per household} \times \text{Number of households} \times \%\ \text{of households with positive WTP})/2$$[7]

The upper estimate of the expanded annual mean was calculated as follows;

$$\text{Expanded annual mean WTP} = \text{Annual mean WTP per household} \times \text{Number of households} \times \%\ \text{of households with positive WTP}$$

The lower estimate of the expanded annual mean WTP for the marine litter reduction is 3,944.06 million LKR (=2,585×5,100,000×(59.8%/2)), and the higher estimate is 7,888.13 million LKR per year (=2,585×5,100,000×59.8%). According to the Central Bank of Sri Lanka, the average annual discount rate is 15% and this rate was used to convert future WTP values into present value amounts. Correspondingly, the present

[7] According to the Federal Register of NOAA (1994), the WTP values derived through CV surveys should be divided by two to avoid the upward bias in hypothetical value statements (Pyo, 2001)

value of mean WTP per household for five years period is 8,665.32 LKR, which was calculated by using the following equation;

$$PV = PMT \times \frac{1-\left[\frac{1}{(1+r)^n}\right]}{r}$$ Where, PMT = 2585 LKR, $r$ = 0.15 and $n$ = 5 years

Hence, the lower estimate of the aggregated present value of the project for five years period is 13,221.11 million LKR, and the higher estimate is 26,442.23 million LKR. Table 0.22 indicates the lower and higher estimated mean values, and the discounted mean values.

Table 0.22: Aggregated WTP for marine litter reduction in Sri Lanka

| **Scenario** | **Aggregated WTP per Year (in million)** | **Aggregated Present Value of the Project for Five Years (in million)** |
|---|---|---|
| Lower estimate | 3,944.06 LKR ($19.72) | 13,221.11 LKR ($66.11) |
| Higher estimate | 7,888.13 LKR ($39.44) | 26,442.23 LKR ($132.21) |

Over two decades ago, very few CV studies have been conducted in developing countries and researchers have found some problems of administering CV questions to low-income, illeterate people in developing countries. Whittington (1998) encountered five issues of conducting CV surveys in developing countries: (i) explaining to enumerators about the CV study; (ii) interpreting responses to CV questions; (iii) setting referendum prices; (iv) constructing joint public-private CV scenarios; and (v) ethical problems in conducting CV surveys. Further, he clearly mentioned the audience as “low-income” and “illiterate”. In spite of being a developing country, the literacy rate of the Sri Lankan people is at a higher level compared to other developing countries. According to the World Bank records (2019), it is 92.3%. The survey results also evident that the average education year of the sample respondents is 15 years which means that average people have at least a diploma after their collegiate education. According to the World Bank classification, Sri Lanka is a lower-middle-income country with an average annual GDP per capita of 3863.7 USD (from 2018-

2020). However, the mean WTP value estimated in this study ($12.93) is comparatively higher than other similar studies regarding marine litter reduction.

The possible motivations for a comparatively higher WTP may be the people's concern over the development of the tourism industry and the fishing industry. Since many of the residents in the sample area were living in the coastal zone, there might be respondents who engage in fisheries activities and coastal tourism activities. Evidently, 4 respondents stated that the reason for their WTP is to attract more tourists to the country which was mentioned under "other reasons", in addition to the presented reasons in the survey. Further, 74% of the respondents strongly agreed with the statement that "marine litter reduction is very important for Sri Lanka coastal tourism industry". In addition, the income level of the people living in the sample area is higher than other provinces in the country. The survey results indicate that the respondents' average income is 5,607 USD per year which is approximately 31% deviation from the estimated average GDP per capita of the country. If there were respondents from the central part of the country, the WTP value would have been lower than the current estimate because marine litter is not a major concern for them as the people living in the coastal zone, and in some areas, the income level is lower than the income level of the current sample. This might be another reason for placing higher WTP values for marine litter reduction. Hence, an island-wide survey should be recommended to estimate a more accurate aggregated WTP values.

# 6. Policy Implications and Conclusion

Marine litter has been identified as one of the severe threats to the coastal environment as well as to the economy of Sri Lanka. This study applies the OOHB dichotomous choice CVM method to assess the economic value of marine litter reduction on the Sri Lankan coast as quantitative information of the environmental damage cost of marine litter. The results were calculated according to the conventional linear logistic model, and the spike model was also employed as there were zero WTP responses in the sample data. The annual income of the household, age, level of awareness about the marine litter issue, and the frequency of visiting a beach were set as the variables for parameter analysis. The sample respondents were between the age of 20 and 65.

According to the survey data analysis, the majority of respondents (42% of the sample) have little knowledge of the marine litter issue in Sri Lanka, and 41% of them have average knowledge. The majority of the respondents (36.5%) visited a beach 1-2 times a year during the 2019-2020 year. The respondents' perception of marine litter reduction was analyzed using the 5-point Likert Scale. All the given statements have not been gone over more than 2.0 on average indicating that respondents acknowledge the importance of marine litter reduction for the environment, the livelihood of fishermen, and residents of Sri Lanka. In addition to that, analysis results show that the respondents have recognized marine litter reduction as an important fact for the development of the tourism industry in Sri Lanka.

One of the most important tasks of a CV study is to expand the sample WTP value to its population. Either truncated mean or overall mean can be used to calculate the population's WTP for marine litter reduction. Duffield and Patterson (1991) stated that truncated mean is superior to the overall mean in the means of three basic criteria: (i) consistency with theoretical constraints; (ii) statistical efficiency; (iii) ability to be aggregated. As they explained, the motivation behind the overall mean and median as a welfare measure is that it can be multiplied by the total number of individuals in a population of interest to get a total value. However, the estimated WTP distribution is

skewed to the right and unbounded above in practice. Therefore, the overall mean is inconsistent with the theoretical constraints and is sensitive to the model chosen. Hence, they proved that the truncated mean satisfies all three criteria and reduces the influence of the upper end of the distribution. Further, truncated mean has always been used in literature for expanding sample estimates to the population. Hence, this study used the truncated mean to aggregate the sample mean WTP value to the population.

The average annual household WTP for the marine litter reduction is 2,585 LKR ($12.93). The sample characteristics were closely related to the population. The lower estimate is 3,944.06 million LKR and the higher estimate is 7,888.13 million LKR per year. The discounted present value of the mean WTP of a household for five years period is 8,665.32 LKR. The aggregated lower estimate for the project period is 13,221.11 million LKR and the higher estimate of the same is 26,442.23 million LKR. However, compared to other similar studies particularly focused on marine litter (e.g. Jin et al., 2020; Choi & Lee, 2018; Monserrate & Ruano, 2020), the estimated mean WTP value in this study ($12.55) is comparatively higher. The WTP could be higher because this study focuses on both use value and non-use value of marine litter reduction, while most of the other studies focus only on non-use value. This study highlighted to respondents a range of different impacts of marine litter such as ingestion, entanglement, aesthetic aspects, and the economic impact on the tourism industry and fisheries industry. The analysis based on the responses suggests two possible reasons for the higher WTP. First, most respondents are more concerned and aware of marine litter issues as they are residing in coastal areas, which affects WTP positively. Many people have started to become more aware of the marine litter because of the X-Press Pearl shipwreck on the Sri Lankan coast, a few months before the CV survey. It had a greater threat on marine wildlife, other wildlife and the food chain as the majority of Sri Lankans fulfill their protein requirement through fish consumption. Second, the people's concern over the development of the tourism industry and the fishing industry. Since many of the residents in the sample area were living in the coastal zone, there might be respondents who engage in fisheries activities and coastal

tourism activities. The majority of the respondents strongly believe that marine litter reduction is a requirement for the development of the coastal tourism industry of the country. Some respondents stated that the reason for their WTP is to attract more tourists to the country which was mentioned under "other reasons", in addition to the presented reasons in the survey. Concerning Table 3 above, 74% of the respondents strongly agreed with the statement that "marine litter reduction is very important for Sri Lanka coastal tourism industry". Tourism was the 3rd largest foreign exchange earner for the country in 2019, and the southern coast has the 35% of the total accommodation capacity which is the highest capacity among other regions in SL that confirms most of the tourists who come to Sri Lanka, visit the southern coast. Since the sample is from western and southern provinces, this could be positively affected the WTP. If there were respondents from the central part of the country, the WTP value would have been lower than the current estimate because marine litter is not a major concern for them as they are not living in the coastal zone, and in some areas, the income level is lower than the income level of the current sample. Hence, an island-wide survey to explore whether changing the area would have made any difference to WTP is recommended.

To the best of the researcher's knowledge, there have not been many economic studies in Sri Lanka that have applied CVM to assess the economic value of marine litter reduction. Thus, this study can be added as a Sri Lankan case study to the literature, and the findings of this study can be applied to future policymaking procedures regarding marine litter reduction on the Sri Lankan coast, especially in western and southern provinces. In addition to that, it is possible to evaluate the benefits of marine litter reduction to the country's tourism industry and the fisheries industry. However, this study needs to be improved in several aspects to ensure that the findings can be applied island-wide. Therefore, if the survey is expanded to the other provinces with government sponsorship, the respondents can be segmented into diverse groups, and the analysis can be made according to various categories such as the income level, geolocation of the residents, etc. to obtain differentiated implications for several

categories. For example, the WTP amounts of the respondents living in the coastal area are different from the WTP amounts of the people living in the central part of the country because the concern over marine litter reduction can be different between the two types of categories.

Secondly, this study follows a conservative approach that considers both true zero WTP and the protest bid responses as zero WTP responses. Therefore, it needs to be analyzed how the truncated mean WTP changes if true zero WTP and the protest bids are treated separately. Finally, some or all of the variables used in the model with covariates, such as income and visit plan can be caused endogeneity bias that may distort the estimation results and/ or decisions based on the results. Hence, it is required to check whether the bias exists and if the bias exists the necessary actions should be taken to rectify it.

# Appendix A

**A Survey on Economic Value of Marine Litter Reduction**

| ID | | | |
|---|---|---|---|

Hello!

I am a postgraduate student at the Department of Marine Fisheries and Business Economics at Pukyong National University in South Korea, undertaking thesis on the topic of "Economic Valuation of Reducing Marine Litter on Coastal Beaches in Sri Lanka". The goal of this survey is to include the public opinions in future decision making process regarding marine litter reduction and removal in Sri Lanka.

You have been chosen to participate in this survey to determine the importance of clean beaches to the people in Sri Lanka. There is no right or wrong answer to any of the questions. Think deliberately and give your thought and mention anything questionable. Your faithful answers are intended to guide the researcher to make accurate estimates. Hence, you are urged to be as sincere as possible in answering the questions.

The information you provided will be kept strictly confidential and only used for the academic purpose.

Thanks for your understanding and cooperation!

*Hasini Siriwardana*
*Postgraduate student at Pukyong National University.*

**❖ Respondents Selection Questions**

1) What is your gender? Male [ ] Female [ ]

2) Which year you were born? ..... ⇒Only those born between 1956 (age 65) and 2001 (age 20) are surveyed.

3) Are you the head of your household or the spouse of the head of your household?

Head of household [ ] Spouse of the head of the household [ ]

Members of the household [ ] ⇒ End of investigation

4) Do your household has a monthly income?

Yes (with income) [ ] No (no income) [ ] ⇒ End of investigation

5) Where do you currently live in?

Gampaha [ ] Colombo [ ] Kalutara [ ] Galle [ ]

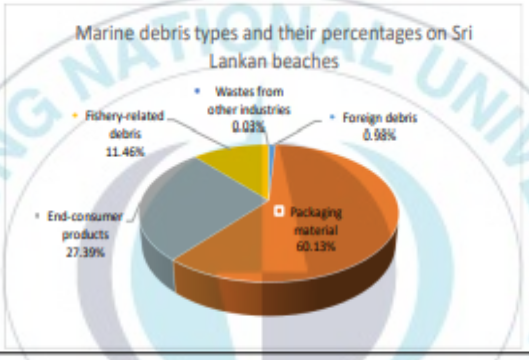
Matara [ ] Hambantota [ ] Other [ ] ⇒ End of investigation

## A. Residents' Perception on Marine Litter Reduction

➢ Please read the following descriptions carefully and feel free to comment on the questions.
[View Card 1]

o Marine litter is human created waste that has been discarded, disposed of, abandoned in, or eventually reaches the marine or coastal environment. Majority of litter items found in Sri Lankan beaches are inland litter flown through rivers to the sea and, solid and liquid wastes dumped from industries and fishing vessels.

o Sri Lanka ranks 5th among the top 20 countries ranked by mass of mismanaged plastic marine debris.




A1) How much do you know about marine litter issue in Sri Lanka?

1. I have no idea [ ] 2. A little [ ] 3. Average [ ]
4. I know much [ ] 5. I know it very well [ ]

A2) How often have you visited a beach within last two years (2019-2020)?

[ ] Once every 2 years [ ] 1-2 times a month
[ ] 1-2 times a year [ ] More than 2 times a month
[ ] 1-2 times in 6 months [ ] No experience in visiting a beach – **Go to A4**

A3) If you have visited a beach in Gampaha, Colombo, Kalutara, Galle, Matara and Hambantota districts during last two years (2019-2020), please give below details about your beach visits.

| Beach Name | Perceived annoyance with beach litter | | | | |
|---|---|---|---|---|---|
| | Not annoying at all | Not so annoying | Somewhat annoying | Annoying | Very annoying |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

A4) Would you like to participate in voluntary beach cleanup programs?

Yes [ ] No [ ]

A5) If so, how much time would you like to spend?

..... days/month ..... hours/day

A6) Please choose the response that best describes your attitudes toward marine litter reduction.

| | SA | MA | A | MD | SD |
|---|---|---|---|---|---|
| A.6.1. Marine litter reduction is important for fishermen to get a quality fish harvest. | | | | | |
| A.6.2. Marine litter reduction is necessary for people to enjoy recreations or leisure such as fishing, sea bathing, walking, relaxing on the beach, etc. | | | | | |
| A.6.3. Marine litter reduction is very important for Sri Lanka coastal tourism industry. | | | | | |
| A.6.4. Marine litter reduction is necessary for me and my family to spend time leisurely in the future. | | | | | |
| A.6.5. Marine litter reduction is necessary to conserve marine ecosystem for my children and my descendants to spend time leisurely in the future. | | | | | |
| A.6.6. Marine litter reduction is important to conserve marine organisms including endangered animals and plants. | | | | | |
| A.6.7. Even if no one visits the marine environments, reduction of marine litter is important. | | | | | |
| A.6.8. Unless marine litter is reduced, it will be a severe threat to marine life, human beings, as well as to the Sri Lankan economy. | | | | | |

SA- Strongly Agree, MA- Moderately Agree, A- Average, MD- Moderately Disagree, SD – Strongly Disagree

## B. Investigation of the Economic Value of Marine Litter Reduction in Sri Lanka

**Hypothetical situation:** Sri Lankan government is going to implement a 5 year program for continuous removal of marine litter on beaches while taking actions on reduction of litter generation sources such as banning of manufacturing/ importing single-use plastic items, etc. Marine litter reduction is a very expensive and grueling task. Hence, the government is considering for an environmental tax to finance the program (eg: payments for beach cleaners, payment for inland waterways cleaners, equipment, etc.). Assume, the money collected through the tax will be spent for this program transparently, without any corruption. If most people would not be willing to contribute, the marine litter reduction efforts could not come into effect. Otherwise, if most people would agree to pay an environmental tax and/or voluntarily participate clean up events, marine litter can be reduced and Sri Lankan beaches can be made as the cleanest beaches of the world.

We would like to know how much your household is willing to pay for an environmental tax. So in consideration of your household income and expenditure, please answer the next questions sincerely.

[View Card 2]


[PROG: The amount presented in B1 is 500 LKR / 1200 LKR / 2000 LKR / 2800 LKR / 3700 LKR / 4500 LKR and 6 amounts are presented in the same ratio]

B1)If the Base Condition is improved to Condition A, would your household be willing to pay ..... LKR annually for next 5 years in order to reduce marine litter in Sri Lankan coast? Please remember that if your household does not pay this amount, it will not be able to reduce marine litter and get the coastal ecosystem services for your descendants.

Yes [ ] ⟶ **(if 'Yes', go to B2)** No [ ] ⟶ **(if 'No', go to B3)**

[PROG: B2 presentation amount = (B1 presentation + 500 LKR)]

B2)If so, would your household be willing to pay ..... LKR annually for 5 years for the continuous reduction of marine litter in Sri Lankan coast?

Yes [ ] ⟶ **(if 'Yes', go to B4)** No [ ] ⟶ **(if 'No', go to B4)**

## B. Investigation of the Economic Value of Marine Litter Reduction in Sri Lanka

**Hypothetical situation:** Sri Lankan government is going to implemet a 5 year program for continuous removal of marine litter on beaches while taking actions on reduction of litter generation sources such as banning of manufacturing/ importing single-use plastic items, etc. Marine litter reduction is a very expensive and gruelling task. Hence, the government is considering for an environmental tax to finance the program (eg: payments for beach cleaners, payment for inland waterways cleaners, equipment, etc.). Assume, the money collected through the tax will be spent for this program transparently, without any corruption. If most people would not be willing to contribute, the marine litter reduction efforts could not come into effect. Otherwise, if most people would agree to pay an environmental tax and/or voluntarily participate clean up events, marine litter can be reduced and Sri Lankan beaches can be made as the cleanest beaches of the world.

We would like to know how much your household is willing to pay for an environmental tax. So in consideration of your household income and expenditure, please answer the next questions sincerely.

[View Card 2]


[PROG: The amount presented in B1 is 1000 LKR / 1700 LKR / 2500 LKR / 3300 LKR / 4200 LKR / 5000 LKR, and 6 amounts are presented at the same rate]

B1)If the Base Condition is improved to Condition A, would your household be willing to pay ..... LKR annually for next 5 years in order to reduce marine litter in Sri Lankan coast? Please remember that if your household does not pay this amount, it will not be able to reduce marine litter and get the coastal ecosystem services for your descendants.

Yes [ ] ⟶ **(if 'Yes', go to B4)** No [ ] ⟶ **(if 'No', go to B2)**

[PROG: B2 presentation amount = (B1 presentation - 500 LKR)]

B2)If so, would your household be willing to pay ..... LKR annually for 5 years for the continuous reduction of marine litter in Sri Lankan coast?

Yes [ ] ⟶ **(if 'Yes', go to B4)** No [ ] ⟶ **(if 'No', go to B3)**

B3)Then, is your household not willing to pay even a single LKR?

Yes, I do [ ] → **(go to B4)**
No, I don't [ ] → **(go to B6)**

B4)Then, what is the maximum amount that your household would be willing to pay each year for next 5 years for the continuous reduction of marine litter?

..... LKR → **(go to B5)**

B5)What is the most important reasons that your household would be willing to pay?

1. For recreations [ ]
2. For future visits and uses [ ]
3. For future generations [ ]
4. For protecting the scenic beauty of Sri Lankan beaches [ ]
5. For avoiding pollution [ ]
6. For ensuring the quality of fish catch [ ]
7. For protecting marine wildlife [ ]

B6)What is the most important reason why your household would not be willing to pay?

1. The cost is too high for my household to afford [ ]
2. Polluters should pay [ ]
3. The cost must be covered using taxes already paid [ ]
4. Not enough information is given [ ]
5. I am not interested in this issue [ ]
6. This issue is not a priority [ ]
7. The government is already spending for this field too much [ ]
8. Others (Please specify: )

## C. Socio-economic Questions

➢ The following information is kept confidential and is used purely for academic purposes.

C1) What is your level of education?

[ ] No school
[ ] Primary school (Grade 1-5)
[ ] Secondary school (Grade 6-11)
[ ] Collegiate (Grade 12-13)
[ ] National certificate/ Diploma
[ ] University Degree
[ ] Master/PHD
[ ] Other (Please specify)
.....

C2) What is your employment status?

[ ] Self Employed
[ ] Government Servant
[ ] Private Sector
[ ] Retired
[ ] Housewife
[ ] Unemployed
[ ] Other (Please Specify .....)

C3) What is the combined average annual income level, your household received after taxes in the last year? (All values are in LKR)

[ ] Less than 180,000
[ ] 180,000 – 360,000
[ ] 360,000 – 540,000
[ ] 540,000 – 780,000
[ ] 780,000 – 1,920,000
[ ] Above 1,920,000

C4) What was your household's average annual spending level over the past years? (All values are in LKR).

[ ] Less than 160,000
[ ] 160,000 – 317,000
[ ] 317,000 – 475,000
[ ] 475,000 – 686,000
[ ] 686,000 – 1,700,000
[ ] More than 1,700,000

**-Thank you very much for taking the survey -**

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