Exploring plastic waste management practices surrounding the Agulhas National Park: The case of Struisbaai Harbour

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PREFACE AND ACKNOWLEDGMENTS

Given the limited research on the relationship between the sources of marine plastic pollution and waste management impacts in South Africa over the past five to ten years, this study aimed to address the gap by examining waste management practices in marine and coastal areas. The research focuses on identifying the sources of plastic waste and assessing the effectiveness of waste management practices in mitigating marine pollution in Struisbaai, Western Cape, South Africa. Marine Protected Areas (MPAs) and coastal regions near protected zones offer a particularly interesting context for this investigation.

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ABSTRACT

Marine pollution, particularly plastic waste, is an increasing global concern affecting coastal areas, ecosystems, and human well-being. While South Africa has seen some research on marine plastic pollution, there is a noticeable gap in understanding the relationship between plastic pollution and waste management effectiveness, especially in Marine Protected Areas (MPAs). The aim of this research was to explore plastic waste management practices surrounding the Agulhas National Park, with a focus on the case study of Struisbaai Harbour. Struisbaai is situated between two MPAs, a National Park, and a nature reserve, where waste management faces challenges due to multiple jurisdictional parties. As a popular tourist destination, waste generation is increasing rapidly, particularly within Struisbaai Harbour, necessitating research into plastic waste management practices. The aim was achieved through four research objectives: determining the extent of plastic waste pollution (RO1), evaluating existing waste management practices (RO2), understanding public perceptions to plastic waste and waste management practices (RO3), and reviewing governance and legislative frameworks concerning plastic waste management in the study area (RO4).

For this study, a mixed-method approach with both qualitative and quantitative research methods was followed. Data was gathered through surveys to gather insight on public perceptions of the current waste management practices within Struisbaai Harbour, supported by on-site observations, waste characterisation, document analysis and document review.

Plastic waste is a significant waste stream with plastic waste contributing up to 59% to the total waste that was characterised in the area. The waste observations and waste characterisation revealed a noticeable increase in plastic waste during the peak tourist season, with plastic waste increasing by up to 34% during the New Year period. The findings indicated a noticeable lack of bins in the harbour and surrounding promenade, with existing bins often being broken or lacking lids. Given the harbour's central role in tourism, it becomes a focus point for plastic waste generation and disposal, intensifying pollution levels. During peak tourist seasons, bins are often seen overflowing and are not emptied regularly, with strong winds contributing to plastic pollution entering the ocean. It is evident that the current waste management infrastructure in Struisbaai Harbour is inadequate to handle increased waste volumes, especially during peak tourist seasons.

A total of 211 responses from the survey questionnaires were recorded and analysed through thematic analysis. The results from the survey indicated it was clear that plastic waste is perceived as the primary pollution issue in Struisbaai Harbour, adversely impacting its aesthetic appeal. Many respondents indicated that beachgoers and tourists are the primary contributors to plastic

waste in the study area. The respondents also reported that existing waste management infrastructure was insufficient, highlighting the need for more waste bins, frequent emptying of bins, and better waste management strategies. These concerns were supported by observational data, which revealed that waste bins were often not emptied according to the schedule, exacerbating the problem of improper waste disposal.

The governance and legislative review showed that, although there is a comprehensive legal framework (international and national) that regulates waste, plastic, and protected areas individually, there is a lack of specific legislative frameworks addressing plastic waste management in Struisbaai and practical execution can be improved. The study recommends the improvement of current waste management practices through developing comprehensive waste management plans, regular waste audits, enhancing infrastructure, encouraging community involvement and increasing public education and awareness on the adverse impacts of plastic waste in marine environments.

Keywords: *plastic marine pollution; plastic waste; Agulhas National Park; waste management; waste management practices; governance and legislation; Struisbaai Harbour*

ABBREVIATIONS AND ACRONYMS

AHEG	Ad-Hoc Open-Ended Expert Group on Marine Litter and Microplastics
AIM	Africa's Integrated Maritime
ALDFG	Abandoned, lost, and discarded fishing gear
AMCEN	African Ministerial Conference on the Environment
AMWN	African Marine Waste Network
AU	African Union
CaC	Command and control
CAM	Cape Agulhas Municipality
CBD	Convention on Biological Diversity
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DFFE	Department of Forestry, Fisheries, and the Environment
ECA	Environmental Conservation Act (Act 73 of 1989)
EEZ	Exclusive Economic Zones
EPR	Extended Producer Responsibility
EPWP	Expanded Public Works Programme
EU	European Union
FAO	Food and Agriculture Organisation
G20	Group of twenty
G7	Group of seven
GDP	Gross domestic product

GESAMP	Group of Experts on the Scientific Aspects of Marine Pollution
GN	Government Notice
GPA	Global Plan of Action
GPML	Global Partnership on Marine Litter
HDPE	High-density polyethylene
IUCN	International Union for Conservation of Nature
IWMP	Integrated Waste Management Plans
LDPE	Low-density polyethylene
MARPOL	International Convention for the Prevention of Pollution from Ships
MDG	Millennium Development Goals
MLRA	Marine Living Resources Act
MPA	Marine Protected Area
MSP	Marine Spatial Planning
NEM:BA	National Environmental Management Biodiversity Act
NEM:ICMA	National Environmental Management Integrated Coastal Management Act
NEM:PAA	National Environmental Management Protected Areas Act
NEM:WA	National Environmental Management: Waste Act No. 59 of 2008
NEMA	National Environmental Management Act of 1998
NOAA	National Oceanic and Atmospheric Administration
NPSWM	National Pricing Strategy for Waste Management
NWMS	National Waste Management Strategy
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAYT	Pay-as-you-throw

PET	Polypropylene terephthalate
POPs	Persistent Organic Pollutants
PVC	Polyvinyl chloride
QR	Quick response
RO	Research objective
SABS	South African Bureau of Standards
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SANS	South African National Standards
SAYT	Save-as-you-throw
SDG	Sustainable Development Goals
SST	Sustainable Seas Trust
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
WCMS	Waste Classification and Management System of 2013
WIOMSA	Western Indian Ocean Marine Science Association
WWF	World Wide Fund for Nature

KEY DEFINITIONS

Macroplastics

Macroplastics are large pieces of plastic debris with a diameter of ≥ 5mm found within the marine environment (Lechthaler *et al.,* 2020). Due to their size, macroplastics have a significant visual and physical impact on the environment (Thushari & Senevirathna, 2020; Bucci *et al.,* 2020), and exposure to environmental stressors causes macroplastics to break down into smaller pieces, forming microplastics (Okeke, 2022).

Marine ecosystems

A marine ecosystem refers to the complex and interconnected community of living organisms (biotic factors) and their physical and chemical environment (abiotic factors) (Balasubramanian, 2011) within an environment that contains a high concentration of saltwater, such as the ocean (Mebunii, 2023). It encompasses a wide range of habitats, including coastal areas, coral reefs, open ocean, deep sea, saltwater marshes, wetlands, and estuaries (Dolbeth & Arenas, 2021).

Marine pollution

The Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), as part of the basic framework of the UN Convention on the Law of the Sea (UNCLOS) 1982 (Article 1.4), defines marine pollution as *"the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality of use of seawater, and reduction of amenities"* (GESAMP, 1980:24).

Marine protected area

The IUCN defines a marine protected area (MPA) as: "*any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment*" (IUCN, 1988:18). Kriegl *et al.* (2021) defines an MPA as a designated area of the ocean or coastal waters that is managed and protected to conserve marine ecosystems, biodiversity, habitats, and species through regulations and management measures to restrict certain human activities within their boundaries.

National Park

A protected area encompassing natural land and/or sea areas designated to safeguard the ecological processes of ecosystems and species (Dudley, 2008).

Nature Reserve

A designated protected area primarily for the conservation of biodiversity and potentially geological or geomorphological features (Dudley, 2008).

Plastic waste

Plastic waste can be defined as any plastic product or object (such as plastic containers, soft drink bottles, straws, plastic bags, etc.) that has reached its end of life and is discarded or abandoned at landfill sites, burned in incinerators, or disposed of by littering and illegal dumping (Acquavia *et al.,* 2021).

Protected area

A protected area, according to the IUCN, is a clearly demarcated geographical region that receives official recognition, allocation, and management either through legal methods or effective means. Its main objective is to secure the lasting conservation of natural habitats, including their related ecosystem services and cultural significance (Dudley, 2008).

Waste

According to the 'EU Directive 2008/98 on waste and repealing certain directives' (2008), waste refers to any material or item that individuals or entities choose to dispose of, plan to dispose of, or are obligated to dispose of.

In South Africa, the legal definition of waste is stipulated in the National Environmental Management: Waste Act (RSA, 2008:9-10):

> *"**Waste** means -*
>
> *a) any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be reused, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act; or*
>
> *b) any other substance, material or object that is not included in Schedule 3 that may be defined as a waste by the Minister by notice in the Gazette.*

TABLE OF CONTENTS

PREFACE AND ACKNOWLEDGMENTS I

ABSTRACT III

ABBREVIATIONS AND ACRONYMS V

KEY DEFINITIONS VIII

CHAPTER 1 INTRODUCTION 1

1.1 Background 1

1.2 Problem statement and rationale for the study 2

1.3 Research aims and objectives 4

1.4 Scope of the research 4

1.5 Defining key terminologies 4

1.5.1 Plastic waste 4

1.5.2 Macroplastics 5

1.5.3 Marine protected area 5

1.5.4 Waste management practices 5

1.6 Potential contribution of the research 6

1.7 Structure and outline of the dissertation 6

1.8 Conclusion 7

CHAPTER 2 LITERATURE REVIEW 8

2.1 Introduction 8

2.2 Background on plastic 9

2.2.1 History of plastic 10

2.2.2 Composition of plastic 11

2.2.3 Types of plastic 11

2.2.4 Categorisation of plastic sizes 14

2.3 Sources and pathways of plastic waste 14

2.3.1 Land-based sources of plastic waste 15

2.3.1.1 Municipal solid waste and direct dumping 16

2.3.1.2 Water-based pollution 16

2.3.1.3 Harbour and port activities 17

2.3.2 Sea-based sources 19

2.3.2.1 Maritime activities as a source of marine pollution 19

2.3.2.2 Abandoned, lost, or discarded fishing gear 21

2.3.2.3 Ocean circulation, ocean currents, wind dispersion, and waves 22

2.3.2.4 Biofouling and biota transportation 23

2.4 Approaches to address plastic waste and related pollution 24

2.4.1 Command and control (CaC) approaches 25

2.4.2 Market-based approaches 26

2.4.3 Agreement-based approaches 28

2.4.4 Civil-based approaches 29

2.5 Environmental behaviour and perceptions 30

2.6 Legal framework for the management of plastic waste 31

2.6.1 International binding agreements with relevance to marine environments and plastic pollution 32

2.6.2 International non-binding strategies and instruments governing marine pollution and plastic waste 35

2.6.3 Regional and sub-regional frameworks governing marine pollution and plastic waste within the African context 41

2.6.4 Regional and sub-regional initiatives directly addressing plastic pollution in marine environments within the African context 43

2.7 South African legal framework for plastic waste management 45

2.7.1 The National Environment Management: Waste Act No. 59 of 2008 (with amendments) 47

2.7.1.1 The National Waste Management Strategy (2020) 47

2.7.1.2 Plastic Bag Regulations 48

2.7.1.3 Waste Management Licensing 48

2.7.1.4 Industry Waste Management Plans (InWMP) 49

2.7.1.5 Extended Producer Responsibility (EPR) regulations 49

2.7.1.6 Norms and standards for the disposal of waste to landfill 50

2.7.1.7 SANS 1728: Guidance on Labelling of Degradable Plastic 50

2.8 South Africa's legal framework for marine protection/protected areas 51

2.8.1 The National Environmental Management: Protected Areas Act (Act 57 of 2003) 51

2.8.2 The Marine Living Resources Act (Act 18 of 1998) 52

2.8.3 The National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) 52

2.8.4 National Environmental Management: Biodiversity Act (Act 10 of 2004) ... 52

2.8.5 Marine Spatial Planning Act (Act 16 of 2018) 52

2.9 Framework for plastic waste management and protected areas management in the Western Cape Province 54

2.9.1 Western Cape Provincial Coastal Management Programme (2016)..... 54

2.9.2 Western Cape Integrated Waste Management Plan (2023-2027)..... 54

2.10 Plastic waste management and protected areas management in the Struisbaai area..... 55

2.10.1 Waste management practices in Struisbaai and Struisbaai Harbour 55

2.10.2 Integrated Waste Management By-Law, 2021 for the Cape Agulhas Municipality (CAM) 56

2.10.3 Waste management practices in Agulhas National Park: the role of SANParks57

2.10.4 Waste management practices in De Mond Nature Reserve: the role of CapeNature 57

2.11 Chapter summary..... 60

CHAPTER 3 METHODOLOGY..... 61

3.1 Introduction 61

3.2 Research design..... 61

3.2.1 Quantitative research methods 61

3.2.2 Qualitative research methods..... 62

3.3 Case study area..... 64

3.3.1 Justification for selecting Struisbaai as the case study area..... 65

3.3.2 Description of the case study area..... 66

3.4 Data collection..... 69

3.4.1 Literature review..... 69

3.4.2 Observations..... 71

3.4.2.1 Plastic waste quantification and categorisation..... 71

3.4.2.2 Waste management infrastructure..... 73

3.4.3 Survey questionnaires 74

3.4.3.1 Developing and piloting the survey questionnaire 74

3.4.3.2 Selection of research participants 77

3.4.3.3 Distributing the survey questionnaire 77

3.4.4 Document review 78

3.5 Data analysis 79

3.5.1 Analysis of data from observations 79

3.5.1.1 Data on plastic waste characterisation 80

3.5.1.2 Data on waste management infrastructure 80

3.5.2 Analysis of data from survey questionnaires 80

3.5.3 Analysis of data from document review 82

3.6 Ethical considerations 82

3.7 Methodological assumptions and limitations 83

3.8 Chapter summary 84

CHAPTER 4 RESULTS AND DISCUSSION 85

4.1 Introduction 85

4.2 Socio-demographic profile of survey participants 85

4.3 Results related to RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour 87

4.3.1 Waste quantification and categorisation results 87

4.3.1.1 Waste categorisation results 87

4.4 Results related to RO2: Determining plastic waste management practices in Struisbaai Harbour 92

4.4.1 Observation results 92

4.4.1.1 Waste management infrastructure 92

4.4.1.2 Littering 94

4.4.2 Results from document review and informal correspondence 96

4.5 Results related to RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour 99

4.5.1 Perceptions of plastic waste in the Struisbaai area 99

4.5.1.1 Perceived primary type of waste found in and around the Struisbaai harbour area 99

4.5.1.2 Perceived main sources of waste in the Struisbaai area 100

4.5.1.3 Perceived biggest challenges towards reducing plastic waste in the Struisbaai marine environment 102

4.5.1.4 Changes that respondents would be willing to make to reduce plastic waste .. 103

4.5.1.5 Factors encouraging respondents to reduce plastic waste in marine environments 104

4.5.1.6 Perceived effective ways of raising awareness about plastic waste in marine areas 106

4.5.1.7 Perceived most effective approaches to reduce plastic waste in marine environments 107

4.5.2 Likert-scale responses: Plastic waste perceptions 110

4.5.2.1 I regularly observe plastic waste on the beach or ocean in the Struisbaai harbour area. 113

4.5.2.2 The sight of plastic waste in and around the Struisbaai harbour bothers me ... 113

4.5.2.3 I believe that the presence of plastic waste affects my enjoyment of the harbour and boardwalks aesthetics 114

4.5.2.4 I feel that the presence of plastic in the ocean and along the harbour and boardwalk in Struisbaai is a problem 115

4.5.2.5 I think plastic waste is a major issue affecting the natural environment in and around Struisbaai harbour 116

4.5.2.6 I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour has become worse over the past five years 117

4.5.2.7 I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour could deter tourists from visiting the area..... 118

4.5.2.8 I am aware of the long-term adverse impacts of plastic pollution on marine ecosystems 120

4.5.2.9 I think that individuals have a responsibility to reduce plastic waste in marine environments..... 121

4.5.2.10 I am willing to avoid the use of single-use plastics such as plastic bags, water bottles, or straws when I am at the beach/in a marine environment..... 122

4.5.2.11 I am willing to pay a reasonable price for products or services that are environmentally friendly and reduce plastic waste in marine environments..... 123

4.5.2.12 I am willing to walk to where waste bins are located to dispose of my waste .. 124

4.5.2.13 I am willing to keep my plastic waste with me and dispose of it at home..... 125

4.5.2.14 I have noticed waste bins located in the Struisbaai harbour and the boardwalk area126

4.5.2.15 I have noticed a difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area 127

4.5.2.16 I think that the current waste management infrastructure (bins/skips) in the Struisbaai harbour and boardwalk area is sufficient..... 128

4.5.2.17 I am satisfied with the placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area..... 129

4.5.2.18 I have encountered overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area 130

4.5.2.19 I think the measures currently in place to manage plastic waste in the Struisbaai harbour area are effective..... 131

4.5.2.20 I think that Struisbaai has the necessary waste management capacity to handle the increased number of tourists during the Holiday season..... 133

4.5.2.21 I think that plastic waste management has improved over the past five years in the Struisbaai area 134

4.5.2.22 Combined discussions on perceptions of plastic waste management in Struisbaai area (Likert scale questions) 135

4.5.3 Perceived opportunities and challenges regarding plastic waste management in the Struisbaai area 137

4.5.3.1 Perceived challenges regarding plastic waste management in the Struisbaai area137

4.5.3.1.1 Tourist behaviour 139

4.5.3.1.2 Insufficient infrastructure 139

4.5.3.1.1 Lack of education and awareness 140

4.5.3.1.1 Insufficient waste management 141

4.5.3.1.2 Infrequent emptying of bins 142

4.5.3.1.3 Lack of enforcement 142

4.5.3.2 Perceived opportunities regarding plastic waste management in the Struisbaai area143

4.5.3.2.1 Improvement of waste infrastructure 145

4.5.3.2.1 Waste awareness, education, and clean-up programmes 146

4.5.3.2.1 Fining system 146

4.5.3.2.2 Improvement of waste management 147

4.5.3.2.1 Work opportunities and job creation 147

4.5.3.2.2 More frequent emptying of waste bins 148

4.5.3.2.1 Better enforcement 148

4.5.3.2.1 Behaviour changes 149

4.5.3.2.2 Banning of plastic products/implement alternatives to plastic products 149

4.5.3.2.3 Incentives 150

4.6 Results related to RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai..... 150

4.7 Chapter summary 152

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS 154

5.1 Introduction 154

5.2 Conclusions 154

5.2.1 Conclusions related to RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour 154

5.2.2 Conclusions related to RO2: Determining plastic waste management practices in Struisbaai Harbour 155

5.2.3 Conclusions related to RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour 155

5.2.4 Conclusions related to RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai..... 156

5.3 Recommendations for improvement and areas of future research 158

5.3.1 Recommendations for improvement of plastic waste management practices158

5.3.1.1 Improving waste services and infrastructure 158

5.3.1.2 Increasing education and awareness to change behaviour..... 159

5.3.1.3 Enhancing regulation and enforcement 160

5.3.1.4 Incentivising good practice 160

5.3.2 Recommendations for further research..... 161

BIBLIOGRAPHY..... 162

ANNEXURE A 216

ANNEXURE B 228

ANNEXURE C 236

LIST OF TABLES

Table 2-1: Applications and characteristics of commonly used synthetic plastics (Source: Rajendran, 2015:345; Hopewell *et al.,* 2009)..... 12

Table 2-2: Strengths and weaknesses of the CaC approach. (Source: Adapted from Nel & Wessels, 2017:52-53). 26

Table 2-3: Potential economic instruments of solid waste management. (Source: Adapted from Department of Environmental Affairs, 2016:8)..... 27

Table 2-4: International binding agreements with relevance to marine environments and plastic pollution. (Source: Adapted from Manyara *et al.*, 2023)..... 33

Table 2-5: International non-binding strategies and instruments governing marine environments and plastic waste (Source: Adapted from Manyara *et al.*,

Table 2-6: Regional and Sub-regional frameworks and initiatives governing marine pollution and plastic waste within the African context. (Source: Adapted from Manyara *et al.*, 2023). 41

Table 2-7: Regional and Sub-regional frameworks and initiatives directly addressing plastic pollution in marine environments within the African context. (Source: Adapted from Manyara *et al.*, 2023). 43

Table 3-1: Overview of the research design. 63

Table 3-2: Types of questions used for the development of the survey questionnaire (Source: Adapted from Botma *et al.,* 2010:136; Dörnyei, 2003)..... 75

Table 4-1: Socio-demographic profile of the participants (n=211)..... 85

Table 4-2: Waste categorisation results. 88

Table 4-3: Frequency table of Likert scale responses. 111

Table 4-4: Perceived challenges regarding plastic waste management in the Struisbaai area (n = 211) 137

Table 4-5: Perceived opportunities regarding plastic waste management in the Struisbaai area 143

LIST OF FIGURES

Figure 2-1: Various sizes of plastic waste. (Source: adapted from Chitaka *et al.*, 2023).14

Figure 2-2: Sources and pathways of plastic waste into marine environments. (Source: adapted from Bråte *et al.*, 2017:23). 18

Figure 2-3: Map of main international maritime shipping routes. (Source: Notteboom *et al.*, 2022)..... 21

Figure 2-4: Transportation pathways of plastic waste across the marine environment. (Source: adapted from Welden & Lusher, 2017). 24

Figure 2-5: Environmental management approaches in South Africa. (Source: adapted from Nel & du Plessis 2001; Nel & Alberts 2018)..... 25

Figure 2-6: International binding agreements with relevance to marine environments and plastic pollution. (Source: Author's compilation). 32

Figure 2-7: Global non-binding strategies and instruments with relevance to marine environments and plastic pollution. (Source: Author's compilation). 36

Figure 2-8: Regional and sub-regional frameworks governing marine pollution and plastic waste within the African context. (Source: Author's compilation). 41

Figure 2-9: Regional and sub-regional initiatives directly addressing plastic pollution in marine environments within the African context. (Source: Author's

Figure 2-10: South African legal framework. (Source: adapted from Mukwevho *et al.,* 2022).46

Figure 2-11: Map South Africa's Marine Protected Areas. (Source: South Africa's MPA's, n.d). 53

Figure 2-12: De Mond Nature Reserve current waste management practices. (Source: Saptou, 2024). 60

Figure 3-1: Struisbaai. A) Parry the stingray; B) a busy day in the harbour; C) Duiker Street Beach; D) buying fresh fish off the harbour jetty; E) the wooden boardwalk; F) Struisbaai harbour and the "chukkies". (Source: Author's photos). 67

Figure 3-2: Struisbaai wind history for 2023. (Source: Windy.App, n.d). 68

Figure 3-3: Map of Struisbaai Harbour and the wooden promenade displaying the three different governance zones. 69

Figure 3-4: Waste collection, sorting, and quantification. (Source: Author's photos). 73

Figure 3-5: Code used in analysing the responses of Section 4 of the questionnaire. (Source: Author's own compilation). 81

Figure 4-1: The total amount of plastic waste collected per day as a percentage. 89

Figure 4-2: Cape Agulhas Municipality refuse collection dates 1-6 January 2024 (CAM, 2023c). 89

Figure 4-3: Distribution of waste bins in the parking lot at the end of the promenade at Duikers beach. The blue and red dots represent the polygon vertices used to demarcate the area, while the yellow line indicates the boundary within which the waste bins are located (Google Earth, 2024). 93

Figure 4-4: Lidless bins in Struisbaai Harbour and along the wooden promenade. (Source: Author's own photos). 95

Figure 4-5: Increased waste visibility in the research area. (Source: Author's own photos).96

Figure 4-6: Overflowing bins in Struisbaai Harbour and along the wooden promenade. (Source: Author's own photos). 98

Figure 4-7: Primary type of waste in Struisbaai Harbour area as perceived by respondents.100

Figure 4-8: Main source of waste in Struisbaai Harbour as perceived by respondents.01

Figure 4-9: The biggest challenge towards reducing plastic waste in the Struisbaai marine environment as perceived by respondents. 102

Figure 4-10: Changes participants would be willing to make to reduce plastic waste. 103

Figure 4-11: Factors encouraging reduction of plastic waste in marine environments. ... 105

Figure 4-12: Most effective ways to raise awareness about plastic waste in marine areas as perceived by respondents. 106

Figure 4-13: The most effective approaches in reducing plastic waste in marine environments. 108

Figure 4-14: Participants perceptions of observations of plastic waste on the beach and in the ocean at the Struisbaai harbour area. 113

Figure 4-15: Participants perceptions of the sight of plastics bothering them..... 114

Figure 4-16: Participant perceptions on the presence of plastic waste affects their enjoyment of the harbour and boardwalks aesthetics. 115

Figure 4-17: Participant perceptions on the presence of plastic in the ocean and along the harbour and boardwalk in Struisbaai being a problem. 116

Figure 4-18: Participant perceptions on plastic waste being a major issue affecting the natural environment in and around Struisbaai harbour. 117

Figure 4-19: Participant perceptions on presence of plastic waste over a five-year period in the Struisbaai coastal area. 118

Figure 4-20: Participant perceptions of the presence of plastic in the ocean and along the coastal area in Struisbaai harbour potentially deterring tourists from visiting the area. 119

Figure 4-21: Participants' awareness of the long-term adverse impacts of plastic pollution on marine ecosystems. 120

Figure 4-22: Participant perceptions of individuals' responsibility to reduce plastic waste in marine environments. 121

Figure 4-23: Participants' willingness to avoid the use of single-use plastics at the beach/in a marine environment. 122

Figure 4-24: Participants' willingness to pay a reasonable price for environmentally friendly products and reduce plastic waste in marine environments..... 123

Figure 4-25: Participants' willingness to walk to waste bins to dispose of their waste. 124

Figure 4-26: Participants' willingness to keep their plastic waste and dispose of it at home.125

Figure 4-27: Participant perceptions of waste bins located in Struisbaai harbour and the boardwalk area. 127

Figure 4-28: Participant perceptions of difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area. 128

Figure 4-29: Participant perceptions of sufficiency of current waste management infrastructure. 129

Figure 4-30: Participant satisfaction with placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area. 130

Figure 4-31: Participant perceptions of overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area. 131

Figure 4-32: Participant perceptions of effectiveness of current measures to manage plastic waste in the Struisbaai harbour area. 132

Figure 4-33: Participant perceptions of waste management capacity to handle peak tourist seasons. 133

Figure 4-34: Participant perceptions of improvement of plastic waste management over a five-year period in the Struisbaai coastal area. 134

CHAPTER 1 INTRODUCTION

1.1 Background

Plastic was first introduced in the 1950s and quickly became one of the most sought-after products due to its versatility (Worm *et al.,* 2017). Because of its long durability and slow degradation, plastic waste mismanagement soon became a global environmental burden (Andrady, 2015). Researchers are increasingly concerned about the large quantities of plastic found in the ocean and the negative impact of this on both marine flora and fauna (Gilman, 2015; Compa *et al.,* 2019). Plastic waste holds various threats to marine ecosystems and coastal areas (Thushari & Senevirathna, 2020; Gall & Thompson, 2015). It damages marine ecosystems and habitats. Abandoned, lost, and discarded fishing gear (ALDFG) entangles wildlife (Gajanur & Jaafar, 2022), and the ingestion of microplastics by marine species often has fatal consequences (Clark *et al.,* 2016). It also negatively impacts marine species' feeding dynamics (Roman *et al.,* 2020; Bucci *et al.*, 2020). Some marine species and organisms accidentally latch onto various marine litter (known as rafting) and can be transported to habitats that are unsuitable for the species, causing an imbalance within the marine ecosystem (Thushari & Senevirathna, 2020). Plastic waste also has negative socioeconomic impacts (Oliveira *et al.,* 2020), is aesthetically displeasing (Shahidul Islam & Tanaka, 2004), can be harmful to human health (Vethaak & Leslie, 2016), and has a negative effect on recreational as well as tourism activities (Liu *et al.,* 2022).

According to the Sustainable Seas Trust (SST, 2021), Africa is currently ranked as the second most polluted continent in the world after Southeast Asia. Although the quantity of waste that flows from the African continent into the ocean is undetermined, it is evident that due to the continent's continuous growth, waste is being generated faster than it can be managed (SST, 2021). Due to insufficient waste management practices, the majority of waste generated in Africa either ends up in landfill sites or is illegally dumped (Jambeck *et al.,* 2018; Godfrey *et al.,* 2020). The eleven biggest gross domestic product (GDP) countries in Africa (including South Africa) are situated near coastal areas, which presents the risk of land-based waste sources entering the ocean (SST, 2021).

According to research conducted by Jambeck *et al.* (2015), South Africa is among the top 20 countries in the world discarding the largest number of land-based waste into the ocean. Similarly, it is believed that South Africa is one of the countries that contributes the most plastic into the ocean internationally (Ryan, 2020). It is estimated that South Africans produce approximately 12.7 million tonnes of domestic waste each year (Polasi *et al.,* 2020). Despite the comprehensive regulatory framework in South Africa, which is aimed at implementing the waste management

hierarchy to ultimately minimise the amount of waste that is disposed to landfill, the majority of waste generated in the country still ends up in landfill sites (Chironda, 2022).

The 2020 National Waste Management Strategy (Department of Forestry, Fisheries, and the Environment, 2020) highlights the concerns related to the *"widespread impact of plastic on our coasts"* with a specific focus on the negative effects of "*single-use plastics such as food wrappers, disposable cups, and straws that are currently destroying our marine habitats"* and are causing *"widespread and severe negative impacts on marine biodiversity"* (Department of Forestry, Fisheries, and the Environment, 2020: 12, 15). The strategic thrust of Pillar 1 of the 2020 National Waste Management Strategy (Department of Forestry, Fisheries, and the Environment, 2020: 34) is specifically aimed at *"minimising the impact of waste and especially plastic packaging in our coasts, rivers, wetlands, and our human settlement environments, by amongst others, diverting waste away from landfill".*

1.2 Problem statement and rationale for the study

Marine ecosystems and coastal areas are significantly affected by anthropogenic activities globally (Häder *et al.*, 2020). Aquatic environments are increasingly impacted due to the expansion of urban developments and recreational activities leading to the overexploitation and unsustainable use of marine materials and resources (Borgwardt *et al.,* 2019). This causes progressive environmental degradation in and pollution of marine ecosystems and coastal areas (Alimba & Faggio, 2019).

Marine pollution is an increasing global concern (Kühn *et al.,* 2015; Veiga *et al.*, 2016; Claro *et al.,* 2019) that negatively affects marine ecosystems, coastal and recreational areas, as well as human health and well-being (Cabral *et al.*, 2019; Kumar & Gurunathan, 2021). Coastal areas are experiencing a dramatic rise in land-based pollution (Verster & Bouwman, 2020), which finds its way into marine ecosystems either through the direct discarding of waste into marine environments, or indirectly through the wind, surface runoff, carried by rivers, wastewater treatment systems, or the discharge of effluent (Boucher & Friot, 2017). Most marine pollution originates from land-based sources (Jambeck *et al.,* 2015; Ryan, 2020; Verster & Bouwman, 2020) and, according to a publication by the International Union for Conservation of Nature (IUCN, 2022), approximately 300 million tonnes of plastic are generated every year, and an estimated 14 million tonnes of plastic enter the ocean annually. Furthermore, according to Adam *et al.* (2020) plastic accounts for roughly 80% of all marine litter found in the ocean.

Although some research has been done on marine plastic pollution in South Africa in the last five to ten years (for example: Verster *et al.,* 2017*;* Chitaka & von Blottnitz, 2019; Verster & Bouwman,

2020; Jambeck *et al.,* 2015; Ryan, 2020; Arabi & Nahman, 2020; Thushari & Senevirathna, 2020; and van Rensburg *et al.,* 2020), the relationship between its sources and how this impacts the management of waste has received little research attention (Godfrey, 2020). There is still a need for more research focusing on waste management in marine and coastal areas, to better understand the sources of plastic waste and the effectiveness of waste management practices in mitigating marine pollution (Harper *et al.,* 2022). One such section that requires interdisciplinary research for the improvement of its waste management practices preventing plastic waste from entering the ocean, is Marine Protected Areas (MPAs). Research in MPAs, or marine and coastal areas that are in close proximity to protected areas especially provides an interesting context, since waste management in protected areas is of utmost importance, and a lack of waste management in protected areas can have detrimental effects on the surrounding environment, as well as various socioeconomic impacts (Roos *et al.,* 2022).

For the purposes of this research, Struisbaai is selected as a case study area. Struisbaai is located between two protected areas, Agulhas National Park and De Mond Nature Reserve. De Mond Nature Reserve falls under the authority of the Western Cape Nature Conservation Board (CapeNature), and this area has also been declared a World Heritage Site (CapeNature, 2023). The area where Agulhas National Park has been established consists of privately owned property, declared Mountain Catchment areas, and other protected areas (SANParks, 2020). The National Park falls under the authority of the South African National Parks (SANParks), CapeNature, the Eastern Cape Parks and Tourism agency, as well as the Department of Environment, Forestry, and Fisheries. Agulhas National Park also forms part of the Cape Floral Region Protected Areas World Heritage Site (SANParks, 2020). Just South of Cape Agulhas approximately 40 km offshore, lies the Agulhas Mud Marine Protected Area (Marine Conservation Institute, 2024).

Due to its location and various activities, Struisbaai has become a popular destination for local as well as international tourists. With the increase in tourist numbers, the amount of waste being generated is also increasing rapidly. Cape Agulhas Municipality (CAM) is responsible for the collection of waste in Struisbaai and certain areas within the harbour and discards the waste at the local landfill site (Cape Agulhas Municipality, 2022). CAM is also responsible for taking recyclable material to the nearest recycling facility in Napier. The Department of Forestry, Fisheries, and the Environment (DFFE) is responsible for waste management in a different sector within the same harbour, making waste management practices much more challenging due to the different legislation and jurisdictions within the same area. Since the harbour is the main attraction for nearly all tourist activities, it is also the place where most waste is generated and discarded.

This research, therefore, explores plastic waste and related management practices within the Struisbaai Harbour area.

1.3 Research aims and objectives

This research aims to explore plastic waste and related waste management practices within a South African coastal area, the Cape Agulhas National Park, focusing on Struisbaai Harbour as a case study area, with a view to making recommendations for improvement.

Based on the research aim, the following objectives are set:

1. Determining the extent (quantities and nature[1]) of plastic waste pollution in Struisbaai Harbour.
2. Determining plastic waste management practices in Struisbaai Harbour.
3. Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour.
4. Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai.

1.4 Scope of the research

The research is conducted in *Struisbaai Harbour* with the primary focus on the collection and quantification of *plastic waste*. The study aims to include and quantify all types of plastic waste, including, but not limited to, plastics such as polyvinyl chloride (PVC), low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene terephthalate (PET), etc. and any other plastic waste that may be found in Struisbaai Harbour. No other waste streams were included in this research. Furthermore, the study specifically focuses on *macroplastics* and does not include microplastics.

1.5 Defining key terminologies

The following key terminologies are defined in the context of this research. These definitions should be considered together with the definitions and key terminologies outlined on pages vi to viii of this dissertation.

1.5.1 Plastic waste

Plastic waste can be defined as any plastic product or object (such as plastic containers, soft drink bottles, straws, plastic bags, etc.) that has reached its end of life and is discarded or abandoned at landfill sites, burned in incinerators, or disposed of by littering and illegal dumping (Acquavia *et al.,* 2021). The use of single-use plastics (plastics that are manufactured to be used

[1] Nature refers to the basic or inherent features, character, or qualities of plastic waste.

only once before being discarded) has increased significantly over the last few years and is one of the biggest contributors to marine pollution (Chen *et al.,* 2021).

1.5.2 Macroplastics

Macroplastics are large pieces of plastic debris with a diameter of ≥ 5 mm found within the marine environment (Lechthaler *et al.,* 2020). Due to their size, macroplastics have a significant visual and physical impact on the environment (Thushari & Senevirathna, 2020; Bucci *et al.,* 2020), and exposure to environmental stressors causes macroplastics to break down into smaller pieces, forming microplastics (Okeke, 2022). There are different types of macroplastics that can include items such as plastic bottles, bags, and fishing gear (Anik *et al.,* 2021). According to van Emmerik (2021), macroplastics have been identified as one of the main sources of marine pollution and are a serious threat to the marine environment.

The terms "macroplastics" and "plastic waste" are used interchangeably throughout the dissertation, as they refer to the same concept within the scope of this study. For the purpose of this research, both terms are intended to convey the same meaning.

1.5.3 Marine protected area

The IUCN defines a marine protected area (MPA) as: "*any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment*" (IUCN, 1988:18). Kriegl *et al.* (2021) defines an MPA as a designated area of the ocean or coastal waters that is managed and protected to conserve marine ecosystems, biodiversity, habitats, and species through regulations and management measures to restrict certain human activities within their boundaries.

1.5.4 Waste management practices

Waste management is the practice of collecting, transporting, handling, and disposing of waste materials by either taking it to landfill, recycling recyclable materials, incinerating, or composting organic waste (Hill, 2022). This practice is carried out sustainably and aims to reduce the adverse effects of waste on both the environment as well as human health and well-being (Abubakar *et al.*, 2022). There are various types of waste such as electronic waste, hazardous waste, solid waste, etc. and proper waste management practices and different strategies and techniques are needed to ensure that all waste types are disposed of in accordance with law and legislation (EPA, 2023a).

1.6 Potential contribution of the research

Quantifying and analysing the plastic waste found in Struisbaai Harbour can raise public awareness and produce a better understanding of the importance of waste management to prevent waste from entering the ocean from land-based sources. This can lead to the development of more sustainable, efficient policies, regulations, and mitigation strategies that are aimed at reducing plastic pollution within marine ecosystems. The research can also provide new incentives for governments and industries to reduce plastic pollution by developing more sustainable materials and encouraging the adoption of eco-friendly practices. By contributing valuable data and insights, this research can play a key role in preserving the marine ecosystems in and around Struisbaai Harbour.

1.7 Structure and outline of the dissertation

The dissertation consists of the following five chapters, as well as a bibliography and annexures.

Chapter 1: Introduction

This Chapter will include an introduction to the study, the background of the study, the problem statement and justification, the research aim and objectives, gaps in the literature, as well as the research methodology.

Chapter 2: Literature Review

The literature review will discuss the main themes of the study. This includes the global as well as national marine pollution problem, with a focus on plastic waste and waste management practices within Struisbaai Harbour; the legal requirements of plastic waste and waste management within Struisbaai Harbour; and the impact of waste on marine ecosystems, with a focus on the marine ecosystem and coastal area of the Agulhas National Park region.

Chapter 3: Methodology

The research design and data collection, data sampling, population, and data analysis will be discussed. This chapter also includes a brief introduction to the study area and discusses the limitations of the study.

Chapter 4: Results and Discussions

The results from observations, questionnaires, and document analysis will be discussed in this Chapter.

Chapter 5: Conclusion and Recommendations

Chapter 5 will focus on discussing the findings and drawing conclusions from the results, as well as providing recommendations for improvement.

1.8 Conclusion

In this chapter, the foundation for the research has been laid out and the critical elements supporting this study have been explored. This chapter began with the provision of a comprehensive background that explored the historical, theoretical, and practical aspects of marine plastic pollution. The problem statement was identified, focusing on a specific gap in existing research and providing the scope and focus of the research study, to better understand the sources of plastic waste and the effectiveness of waste management practices in marine and coastal areas to mitigate marine pollution. The research objectives were defined and provided the targets of the study that must be achieved to accomplish the research aim. The objectives ensure that the research remains focused, systematic, and aligned with the goal of the study. The following chapter explores existing literature to provide an in-depth understanding of the research topic, address the research problem, and achieve the outlined research objectives.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

An extensive literature review is conducted in this chapter to provide an in-depth study to discern the recurring themes within the research findings and to draw conclusions. This chapter provides context for the study and aims to contribute to the research objectives by studying the literature on marine pollution, sources, and pathways of marine pollution; the types of plastic pollution found within coastal areas; and determining existing waste management frameworks to combat marine pollution on a global and national scale.

The literature study used keywords such as “origin of plastic”, “types of plastic”, “marine pollution”, “marine plastic pollution”, “plastic waste”, “sources of marine pollution”, “transportation of marine pollution”, “marine legislation”, “waste management”, and “Agulhas National Park” in different combinations. To perform the literature study, scientific and academic publications, books, published theses and dissertations, as well as other related sources, were explored. Several online databases were used to conduct the research, including Google Scholar, Research Gate, Elsevier, Science Direct, and Scopus, as well as the online and on-campus library of the North-West University at the Potchefstroom Campus.

This study draws on ideas of previous studies and other authors who have studied plastic pollution in marine environments. A study conducted by Verster and Bouwman (2020) highlighted land-based sources and pathways of marine plastics in a South African context. Similarly, Ryan (2020) evaluated the transport and fate of marine plastics in South Africa and adjacent oceans. Weideman *et al*. (2020) conducted a Master's thesis on quantifying land-based sources of plastic pollution in South Africa. The study focused on identifying significant sources of litter to develop effective strategies for preventing plastic waste from entering the marine environment, using Cape Town's stormwater run-off system and the Orange-Vaal River system in Gauteng as case studies. Another study addressed meso- and microplastics in harbour environments, focusing on the Port of Durban (Preston-Whyte *et al.,* 2021). Over recent years, environmental legislation and governance frameworks for pollution and marine plastic pollution have become highly researched topics (IUCN, 2020; da Costa *et al.,* 2020; Sadan & De Kock, 2021; Manyara *et al.,* 2023). The study of Harper *et al.* (2022) focused on waste behavior in MPAs but was generic and did not focus on plastic waste.

This study is unique in its comprehensive approach to plastic pollution in marine environments. It encompasses the identification of sources and pathways, the composition of pollutants, and the legislative and governance frameworks that address plastic pollution on both global and national

scales. Additionally, the study explores environmental behaviour, examining how human actions contribute to marine pollution. It quantifies and characterises the nature of waste found in specific study areas, including areas situated close to marine protected areas and nature reserves. Notably, there is a significant research gap regarding waste management practices in small harbour environments in the Western Cape, as most existing studies focus on larger cities and more densely populated areas rather than small coastal towns.

The research objectives are discussed in the following sections:

Objective 1, which focuses on determining the extent and nature of plastic waste pollution in Struisbaai Harbour, is addressed in Section 2.3. This section, particularly subsections 2.3.1 and 2.3.2, provides detailed insights into how plastic waste enters marine environments, which is directly related to the quantification of pollution that this objective seeks to explore.

For Objective 2, which aims to determine the plastic waste management practices in Struisbaai Harbour, the relevant information is covered in Section 2.10. This section offers a comprehensive review of the current waste management practices at Struisbaai Harbour and surrounding protected areas, such as Agulhas National Park, forming a basis for evaluating the effectiveness of these practices.

Objective 3, which seeks to explore public perceptions of plastic waste and waste management practices, is addressed in Section 2.5. This section discusses public actions and environmental behaviours that contribute to waste generation and management, providing context on the public's role in addressing plastic pollution, thus linking to this objective.

Lastly, Objective 4, which evaluates the governance and legislative frameworks for plastic waste management in Struisbaai, is covered in Sections 2.6 and 2.8. Section 2.6 and its subsections (2.6.1 to 2.6.3) review international and national frameworks, while Section 2.8 delves into the South African governance structures that influence waste management practices in the area. These sections support the analysis required for evaluating governance structures, fulfilling the aim of the fourth objective.

2.2 Background on plastic

This section provides an overview into the history of plastic, its chemical composition, diverse classification of plastic types, and the various size categories of plastic waste.

2.2.1 History of plastic

The development and use of polymers can be traced to the early 1600s BCE when natural rubber was used to make rubber balls and was modelled into statues and figurines (Hosler *et al.,* 1999). Humans further experimented with and created different types of polymers in the following years (Andrady & Neal, 2009), with people becoming increasingly dependent on the use of rubber and plastics in everyday use. In 1862, Alexander Parkes developed Parkesine, a synthetic polymer that marked the beginning of future advancements in modern plastics (Rajendran *et al.,* 2015). Shortly thereafter, in 1868, John Wesley Hyatt developed cellulose nitrate, otherwise known as celluloid, a substitute for the ivory in billiard balls (Ebewele, 2000; Rasmussen, 2021). This is the first partially synthetic plastic to be introduced to the world (Swallow, 1951).

The first truly synthetic plastic, known as phenol-formaldehyde plastics, was introduced by Dr Leo Hendrick Baekeland in 1907 (Klun *et al.,* 2022), 41 years after John Wesley Hyatt invented celluloid. The product became known as Bakelite, and it was initially used as an electrical insulator (Chalmin, 2019). This revolutionary discovery became the foundation for the manufacturing of a variety of products, such as motor vehicles, cookware, toys, handheld radio sets, telephone receivers, and electrical appliances (American Chemical Society National Historic Chemical Landmarks, 1993; Rajendran *et al.,* 2015). Subsequently, according to Ebewele (2000), through the development of polymerisation and other advancements, various other polymers emerged in the 1920s, such as nylon (used for toothbrush bristles and medical sutures), polyvinyl chloride (found in flooring materials and furniture), cellulose acetate (used for the manufacturing of toothbrushes, hair combs, and spectacle frames), and others.

During World War I and World War II, plastics such as polyvinyl chloride (PVC) were used as alternatives to metal, glass, wood, rubber, and leather (Wickson & Grossman, 2008). The demand for plastic products increased significantly after World War II, driven by industrialisation and consumer demand for durable and lightweight materials (Geyer *et al.,* 2017). Plastic production experienced a global expansion (Freinkel, 2011), leading to the widespread adoption of newer plastics like polypropylene, polyester, silicone, polyethylene terephthalate, and polystyrene across various industries and everyday products (Rajendran *et al.,* 2015; Andrady & Neal, 2009).

Plastic production expanded into the 20th century, with various types of polymers and plastics being developed for different purposes (Feldman, 2008). From 1950 to 2021, it is estimated that the global production of plastic has grown exponentially from 2 million tonnes to 390 million tonnes in 2021 (Statista, 2023), showing an annual increase of 4%. Due to its versatility, durability, cost-effectiveness, and tendency to be a lightweight material, plastic is a popular material used in many industries (Andrady, 2015) and is also a popular material used in everyday life. The extensive

global demand for plastic has caused a mass production of polymers and plastic materials, making plastic production the most prolific man-made product of all time (Geyer *et al.,* 2017). According to Jansen (2016), the distinctive characteristics of plastic, as mentioned above, are the result of plastics' unique polymer structure.

As mentioned above, the production of plastics has grown significantly over the last 50 years. The development and proper management of plastics and polymers are important topics of research due to their environmental impact. Over recent years, plastic waste has become a major global problem, on land as well as in the ocean, and has seen a rise in media attention (Letcher, 2020).

Section 2.2.2 provides a description of the composition of plastic.

2.2.2 Composition of plastic

Plastic is a category of synthetic organic polymers characterised by long, chain-like molecules with a notably high average molecular weight (Law, 2017). It is a human-made polymer that is produced through chemical processes (Landrigan *et al*., 2023). The term "polymer" is derived from the Greek word's "poly", meaning "many", and "meres", meaning "parts" (Namazi, 2017). Polymers are large molecules (also called macromolecules) comprised of repeating subunits called monomers (Chandra, 2013) and are formed by either polyaddition or polycondensation (Atiwesh *et al.,* 2021), a process in which the monomers are chemically bonded together to form long polymer chains (Sperling, 2006; Carothers, 1931). According to Singh *et al.* (2022), the monomers used in the production of synthetic plastics are mainly sourced from hydrocarbons, including coal, oil, petroleum, as well as natural gas.

2.2.3 Types of plastic

Polymers can be classified into three different categories, natural polymers, semi-synthetic polymers, and synthetic polymers. Natural polymers such as proteins and cellulose are found in living organisms (Yenagolla *et al.,* 2022) and can be extracted from plant and animal sources (Saleh, 2021). Some examples include silk, wool, and cellulose (Shrivastava, 2018). Synthetic polymers are man-made polymers artificially produced through chemical reactions or polymerisation processes (Kaushik *et al.,* 2016). They are typically derived from petroleum oil, and examples of synthetic polymers include synthetic fibres (nylon), elastomers (rubber) and polystyrene (Shrivastava, 2018). Semi-synthetic polymers are natural polymers that are chemically altered to enhance their properties or change their functions (Gutierrez Cisneros *et al.,* 2021).

The arrangement of monomers and the specific chemical composition of the polymer plays a crucial role in determining the distinct properties of each synthetic plastic (McAdam *et al.,* 2020). There are three types of polymers: plastics, elastomers, and fibres (Ouellette & Rawn, 2015). Elastomers are polymers known for their rubberlike elasticity, allowing the material to be stretched into various shapes (Özdemir, 2020). Once the applied force is released, elastomers can quickly revert to their original form (Alarifi, 2023).

There is a broad spectrum of plastics, each characterised by its respective chemical structures, properties, as well as its reaction to heat and pressure. They are classified under two categories, thermosets, and thermoplastics (Rajendran, 2015). Thermosetting plastics are crosslinked polymers that undergo a chemical reaction and are cured into a permanent shape (Peters, 2002). Curing takes place by applying heat rapidly, and once the thermosets are cured, the product becomes hard and heat-resistant and cannot be remelted or reformed again (Sastri, 2022). Unlike thermosetting, thermoplastic polymers have linear chains and are not cured into a permanent shape when exposed to heat (Lim *et al.,* 2023). Instead, thermoplastics are melted, moulded and cooled. They can be remelted and remoulded multiple times when exposed to heat (Huang, 2022) and become a hardened shape when cooled. Fibres are used to produce materials with high tensile strength and flexibility. They can be spun into long, continuous fibres to create textiles and other materials (Ouellette & Rawn, 2015).

Thermoplastics are the most widely used plastics for packaging due to their versatile nature (Kazemi *et al.,* 2021). Among the many types of plastics used in packaging, seven specific types are commonly used (see Table 2-1). Synthetic plastics are also used for medical devices, electronics, construction materials, car manufacturing, and more.

Table 2-1: Applications and characteristics of commonly used synthetic plastics (Source: Rajendran, 2015:345; Hopewell *et al.,* 2009).

Type of plastic	Characteristics	Application	Recyclability
Polypropylene terephthalate (PET) 	Strong and lightweight, excellent gas and moisture barrier.	Soft drink, water and dressing bottles, peanut butter and jam jars.	Widely recyclable.
High-density polyethylene (HDPE) 	High density, great strength and toughness, chemical resistant, water, and moisture resistant, electrical insulation.	Milk, juice, and water bottles, trash and retail bags.	Highly recyclable.

Type of plastic	Characteristics	Application	Recyclability
Polyvinyl chloride (PVC) 	Good chemical resistance, flame retardant, electrical insulation properties, and versatile processing options.	Juice bottles, cling films, raincoats, visors, shoe soles, garden hoses, and electricity pipes.	Recyclable but less commonly accepted due to challenges in processing and potential for contamination.
Low-density polyethylene (LDPE) 	Low density, high flexibility and softness, impact resistant, chemical resistant, water, and moisture resistant, electrical insulation.	Frozen food bags, squeezable bottles, flexible container lids.	Recyclable.
Polypropylene (PP) 	High stiffness, good chemical resistance, excellent heat resistance, low density.	Bottle caps, drinking straws, medicine bottles, car batteries, disposable syringes.	Recyclable.
Polystyrene (PS) 	Rigid, lightweight, good thermal insulation, transparent or opaque options available.	Packing materials, laboratory ware, disposable cups, plates, trays, and cutlery.	Recyclable but often limited due to low market demand.
Others (often polycarbonate) 	High impact resistance, transparency, good dimensional stability, and excellent heat resistance.	Beverage bottles, baby milk bottles, electronic casing.	Recycling feasibility varies, may require specialised processing techniques.

2.2.4 Categorisation of plastic sizes

Plastic waste found within the ocean is typically organised into four size groups, megaplastics, macroplastics, mesoplastics, and microplastics (Thushari & Senevirathna, 2020). All these plastic types are abundant within marine environments and can have adverse effects on marine life (Fava, 2022). Extremely large pieces of plastics exceeding 1 m in size are called megaplastics (Ozturk & Altinok, 2020). Macroplastics are large pieces of plastic debris larger than 20 mm (Debroy *et al.,* 2021) and, due to its size, it is often visible to the human eye, leading many to believe that macroplastics are the biggest threat to the environment (Napper & Thompson, 2020). Mesoplastics have a size of 5 to 20 mm (Szymańska & Obolewski, 2020), and microplastics are tiny plastic particles, less than 5 mm in size, that result from the fragmentation of larger plastic items or are intentionally manufactured at a small scale (Lechthaler *et al.,* 2020). Figure 2-1 illustrates the various sizes of plastic waste. This research mainly focusses on macroplastics that accumulate within the predetermined geographical area situated in Struisbaai Harbour.

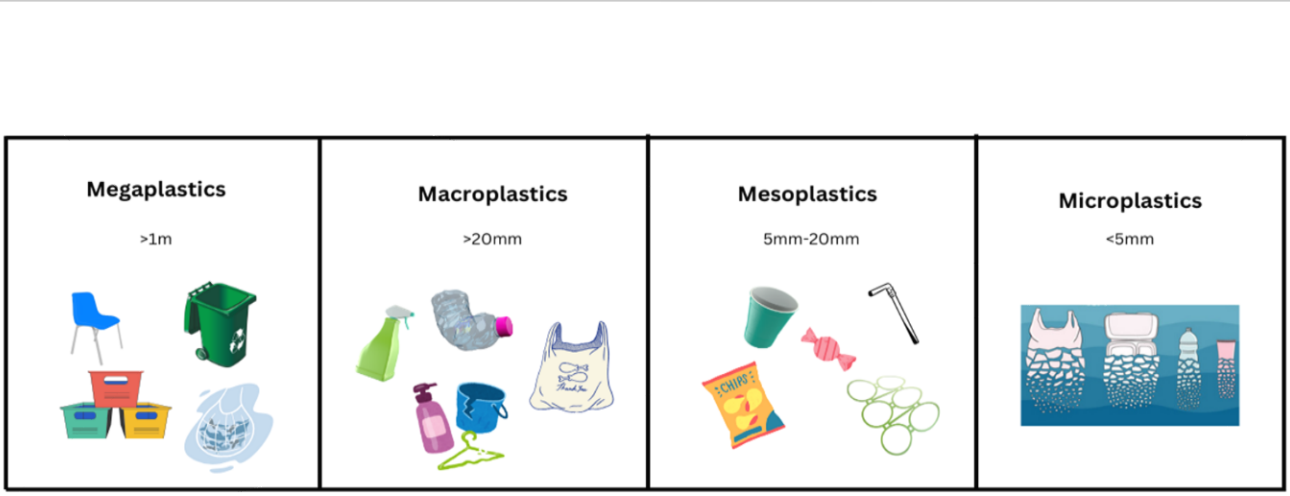


Figure 2-1: Various sizes of plastic waste. (Source: adapted from Chitaka *et al.*, 2023).

2.3 Sources and pathways of plastic waste

According to Veiga *et al.* (2016), and Kumar and Gurunathan (2021), marine pollution consists of all types of materials, substances, and items that cause harm to marine ecosystems. These materials are either directly or indirectly deposited in coastal and marine ecosystems through illegal dumping, surface run-off, river transport, wind dispersion, or the discharge of effluents (Figure 2-1) (Boucher & Friot, 2017). Around 300 million tonnes of plastic are generated annually, and an estimated 14 million tonnes of plastic waste finds its way into the ocean (IUCN, 2022).

Plastic waste has various sources and pathways (Derraik, 2002) and, according to a publication by Verster and Bouwman (2020), most marine pollution originates from land-based sources, with plastic waste alone accounting for nearly 80% of all marine waste found within the ocean (Adam *et al.,* 2020). Because of its transboundary and cross-continental nature, marine pollution originates from both local sources and global contributions (Subedi & Pandey, 2022). There are two main categories of pollution, point source and non-point source pollution. The U.S. Environmental Protection Agency (EPA) defines point source pollution as *"any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged"* (EPA, 2022). Factories and sewage treatment plants are examples of point source pollution (NOAA, 2013b). Non-point source pollution refers to pollution that originates from multiple, widely distributed sources, making it difficult to determine a single origin. It typically results from surface runoff that carries contaminants from various land-based activities (NOAA, 2013c).

The sections below focus on the sources and pathways of land-based and sea-based sources of plastic waste. Approximately 80% of marine waste is attributed to land-based sources, while the remaining 20% is associated with sea-based sources (Verster & Bouwman, 2020).

2.3.1 Land-based sources of plastic waste

Land-based sources of marine pollution are caused by various anthropogenic activities that introduce contaminants into coastal and marine environments (UNEP, n.d.). Land-based sources are often the main sources of waste found within the marine environment (Verster & Bouwman, 2020). According to Ryan *et al.* (2009), rivers, stormwater systems, windblown litter, and waste left by beachgoers are the main sources and pathways of land-based marine pollution (Figure 2-1). Several studies have identified urban and populated areas as the most significant contributors of waste to marine ecosystems (Jambeck *et al.*, 2015; Marais *et al.*, 2004; Rech *et al.*, 2014; Ryan *et al.*, 2009; Weideman *et al.*, 2020; Verster & Bouwman, 2020). Mismanaged and discarded waste has the potential to be transported by wind or rainfall into rivers and stormwater systems, serving as major conduits and sources of waste (Mihai *et al.,* 2022). As noted in the research by Moora and Piirsalu (2016), waste is transported to oceans through three primary pathways, all of which are influenced by human activities. These pathways include direct dumping, transportation by wind and air, as well as water-based conveyance through rivers, surface runoff, stormwater pipes, floods, and sewerage systems (Figure 2-2).

2.3.1.1 Municipal solid waste and direct dumping

Over the last few years, there has been a rise in global population and urbanisation, causing higher consumption rates and a surge in economic growth, resulting in an increase in the amount of waste generated globally (Department of Environmental Affairs, 2012; Jambeck *et al.,* 2018). Improper waste disposal practices, illegal dumping, littering, poor waste collection services, and poorly managed landfills contribute to the transport of waste from land to sea (Alpizar *et al.,* 2020; Winterstetter *et al.,* 2023). Illegal and direct dumping of municipal solid waste (MSW) not only pollutes the environment but also poses serious health risks to both humans and marine life, particularly impacting the oceans and waterways globally (Graham, 2024). In South Africa, illegal dumping of MSW occurs on a large scale, particularly in informal settlements and areas with limited access to proper waste disposal facilities. This exacerbates the probability of waste entering aquatic ecosystems (Verster & Bouwman, 2020).

2.3.1.2 Water-based pollution

Urban areas are hotspots for pollutant generation due to concentrated anthropogenic activities (Lapointe *et al.,* 2022). Rainfall and stormwater runoff from various surfaces such as pavements, roads, parking lots, infrastructures, and industrial zones can carry a spectrum of contaminants, including heavy metals, oil, pathogens, and nutrients, directly into coastal waters (Halcyon *et al.,* 2023). Agricultural activities are the biggest contributor to surface and groundwater pollution globally (Nzengung & Gugolz, 2022). Fertilisers, pesticides, herbicides, and animal waste are carried by surface runoff or leachate into groundwater, ultimately making their way into coastal waters (Kumar *et al.,* 2021b). These contaminants have adverse effects on marine ecosystems and living organisms (Chagas de Araújo *et al.,* 2021). Inadequate or poorly maintained sewage and wastewater treatment systems can lead to the release of untreated or partially treated sewage into rivers and coastal waters, introducing pathogens, nutrients, and a range of contaminants into marine environments (Bashir *et al.,* 2020). Industrial processes generate a diverse range of pollutants such as chemicals, heavy metals, and organic matter. Improperly treated or untreated industrial effluents can contaminate nearby water bodies, posing risks to marine life and ecosystem health (Kanu & Achi, 2011). While these pollutant categories pose threats to marine ecosystems, plastic pollution stands out as the most persistent pollutant found globally in oceans (Thushari & Senevirathna, 2020).

Rivers serve as significant pathways for marine plastic pollution (Helenski *et al.,* 2021) and, according to an article written by van Emmerik *et al*. (2022), rivers are the main source of transportation for plastic pollution from inland areas to coastal and oceanic environments. Plastic waste (such as bottles, single-use packaging, plastic bags, etc.), enters rivers through various

sources such as urban runoff, littering, inadequate waste management practices, and illegal dumping (IUCN, 2021). Once in rivers, plastic pollution is transported downstream by hydrological factors, eventually reaching the ocean where it accumulates in garbage patches and poses threats to marine ecosystems (Meijer *et al.,* 2021; Landrigan *et al.,* 2020). Along the way, plastics can break down into smaller fragments known as microplastics through UV degradation or other processes (Verster & Bouwman, 2020), which can be ingested by aquatic organisms, leading to adverse effects on marine life and ecosystems (Chatterjee & Sharma, 2019).

2.3.1.3 Harbour and port activities

Harbour and port activities can contribute significantly to land-based marine pollution in various ways. Ships regularly discharge sewage, wastewater, and bilge water (water that is contaminated with oil) directly into the ocean (EPA, 2023a). Improper waste disposal from ships and port activities can also lead to pollutants entering the marine environment (Figure 2.1) which also has a negative impact on human health (WHO, 2011). Ships are coated with antifouling paints that contain chemicals that are harmful to marine organisms and environments. These chemicals are often released into the water through leachate and during ship maintenance activities (Telegdi *et al.,* 2016). Accidental oil and chemical spills within port areas from ships and pipelines are also not uncommon, especially during the loading and unloading of big oil tankers (Khan *et al.,* 2021). Stormwater runoff collects contaminants from the paved surfaces within the port area, subsequently releasing the contaminants directly into the water (Gnecco *et al.,* 2007). Ballast water, used to stabilise ships during transit, can contain invasive species, pathogens, and pollutants (Kumar, 2021) and improperly managed ballast water can introduce non-native species, disrupt local ecosystems, and spread diseases.

Ports and harbours are hubs of maritime activity where plastic waste can enter the marine environment (APWC, 2020) through various ways. Cargo ships, cruise ships, and vessels transporting goods to and from ports often generate plastic pollution through the disposal of packaging materials, single-use plastics, and other waste generated during shipping operations (APWC, 2020). Ports are hubs for fishing vessels and the fishing industry (Huntington *et al.*, 2015), and commercial and recreational fishermen use fishing gear, which, if discarded or lost improperly, becomes "ghost gear," posing threats to marine life (Thorbjørnsen *et al.,* 2023). Ports are also locations where recreational boating (Ibabe *et al.,* 2020) and tourism (Lousada & Castanho, 2023) occur. Plastic pollution from recreational boaters, tourists, and visitors to port areas, such as discarded bottles, bags, and food packaging, can contribute to marine plastic pollution in harbour waters and coastal areas (UN Environment, 2017b; Ibabe *et al.,* 2020).

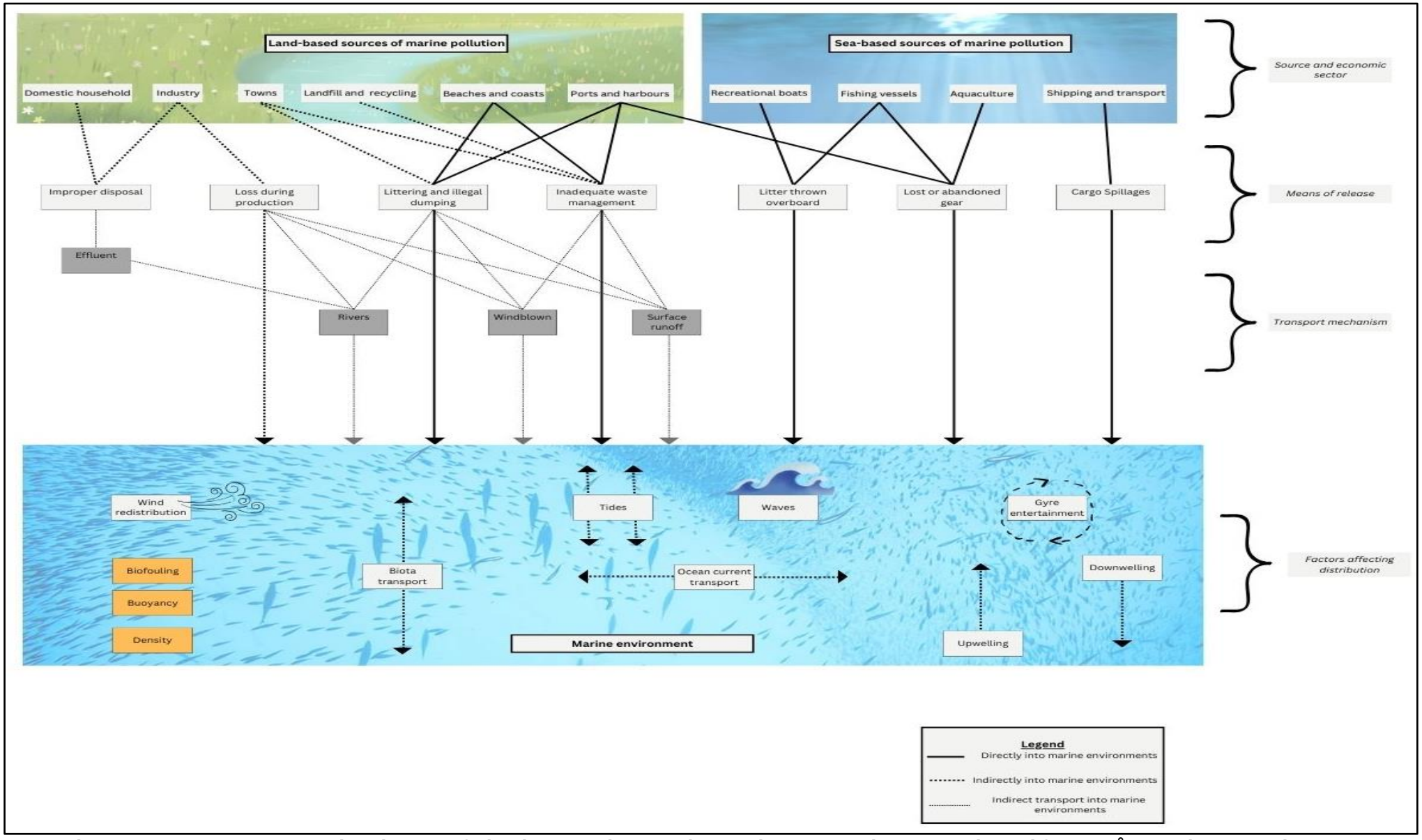


Figure 2-2: Sources and pathways of plastic waste into marine environments. (Source: adapted from Bråte *et al.*, 2017:23).

2.3.2 Sea-based sources

Even though it is widely known that marine pollution mainly originates from land-based sources, several studies have shown that marine pollution from sea-based sources also plays a vital role (Bergmann *et al.,* 2017; Lebreton *et al.,* 2018). As indicated in Figure 2-2, fishing activity, shipping lanes, commercial fishing boats, merchant ships, military ships, research ships, leisure boats, cruise ships, as well as offshore oil rigs are a few examples of common sea-based sources (Derraik, 2002; Mouat *et al.*, 2010). Wind dispersion, ocean circulation, currents, and waves also play a major role in the transport of waste to coastlines (Schumann *et al*., 2019). Due to rotating ocean currents (known as gyres) and winds, plastic waste often collects in “garbage patches" in ocean basins (Ryan *et al.,* 2019) and can be transported over vast distances because of its durability and buoyancy (Galgani *et al.*, 2015). Most floating debris washes up on shores and breaks down into smaller pieces, known as microplastics (Andrady, 2015). Plastic waste is often caught in water columns and sink to the bottom of the ocean floor, leading to slow degradation and harm to marine ecosystems (Gilman *et al.,* 2021).

Sea-based marine pollution can enter the ocean either through accidental loss of waste, poor waste management practices, or direct and illegal dumping of waste into the ocean (Sheavly & Register, 2007). Figure 2-4 provides a summary of the pathways of plastic waste across the marine environment.

2.3.2.1 Maritime activities as a source of marine pollution

According to Oceana Europe (2022), the shipping industry is considered to be a significant contributor to marine pollution and environmental degradation (Saliba *et al.*, 2022). Greenhouse gas emissions, oil pollution, the generation of hazardous waste and solid waste, and bilge water, among other pollutants, are examples of some of the pollutants produced on board ships (Hussain, 2019). Despite the existence of an extensive international waste legislative framework and regulations for waste management in the maritime industry, there have been concerns about governance, enforcement, and compliance with these regulations (Martin, 2021). Since the legal framework is very broad, enforcement can be challenging. This can create a "grey area" where some vessels may not fully comply with waste management regulations (Graham, 2024). This causes major problems for the management of waste that endangers marine environments (Dąbrowska *et al.,* 2021). This is also relevant to plastic pollution generation originating from maritime activities.

Plastics are traded globally, with oceans playing a pivotal role as a primary mode of transportation for international trade. Cargo shipping accounts for nearly 90% of goods exchanged between

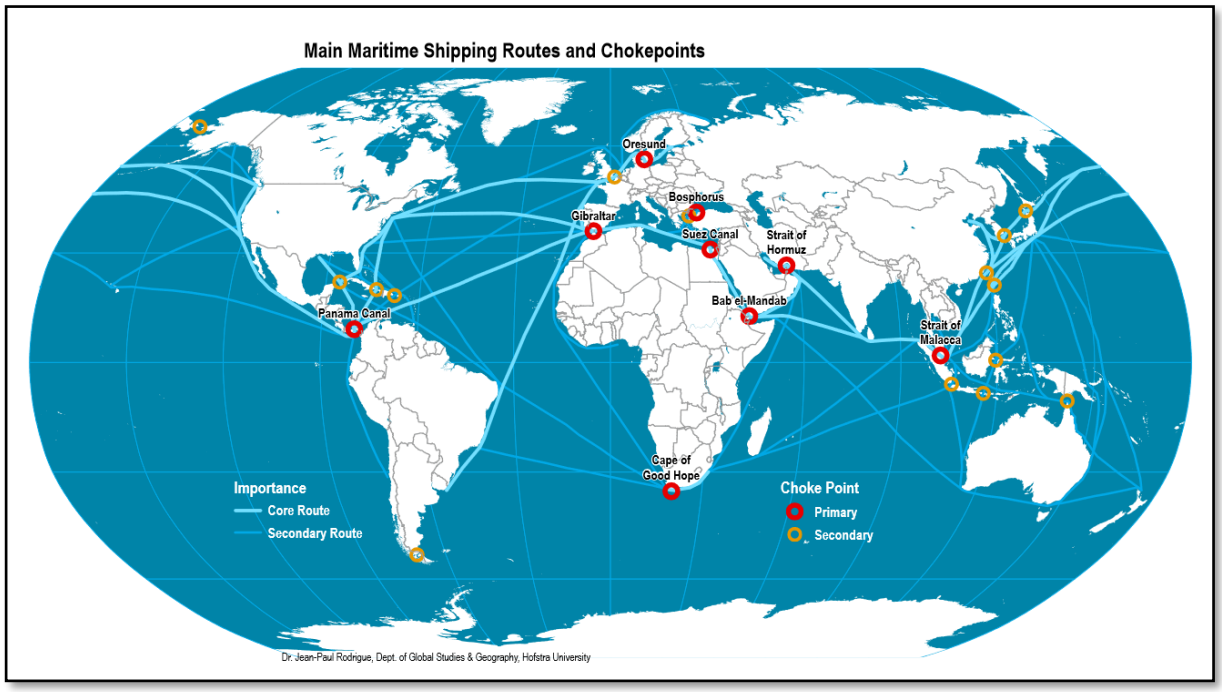
countries (Saliba *et al.,* 2022). Accidental container spills from cargo ships, fishing vessels, and cruise ships can cause an increase in marine plastic pollution (Wan *et al.,* 2022). Improper waste management practices on ships can lead to the release of plastic waste directly into the marine environment (Dąbrowska *et al.,* 2021). The maritime shipping and transport industry has grown significantly in the last few years (Noble, 2019) and, with this, the amount of vessel-generated waste, including plastic packaging and single-use plastics, has also increased significantly (Bello, 2022). According to an article written by Dąbrowska *et al.* (2021), cruise liners are the biggest threat to the marine environment, producing approximately 636 000 tonnes of waste annually. Mismanaged waste and illegal dumping of waste from ships into the ocean (Ramirez-Llodra *et al.,* 2011) lead to the accumulation of plastic waste in the ocean (Thushari & Senevirathna, 2020).

Aquaculture operations are also a contributor to marine plastic pollution (Skirtun *et al.,* 2022). Aquaculture practices are recognised as the world's fastest-growing food sector, providing over 50% of the global fish supply (Rogers, 2023), and production is anticipated to double by 2050 (DNV, 2021). This expansion contributes to an increase in plastic pollution generated from aquaculture operations (Skirtun *et al.,* 2022). Plastic materials are used in aquaculture operations for various purposes, including cages, nets, ropes, buoys, and packaging (Lusher *et al.,* 2017). Improper disposal, lack of waste management facilities, poor installation, and accidental loss of these materials can result in them entering the marine environment (Huntington, 2019). The offshore oil and gas industry maintains substantial infrastructure both on and beneath the seabed, with plastic materials frequently employed in essential equipment and structures such as pipelines, umbilicals, and cables. (Oluwoye *et al.,* 2023). Most of these plastic materials have either reached or are approaching the end of their service life and are either removed, partially removed, or left in place (Melbourne-Thomas *et al.,* 2021), which can result in significant environmental impacts (Marappan *et al.,* 2022).

The case study area, Struisbaai, is located in the Southern Cape region of the Western Cape Province of South Africa (Isaacs, 2011) and is situated at the southernmost tip of Africa, close to one of the Europe-Asia shipping routes (Notteboom *et al.,* 2021). Also known as the Cape Route or sea route to India, this route was once one of the most important shipping routes for international trade, providing passage to vessels between the Indian Ocean and the Atlantic Ocean (Ward, 2007). In 1869, the Suez Canal was established, providing a new, shorter passageway for vessels between the Indian Ocean and Atlantic Ocean (Notteboom & Rodrigue, 2011; Martínez-Zarzoso, 2013), but high winds in the Canal limited sailing ships to use this passage, resulting in steamships becoming the preferred method of transportation (Huber, 2015). The Cape Route was still used regularly, although it became a less popular trading route and secondary to the Suez Canal route (Essallamy *et al.,* 2020). During this time, the Suez Canal had

a limit on the size of vessels that could use the passage (Suez Canal Authority, 2019), and larger ships were still required to use the Cape Route. In 2015, the Suez Canal was expanded (Hamilton, 2014), allowing larger ships to use the passageway and increasing the capacity of ships allowed within the Canal (Castellanos-Galindo *et al.,* 2020; Galal El-Din Thabet Shams El-Din & Rashedy, 2023). As can be seen in Figure 2-3, the Cape Route is still used by large tanker ships as an alternative route to the Suez Canal and is a crucial passageway for global trade, particularly for the transportation of crude oil from regions such as the Middle East to markets in Europe and the Americas (Valori & Kogosowski, 2022). Many shipping industries also prefer to take the longer Cape Route to avoid paying the high transit fees of the Suez Canal, even if their ships are within the maximum capacity requirements of the Canal (Essallamy *et al.,* 2020; Mann, 2023).

Figure 2-3: Map of main international maritime shipping routes. (Source: Notteboom *et al.*, 2022).



2.3.2.2 Abandoned, lost, or discarded fishing gear

The fishing industry is also a big contributor to marine pollution (Nguyen & Brouwer, 2022). Abandoned, lost, or otherwise discarded fishing gear (ALDFG), also known as derelict fishing gear or “ghost gear”, is another major source of marine pollution (Richardson *et al.,* 2018) and threatens marine ecosystems and marine life (Do & Armstrong, 2023). It is estimated that 640 000 tonnes of ghost gear enter the ocean annually and that nearly 10% of all marine pollution found within the ocean is fishing gear originating from big commercial fishing vessels and aquaculture industries (Macfayden *et al.*, 2009; Environmental Investigation Agency, 2021). ALDFG includes fishing nets, lines, traps, and other equipment that have been left or lost in the marine environment

(Georgia Strait Alliance, 2023). These types of gear are made of durable materials, such as plastic, nylon, and metal (Watson *et al.,* 2022). ALDFG has significant environmental impacts, entangling marine mammals such as sea turtles and seabirds that can lead to suffocation, injury, or drowning (Lovell, 2023); lost and abandoned fishing gear can also continue to catch marine life without being actively operated by fishermen and anglers, resulting in a phenomenon known as "*ghost fishing*" (Macfayden *et al.*, 2009:1). It also has negative socio-economic impacts, can become a danger for the navigation of vessels, increasing the risk of damage to vessels and contributing to environmental degradation and habitat loss. This can lead to a decline in fish and marine mammal population (NOAA, 2015; Sullivan *et al.,* 2019; Goodman *et al.,* 2021). Several factors contribute to the accumulation of ALDFG in the oceans. Some of these factors include, but are not limited to, accidental loss of fishing gear, improper disposal, abandonment or deliberate disposal into the ocean, and extreme weather events such as high winds and storms (Savels *et al.,* 2022).

2.3.2.3 Ocean circulation, ocean currents, wind dispersion, and waves

The transportation of waste across the ocean can take place through various pathways (Galgani *et al.,* 2015). The density of the polymer determines whether waste will float on the surface or sink to the ocean floor (Schwarz *et al.,* 2019). Plastic waste is usually a lightweight material with positive buoyancy, meaning that plastic tends to float on the ocean surface (van Sebille *et al.,* 2020). However, plastic waste can often get caught up in waves and ocean currents, trapping plastic in water columns known as gyres, causing it to sink to the ocean floor (Kruse *et al.,* 2023). Plastics have been found in the deepest part of the ocean; a plastic bag has been found in the Mariana Trench around 10 898 m below the surface (UNEP, 2018). Ocean circulation involves the movement of water in large, interconnected systems called ocean currents, which circulate around the globe (University of California Museum of Palaeontology, 2022).

Ocean currents are continuous, directed movements of seawater that carry water, heat, marine organisms, and pollutants such as plastic waste around the globe (Caldeira *et al.,* 2021). Ocean currents can be classified into two categories, surface currents, and deep-sea currents (NOAA, 2011). Surface currents, driven by wind and influenced by factors like the Earth's rotation, play a crucial role in the movement of plastic waste in the ocean (Hall, 2023). Plastic waste can be carried by ocean currents over vast distances, reaching new regions far from its point of origin (Do Sul *et al.,* 2013; Saha, 2018). Another method of transportation of plastic waste is waves. Waves are oscillations on the surface of the ocean mainly caused by wind moving over the ocean basin (NOAA, 2013a), but other factors including seismic activity and tidal forces also contribute to the creation of waves (Trujillo & Thurman, 2017). Floating plastic waste is subject to strong winds and direct sunlight, and strong winds can cause plastics to break down into smaller

particles, known as microplastics, which get swept up into the atmosphere and transported through the air (Sexton, 2020). Direct sunlight, UV radiation, and high surface temperatures are also factors that contribute to the breakdown and fragmentation of plastic waste into microplastics (Oliveira *et al.,* 2020; Dimassi *et al.,* 2022).

These processes are interconnected and can work together to transport plastic waste over long distances. Plastic waste can accumulate in specific regions known as "garbage patches" or accumulation zones (NOAA, 2023a). These areas, located within major oceanic gyres, are characterised by the convergence of multiple ocean currents (Filho *et al.,* 2021). Here, plastic debris accumulates due to the combined effects of wind dispersion and ocean circulation (Eriksen *et al.*, 2016). According to an article by the NOAA (2023b), there are five major oceanic gyres found around the globe. These are the North Atlantic Gyre, the South Atlantic Gyre, the North Pacific Gyre, the South Pacific Gyre, and the Indian Ocean Gyre. The Great Pacific Garbage Patch is the biggest in the world and is roughly 1.6 million km^2 (Lebreton *et al.,* 2018).

2.3.2.4 Biofouling and biota transportation

Biofouling of marine plastic pollution refers to the process by which living organisms, such as bacteria, algae, and other macro- and micro-organisms, attach themselves to the surface of plastic materials in the marine environment (Subías-Baratau *et al.,* 2022). This phenomenon can lead to the formation of biofilms and the colonisation of marine plastic debris by a variety of organisms (Kaiser *et al.,* 2017). When plastic debris enters the marine environment, its surface provides a substrate for micro-organisms to attach and grow (Wright *et al.,* 2020). Over time, the accumulation of organisms can modify the surface properties of the plastic and can increase the weight of plastic debris as organisms, detritus, and other materials adhere to its surface (Artham *et al.,* 2009). This may lead to changes in the buoyancy of the plastic, potentially affecting its transport and distribution in the ocean and can also cause plastic debris to sink (Fazey & Ryan, 2016). Biofouling can also contribute to the transportation of invasive species across oceanic regions (Rech *et al.,* 2016). This is called biota transportation of marine plastic pollution and refers to the movement of plastic debris through ecosystems by living organisms (Bråte *et al.,* 2017; Welden & Lusher, 2017). Organisms attached or entangled to plastic debris may be carried over

long distances to different locations, potentially leading to the introduction of non-native species to new environments (Kannan *et al.,* 2023).

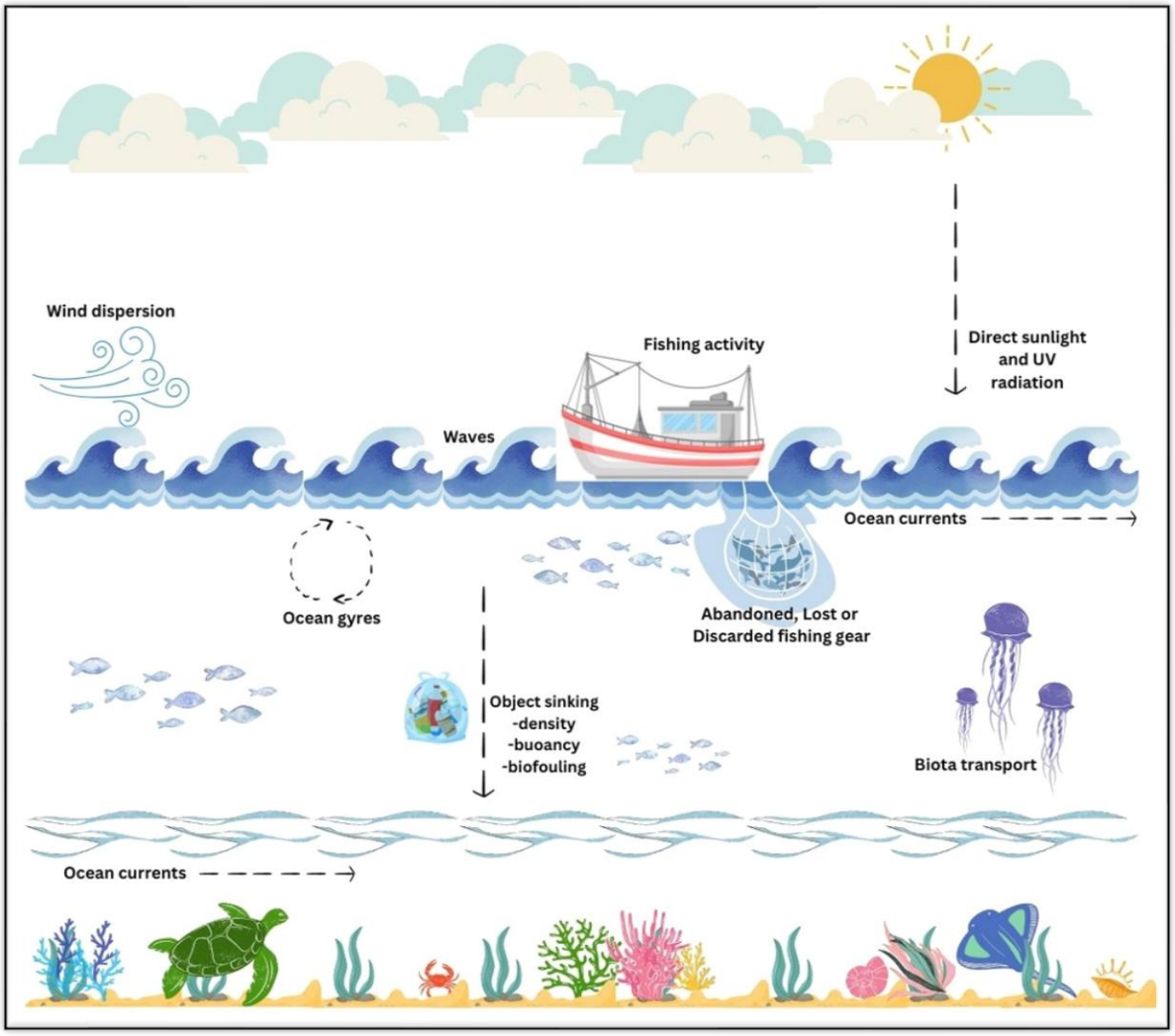


Figure 2-4: Transportation pathways of plastic waste across the marine environment. (Source: adapted from Welden & Lusher, 2017).

2.4 Approaches to address plastic waste and related pollution

Nel and Du Plessis (2001) outline four different environmental management approaches. These approaches offer strategies that can be effectively adapted to tackle plastic pollution in South Africa. As shown in Figure 2-5, they are categorised into the command and control-based (CaC); fiscal/market-based; civil-based; and agreement-based approaches (Nel & du Plessis 2001; Nel & Alberts 2018). These instruments often have the same characteristics that span multiple approaches. In such cases, these instruments are called hybridised instruments (Mukwevho *et al.,* 2022).

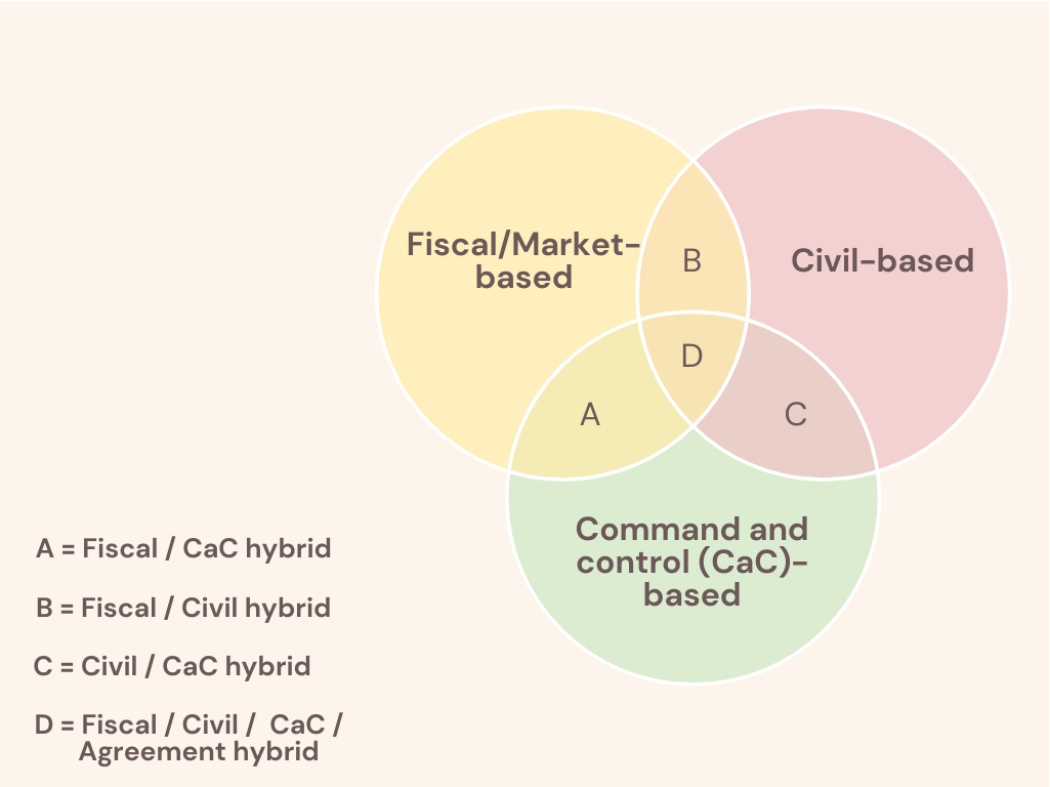


Figure 2-5: Environmental management approaches in South Africa. (Source: adapted from Nel & du Plessis 2001; Nel & Alberts 2018).

Command and control-based, fiscal/market-based, agreement-based, as well as the civil-based approaches are discussed in more detail below.

2.4.1 Command and control (CaC) approaches

The governance strategy known as the command-and-control (CaC) based approach is rooted in a standard-based framework for environmental management, originating from a worldview centred on predict-and-control principles (Berck, 2018). Typically, the CaC is a traditional approach characterised by top-down decision-making with a hierarchical structure and remains the first choice in environmental management (Gorod *et al.*, 2018). This leadership style involves political authorities implementing legal and enforcement measures, along with established norms and standards, to regulate behaviour within society. Its objective is to ensure stakeholders' compliance with the regulations set forth by modern corporations (Featherby, 2018). Table 2-2 provides an overview of the strengths and weaknesses of the CaC approach to environmental enforcement and Section 2.6 provides more detail on this approach.

Table 2-2: Strengths and weaknesses of the CaC approach. (Source: Adapted from Nel & Wessels, 2017:52-53).

Strengths	Weaknesses
• Dependability • Clarity • Encourages compliance in the private sector • Easy to detect compliance or non - compliance • Effective for: - Addressing single media issues - Controlling point-source emissions - Waste management - Protecting endangered species • Promotes innovation and new technologies	• Limited effectiveness in policy decision-making • Inefficiency in cost delivery • Challenges in enforcement • Very information intensive • Ineffective universal application • Lack of incentives • Potential for legal disputes • Administrative complexities • Proliferation of laws and regulations • Inflexibility to adapt to changing circumstances • Difficulty addressing cross-media impacts • Challenges in addressing regional and global issues • Limited coverage across all the cycle phases • Dependent on political will for enforcement

2.4.2 Market-based approaches

Market-based approaches or fiscal instruments use market-driven disincentives or incentives to influence specific responses or behaviours (Nel & Wessels, 2017). The fiscal approach relies on incentivising or disincentivising individuals or entities to achieve a specific outcome (ENVASS, 2017; Weersink *et al.*, 1998). Financial incentives encompass various instruments such as tax adjustments, tradable permits, subsidies, levies, alterations in land ownership, tariffs, and emission permit trading (Gaitán-Cremaschi *et al.*, 2017; Vračarević, 2014).

Fiscal and economic-based approaches to the management of plastic waste involve using financial incentives, taxes, subsidies, and market mechanisms to encourage responsible waste management practices and discourage the production and consumption of single-use plastics (Gaitán-Cremaschi *et al.*, 2017; Vračarević, 2014).

The National Pricing Strategy for Waste Management (NPSWM) is a legislative requirement of the National Environmental Management Waste Amendment Act (Act No. 26 of 2014) and gives effect to the National Waste Management Strategy (NWMS). The NPSWM aims to address the economic aspects of waste management, including the cost of waste disposal and the associated pricing mechanisms (Department of Environmental Affairs, 2016). The key objectives of this strategy include promoting waste minimisation, encouraging recovery, recycling, and reuse, and aligns with the "polluter pays" principle, ensuring that the costs of waste management are carried by producers and consumers in a fair and transparent manner (Department of Environmental Affairs, 2016). It also implements industry waste management plans (IndWP) for activities producing specific waste streams. The NPSWM has mandatory environmental charges in place for various waste streams, including plastic bags and plastic packaging. Table 2-3 provides an overview of the potential economic instruments of solid waste management as stipulated in the NPSWM.

Table 2-3: Potential economic instruments of solid waste management. (Source: Adapted from Department of Environmental Affairs, 2016:8).

Category	Instruments
Downstream instruments	• Volumetric tariffs ("pay-as-you-throw") • Waste disposal taxes (including landfill and incineration taxes)
Upstream instruments	• Material and input taxes (including virgin material taxes; taxes on hazardous materials, etc.) • Product taxes • Advance recycling fees (ARFs) • Deposit refund schemes • EPR schemes
Subsidy-based instruments	• Recycling subsidies • Tax rebates and benefits • Capital financing

Some examples of fiscal and economic-based approaches to plastic waste management in South Africa are discussed below. Many of these are coupled with legislation (CaC-fiscal hybrid).

1. **Plastic Bag Levy**: South Africa introduced a plastic bag levy in 2003, which imposes a small fee on single-use plastic bags distributed by retailers (Department of Environmental

Affairs and Tourism, 2003). This levy aims to reduce the use of plastic bags, promote reusable alternatives, and generate revenue for environmental initiatives.

2. **Extended Producer Responsibility (EPR)**: EPR programmes shift the financial responsibility for managing waste from municipalities to producers and importers of plastic products (Nahman, 2010). Producers are required to finance and implement recycling and collection schemes for their products, incentivising them to design products that are more recyclable and environmentally friendly (Bünemann & Brinkmann, 2019; Van Rossem *et al.*, 2006). South Africa has four industry-driven Producer Responsibility Organisations (PROs) for the plastics industry – PETCO for PET, Polyco for polyolefins, the Polystyrene Association for polystyrene, and the Southern African Vinyls Association for PVC (Plastics SA, n.d.). These PROs collect voluntary fees from members, funding the collection, sorting, and recycling of materials by diverse stakeholders, from informal waste pickers to large-scale recyclers (Plastics SA, n.d.).
3. **Deposit Refund Schemes**: Deposit refund schemes involve consumers paying a deposit on beverage containers at the point of purchase, which is refunded when the container is returned for recycling (Watkins *et al.,* 2019). These schemes provide a financial incentive for consumers to recycle and, in South Africa, informal waste pickers have established an informal system for the collecting, separating, reselling, and reintegrating recyclable materials, including plastic products, into the value chain. (Department of Environment, Forestry, and Fisheries, 2020). Pick ‘n Pay and Polyco in South Africa are working together to encourage environmental sustainability through reverse vending machines (RVMs), to encourage customers to recycle their waste by offering digital cash and vouchers as incentives (Mafu, 2024).

These fiscal and economic-based approaches complement regulatory measures and voluntary initiatives to reduce plastic waste in South Africa, providing economic incentives for businesses and consumers to adopt more sustainable waste management practices and promote a circular economy.

2.4.3 Agreement-based approaches

This approach involves voluntary agreements between stakeholders, such as industries and governments, to achieve specific environmental outcomes (Delmas & Terlaak, 2001). While it can be a powerful tool in addressing environmental issues, it is typically integrated with other instruments rather than existing as a stand-alone approach, as illustrated in Figure 2-5 letter D (Mukwevho *et al.,* 2022).

For the purpose of this study, the focus will be on the command and control-based, fiscal/market-based, and civil-based approaches. The agreement-based approach, while significant, is not discussed in detail due to its hybrid nature and limited stand-alone application in the context of this research.

2.4.4 Civil-based approaches

The civil-based approach encompasses all measures aimed at informing, empowering, educating, and motivating communities to actively participate in the enforcement process (Nel & Wessels, 2017). It prioritises public involvement in defining and achieving sustainable development goals and are instrumental in safeguarding essential environmental rights (Fraser *et al.*, 2006; Toxopeüs, 2015). When applied to plastic pollution, this approach is centred on involving and empowering individuals, communities, and organisations to address the issue at various levels.

The *South African Initiative to End Plastic Pollution in the Environment* was established in 2019, aiming to address the pervasive issue of plastic pollution within the country (Hanekom, 2020). It relies on stakeholder engagement (governmental and international organisations) and represents all role players (fast food franchises and retailers, to name a few) (Plastics SA, 2019) within the national plastic packaging value chain, using the collaboration of members to work towards preventing and eradicating plastic pollution in the environment, aiming for a positive impact on environmental conservation (Hanekom, 2020).

- The PET Recycling Company (PETCO) is an organisation involved in plastic waste management in South Africa, including the Western Cape Province. PETCO was established in 2004 and is a voluntary industry-led initiative that promotes the recycling of various plastic products across the packaging value chain, promoting a circular economy (PETCO, n.d.). As a non-profit company, PETCO works with various stakeholders across the PET value chain, including producers, recyclers, retailers, brand owners, and consumers, to increase PET recycling rates, reduce littering, and minimise the environmental impact of PET plastic packaging (PETCO, n.d.). PETCO operates through a model of extended producer responsibility (EPR), where companies that produce PET products take responsibility for the collection and recycling of their packaging materials (IFC, n.d.). The organisation provides support and funding for PET recycling infrastructure, awareness campaigns, and education programs (IFC, n.d.). PETCO also collaborates with municipalities, government agencies, NGOs, and community groups to promote PET recycling initiatives and implement sustainable waste management practices.

- Parley South Africa is a branch of Parley for the Oceans, an organisation dedicated to combating plastic pollution in oceans worldwide (Parley, n.d.a). Parley South Africa focuses on raising awareness, implementing initiatives, and collaborating with local communities, businesses, and governments to address the plastic pollution crisis in South Africa's coastal areas and marine environments. They work on various fronts, including beach clean-ups, plastic recycling programs, educational campaigns, and advocating for policy changes to reduce plastic waste and promote sustainable practices (Parely, n.d.b).

- Plastics SA organizes an annual Clean-Up and Recycle SA Week to coordinate South Africa's participation in the International Coastal Clean-up Day (ICC). This nationwide initiative aims to clean beaches across the country and raise awareness among South Africans about the importance of recycling (Plastics SA, 2022).

- The Litterboom Project in South Africa has initiated a new campaign known as the Plastic Neutral Campaign, aiming to further reduce plastic pollution in the environment (Pratt, 2024).

From a case study specific context, Cape Agulhas Municipality (CAM) has several awareness campaigns for waste management:

- The "Youth in Waste" Projects focus on raising awareness about recycling and combating illegal dumping, which is a significant challenge for the municipality. Door-to-door awareness initiatives are integrated into an Expanded Public Works Programme (EPWP), while campaigns promoting recycling are held in businesses, shopping malls, and schools (Cape Agulhas Municipality, 2023b).

- The Municipality is actively promoting the adoption of the wheelie bin system through an ongoing awareness campaign (Cape Agulhas Municipality, 2023b).

- The DEA&DP allocated resources for 22 new environmental personnel as part of the Presidential Good Green Deeds Campaign (Cape Agulhas Municipality, 2023b).

2.5 Environmental behaviour and perceptions

Environmental behaviour refers to the actions and practices of individuals or groups that impact the environment (Krajhanzl, 2010). These behaviours can be either positive, contributing to environmental sustainability and protection, or negative, leading to environmental degradation and harm (Banwo & Du, 2019). Pro-environmental behaviour refers to actions taken by individuals or groups that are intended to minimise their negative impact on the environment and promote sustainability (Tian & Liu, 2022). According to Pahl *et al.* (2017) as cited in Hartley *et al.* (2018), "*human behaviour is the sole source of marine litter, and changing perceptions and behaviour is key to tackling litter escaping into the natural environment*". Understanding environmental behaviour and public perceptions of plastic pollution are crucial for developing effective strategies to promote sustainable practices and mitigate environmental issues (Hartley *et al.,* 2018). There are several factors that influence how communities and individuals approach waste management:

1. **Social Norms and Cultural Values**: Community standards and cultural beliefs significantly impact environmental sustainability actions. Social approval or disapproval can motivate individuals to follow environmentally friendly practices (Saracevic & Schlegelmilch, 2021).
2. **Individual Motivations**: Personal motivations, both extrinsic (external rewards) and intrinsic (internal satisfaction), are very important. Extrinsic motivations include financial

rewards or social recognition, while intrinsic motivations involve personal satisfaction from contributing to environmental sustainability (Silvi & Padilla, 2021).

3. **Psychological Factors**: Beliefs, attitudes, and perceptions about waste and the environment play a significant role. Understanding these psychological factors can help design interventions that promote pro-environmental behaviour (Barr, 2007).

Nearly 80% of all marine pollution comes from land-based sources (Verster & Bouwman, 2020; Adam *et al.,* 2020), which means that several stakeholders are accountable for mitigating plastic pollution. One of the key stakeholders in mitigating plastic pollution is the general public. The general public significantly influences the reduction of marine litter through their behaviour, lifestyle choices, consumption habits, waste management practices, and active support or involvement in policies aimed at reducing marine litter (Pahl *et al.,* 2017). Determining environmental behaviour towards waste plays an important role in encouraging responsible waste management and reducing the environmental impacts of waste.

2.6 Legal framework for the management of plastic waste

From a command-and-control (CaC) perspective, law acts as a framework to uphold standards and regulate human behaviour, ensuring order and compliance with established regulations. It serves as a crucial tool for setting guidelines and addressing societal issues, including environmental concerns like plastic waste, which poses significant threats to both humans and the environment (Puluhulawa & Puluhulawa, 2021).

Various environmental laws have been implemented for regulating various aspects of plastic waste management on global (Barsalou & Picard, 2018), regional, sub-regional, and national scales (Sadan & De Kock, 2021), ensuring the transboundary protection of human health and the environment from the adverse impacts of improper waste disposal and handling (Campbell-Mohn & Cheever, 2023). The environmental legal framework is a broad framework that covers all sorts of environmental issues. It was therefore important to differentiate between the different legislations to determine those applicable to this study. The legislation applicable to plastic pollution and marine environments was divided into different sub-categories to provide an in-depth analysis of the international, regional, sub-regional, and national legislation.

The following sections are based on the legal and policy frameworks related to plastic waste, plastic pollution in the marine environmental context provided by Manyara *et al.* (2023), Sadan and De Kock (2021) and the UN Environment (2017a). The international legal framework can be divided into two different sections, binding agreements, and non-binding agreements. There are

also various regional and sub-regional frameworks and initiatives, and South Africa has an intensive legal framework that is discussed in the sub-sections below.

2.6.1 International binding agreements with relevance to marine environments and plastic pollution

Legally binding agreements are formal arrangements between parties that are enforceable by law (Pimentel, 2024). These agreements create legal obligations and responsibilities for the parties involved, requiring them to comply with the terms and conditions outlined in the agreement (Battle, 2022). Failure to meet these obligations can result in legal consequences, such as fines, penalties, or other forms of legal action (Commission of the European Communities, 1996).

The international legal framework with binding agreements pertaining to marine environments and plastic pollution can be classified into three main categories: 1) pollution-oriented agreements; 2) biodiversity and species-oriented agreements; and 3) chemicals and waste-oriented agreements (Figure.2-6). The aims, goals, scope, methods, and compliance requirements of these agreements vary from one agreement to another.

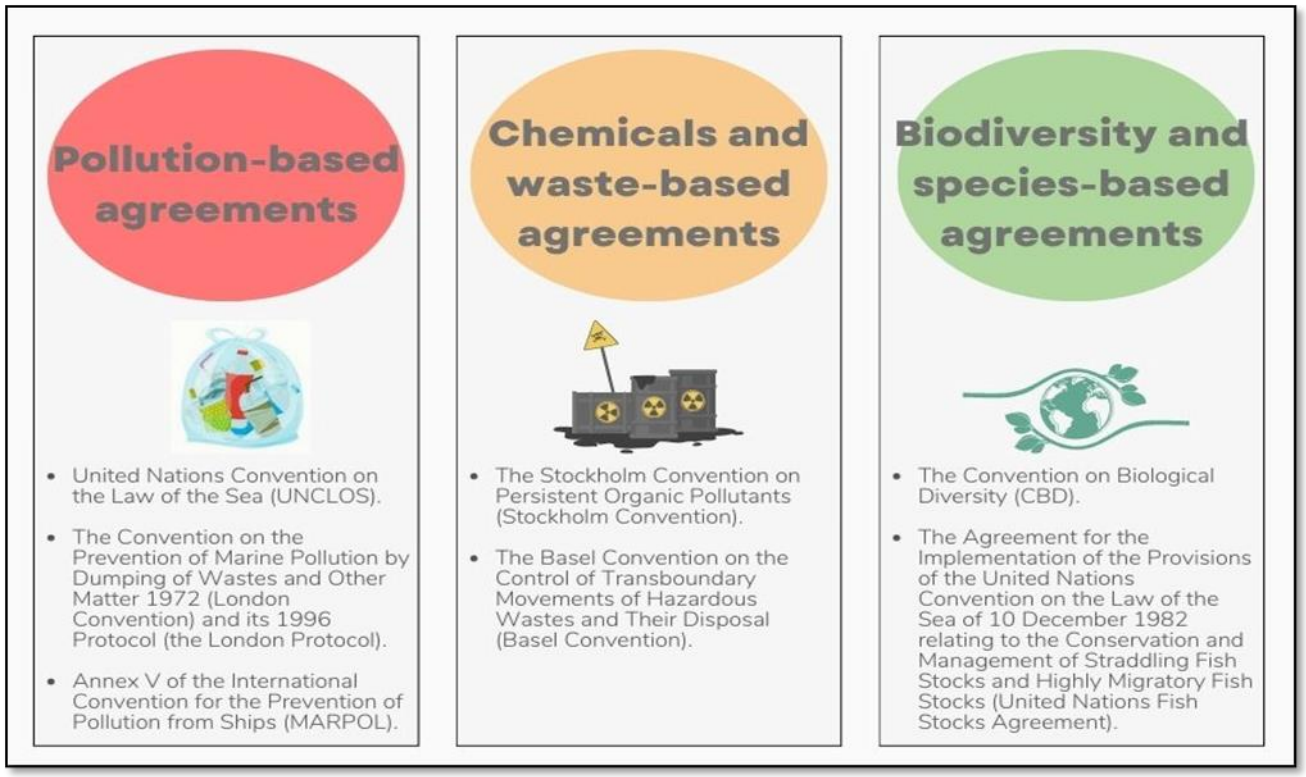


Figure 2-6: International binding agreements with relevance to marine environments and plastic pollution. (Source: Author's compilation).

Table 2-4 provides an overview of each legislation's relevance to the context of this research.

Table 2-4: International binding agreements with relevance to marine environments and plastic pollution. (Source: Adapted from Manyara *et al.*, 2023).

Legislation/Framework	Relation to the marine environment and plastic waste
London Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter (1972)	*The London Convention is an international treaty aimed at protecting the marine environment by regulating and prohibiting the disposal of certain pollutants directly into the ocean. Any materials that are authorised for direct disposal into the ocean are closely regulated and assessed to ensure that these materials do not have adverse effects on marine environments and human health (EPA, 2023b).*
International Convention for the Prevention of Pollution from Ships MARPOL Annex V (1973)	*MARPOL (International Convention for the Prevention of Pollution from Ships) is one of the most significant international agreements addressing maritime pollution (IMO, 2019b). The convention is officially known as the "International Convention for the Prevention of Pollution from Ships", 1973, as modified by the Protocol of 1978 relating thereto. MARPOL aims to prevent various forms of marine pollution from ships, including oil pollution, chemical pollution, sewage, garbage, and air pollution from ships' exhausts (Raunek, 2022). The convention consists of six annexes, each addressing different types of pollution, with Annex V specifically addressing the prevention of pollution caused by waste generated from ships (IMO, 2019b).*
The 1982 United Nations Convention on the Law of the Sea (UNCLOS).	*UNCLOS, also known as the Law of the Sea Convention or the Law of the Sea Treaty, provides a broad legal framework governing all activities and rights related to the world's oceans and their resources. This convention combines traditional norms guiding oceanic utilisation with legal concepts and rules, effectively addressing emerging concerns in the maritime environment. While enforcing existing principles, the Convention also introduces new legal frameworks and concepts to address the evolving challenges associated with ocean governance. Additionally, it provides a structured foundation for the ongoing development of specific areas within the broader context of maritime law (IMO, 2019a).*
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989) and Plastic Waste Amendments to the Basel Convention (2019)	*The Basel Convention of 1989 regulates the transboundary movement of hazardous waste and other waste, ensuring its safe and environmentally sustainable management (Basel Convention, 1989).* *The Basel Convention plays a pivotal role as the sole global, legally binding instrument specifically designed to address the issue of plastic waste. Its significance is accentuated by the*

Legislation/Framework	Relation to the marine environment and plastic waste
	fact that, as of 2019, it stands as the only international agreement with a specific focus on addressing the challenges posed by plastic pollution. During the Conference of the Parties in 2019, crucial steps were taken to enhance the convention's efficacy in dealing with plastic waste. The adoption of the Plastic Waste Amendments in Annexes II, VIII and IX marked a significant development, offering clarity on the specific types of plastic waste subject to control procedures for exports, transit, and imports (UNEP, n.d.b).
The Paris (OSPAR) Convention for the Protection of the Marine Environment of the North-East Atlantic (1992)	*OSPAR is a regional seas convention that sets out measures to prevent and reduce pollution from various sources, including land-based activities, dumping, incineration, shipping, and offshore installations. It addresses pollutants such as nutrients, hazardous substances, and radioactive substances (OSPAR Commission, 1992).*
The Convention on Biological Diversity (CBD) (1992)	*Established in 1992, the Convention on Biological Diversity (CBD) is an international binding document which aims to conserve biodiversity, promote sustainable use of biological resources, and ensure equitable sharing of benefits derived from genetic resources (United Nations, 1992). While the CBD does not specifically focus on plastic pollution, several targets has been adopted that addresses the impact of pollution on biodiversity, such as Aichi Biodiversity Target 8 (UN Environment, 2017a).*
The UN Fish Stocks Agreement (1995)	*Formally known as the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, the UN Fish Stocks Agreement is an international treaty adopted in 1995 (United Nations, 2023).* *It aims to ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks, which are fish populations that migrate between the Exclusive Economic Zones (EEZs) of multiple countries and the high seas. The agreement establishes principles and measures for the conservation, management, and sustainable exploitation of these fish stocks, and article 5(f) also includes responsibilities on States to reduce pollution, waste, and ghost fishing resulting from lost or abandoned gear (UN Environment, 2017a), which is mostly made of plastics.*

Legislation/Framework	Relation to the marine environment and plastic waste
The United Nations Convention on the Law of the Non-navigational Uses of International Watercourses (1997)	*The UN Watercourses Convention, adopted in 1997, is an international treaty that provides a framework for the cooperative management, protection, and sustainable use of transboundary watercourses. Article 21 stipulates the need to prevent, minimise, and regulate pollution in international watercourses, which includes plastic pollution (Loures et al., 2009).*
The Stockholm Convention (2001)	*The Stockholm Convention on Persistent Organic Pollutants (POPs), established in 2001, primarily focuses on addressing the production, use, and disposal of specific hazardous chemicals known as persistent organic pollutants (POPs). While the Convention primarily targets substances like pesticides and industrial chemicals, it indirectly addresses certain aspects of plastic pollution (Raubenheimer & McIlgorm, 2008).* *Some plastics contain additives or contaminants that are POPs, such as PBDEs, PFOS, etc. These chemicals can leach out of plastics over time and contaminate the environment, including water bodies. Additionally, open burning of plastics can also release POPs, facilitating their transport in the environment (Manyara et al., 2023).*
The Global Plastic Treaty (draft 2024)	*Even though the treaty has not come into effect at the time of writing, it is worth noting the potential contribution of the upcoming Global Plastic Treaty. 175 nations are currently busy with negotiations for a new global treaty to end plastic pollution by 2040 (UNEP, 2022). The United Nations Member States aim to have all negotiations completed before the end of 2024 (UNEP, 2022). According to Plastics Europe the goal of this treaty is to "end plastic pollution by 2040 through a circular economy where all plastic applications are reused, recycled, and responsibly managed during and after use while enabling a lower greenhouse gas emissions plastic economy" (Plastics Europe, 2023).*

2.6.2 International non-binding strategies and instruments governing marine pollution and plastic waste

Global non-binding strategies and instruments governing marine pollution and plastic waste refer to international agreements, guidelines, or frameworks that provide recommendations, principles, or best practices for addressing these issues (OECD, 2021). Unlike legally binding treaties, these instruments are not enforceable by law (OECD, 2021), but serve as important tools for promoting

cooperation, raising awareness, and guiding action on marine pollution and plastic waste at the global level (Manyara *et al.,* 2023). Figure 2-7 provides a schematic summary of these instruments.

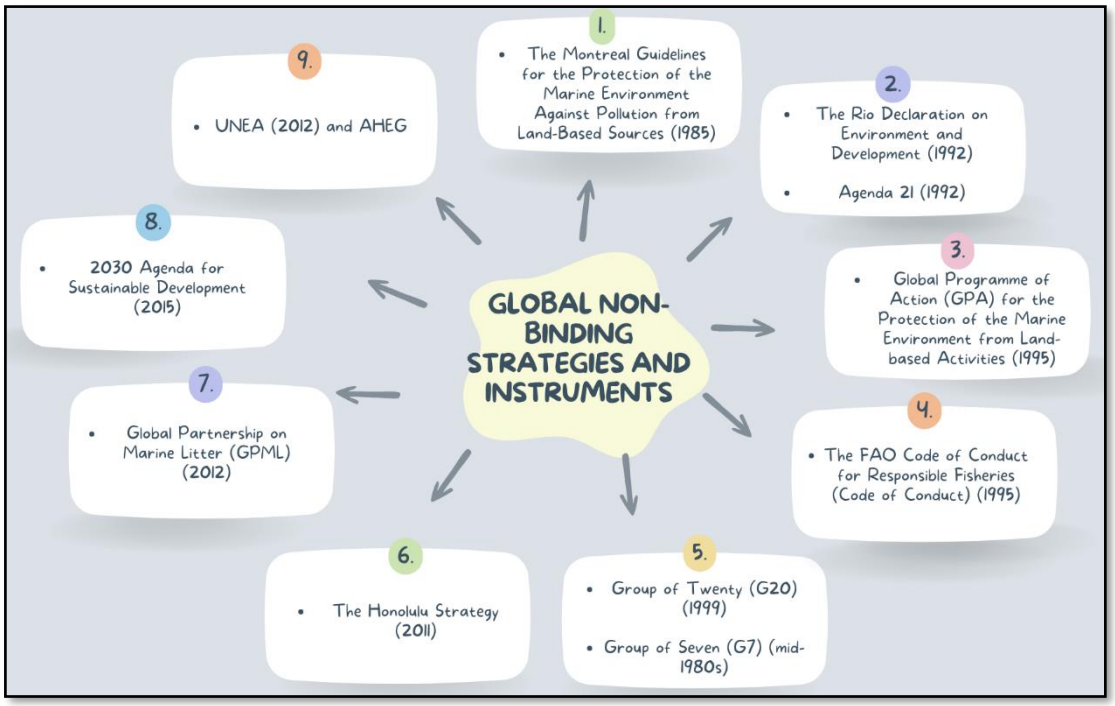


Figure 2-7: Global non-binding strategies and instruments with relevance to marine environments and plastic pollution. (Source: Author's compilation).

Table 2-5 provides an overview of the non-binding strategies and instruments on a global scale applicable to this study.

Table 2-5: International non-binding strategies and instruments governing marine environments and plastic waste (Source: Adapted from Manyara *et al.*, 2023).

Legislation/Framework	Relation to the marine environment and plastic waste
The Montreal Guidelines for the Protection of the Marine Environment Against Pollution from Land-Based Sources (1985)	*These guidelines contribute to international efforts aimed at safeguarding marine ecosystems. The guidelines provide a comprehensive framework for addressing pollution originating from activities on land, emphasising the need for coordinated, cross-border measures to protect the marine environment (Montreal Guidelines, 1985).*

Legislation/Framework	Relation to the marine environment and plastic waste
The Rio Declaration on Environment and Development (1992) Agenda 21 (1992)	*The Earth Summit, officially known as the United Nations Conference on Environment and Development (UNCED), took place in Rio de Janeiro, Brazil, in June 1992. The summit aimed to foster international cooperation and establish a global agenda for sustainable development. The key outcomes of the Earth Summit include:* ***The Rio Declaration*** *The Rio Declaration is a foundational document that articulates key principles for sustainable development. Comprising 27 principles, the Rio Declaration serves as a guide for international cooperation on environmental issues and the integration of environmental and developmental considerations (The Rio Declaration, 1992). While it does not explicitly mention plastic waste management, its principles are highly relevant to addressing this issue.* ***Agenda 21*** *Agenda 21 is a comprehensive action plan for achieving sustainable development in the 21st century. It addresses a wide range of issues, including poverty, deforestation, pollution, and the depletion of natural resources (Agenda 21, 1992). Chapter 17 of Agenda 21 specifically addresses the protection, safe, and environmentally sound management of the Oceans. Chapter 21 of Agenda 21 addresses the managing of solid wastes and sewage, which includes the managing of plastics.*
Global Plan of Action (GPA) for the Protection of the Marine Environment from Land-based Activities (1995)	*The GPA aims to protect the marine environment from the adverse impacts of land-based activities (WWF, 2019). It provides a framework for regional, national, and international collaboration in identifying and implementing effective measures to prevent, reduce, and control pollution from various sources, including industry, agriculture, and urban development. According to UNEP (2017) it is "currently (in 2019) the only global intergovernmental mechanism entirely dedicated to addressing this issue". The GPA also includes plastic waste and microplastics as part of its list of nine sources responsible for marine degradation (WWF, 2019).*

Legislation/Framework	Relation to the marine environment and plastic waste
The FAO Code of Conduct for Responsible Fisheries (Code of Conduct) (1995)	*The Code of Conduct was established by the Food and Agriculture Organisation (FAO) to address various aspects of fisheries management and conservation, including the prevention and management of ALDFG (FOA, 1995). The Code of Conduct provides guidance on measures to prevent, reduce, and mitigate the impacts of ALDFG, promoting responsible and alternative fishing practices and sustainable management of fisheries resources (FOA, 1995).*
Group of Twenty (G20) (1999) and Group of Seven (G7) (mid-1980s)	*The Group of Twenty (G20) and the Group of Seven (G7) are two prominent international forums for economic cooperation and decision-making among major economies (Nelson, 2020).* ***G20*** *The G20 is a forum for the governments and central bank governors from 19 countries and the European Union (EU), representing major advanced and emerging economies (Hutt & Conley, 2022). In 2017, the G20 adopted the G20 Action Plan on Marine Litter, followed by the G20 Implementation Framework for Actions on Marine Plastic Litter in 2019. Additionally, the Osaka Blue Ocean Vision was introduced with the aim to eradicate any additional pollution from marine plastic waste by 2050, using a comprehensive life-cycle approach (Gamaralalage, 2023).* ***G7*** *The G7 is an informal group consisting of seven major advanced economies: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States (Government of Canada, 2023). Originally formed in the 1970s as the Group of Five (G5), it was expanded to include Canada and Italy in the 1980s, becoming the G7 (Nelson, 2020). In 2018, leaders agreed to the Ocean Plastics Charter, committing to take concrete actions to address marine plastics pollution (Plastic Action Centre, 2024). The charter includes measures such as promoting sustainable plastics management, reducing single-use plastics, supporting innovation in plastics recycling, and supporting developing countries in addressing plastics pollution and improving waste management infrastructure (IISD, 2018). Furthermore, in 2021, leaders also*

Legislation/Framework	Relation to the marine environment and plastic waste
	implemented the G7 2030 Nature Compact, pledging to address the rising levels of plastic pollution in the ocean through concrete actions (Weymouth, 2021).
The Honolulu Strategy (2011)	*This serves as a holistic and worldwide collaborative framework aimed to mitigate the ecological impacts of marine pollution, as well as its effects on human health and the economy. The Strategy's objectives include limiting the amount and impact of land-based pollution entering the marine environment; minimising the amount and impact of sea-based sources of marine pollution; and reducing the amount and impact of accumulated marine pollution in coastal areas and beaches (UNEP & NOAA, 2011).*
Global Partnership on Marine Litter (GPML) (2012)	*The GPML is a cooperative effort led by UNEP which focuses specifically on combating marine litter and plastic pollution. It brings together governments, private sector entities, non-governmental organisations, and academia to develop and implement strategies for reducing marine litter at its source and improving waste management practices to prevent plastic waste from entering the ocean (United Nations, 2018). The Global Partnership on Marine Litter align with international efforts to achieve Sustainable Development Goal 14 (SDG 14) - "Life Below Water," which includes a target to prevent and significantly reduce marine pollution of all kinds by 2025.*
2030 Agenda for Sustainable Development (2015)	*The Sustainable Development Goals (SDGs) were officially adopted by the United Nations General Assembly in September 2015 (UN DESA, 2015). They replaced the Millennium Development Goals (MDGs) and provides a comprehensive framework for addressing global challenges and achieving sustainable development by 2030 (UN DESA, 2015). According to Kumar et al (2021a), out of the 17 SDGs and 169 targets established by the UN, only one goal specifically addresses plastic pollution:* ***SDG 12: Responsible Consumption and Production Patterns*** *This goal has 11 targets emphasises the need to promote sustainable consumption patterns and efficient resource use. Target 12.5 specifically focuses on substantially*

Legislation/Framework	Relation to the marine environment and plastic waste
	reducing waste generation through prevention, reduction, recycling, and reuse (The Global Goals, 2024a). *Unsustainable global plastic production, consumption, and waste pose significant challenges worldwide, necessitating extraordinary efforts from the international community to achieve sustainable practices in plastic consumption and production (Walker, 2021).* ***SDG 14: Life Below Water*** *Target 14.1 focuses specifically on the conservation and sustainable use of oceans, seas, and marine resources. It includes targets related to reducing marine pollution, including plastic pollution from land-based sources, and improving the conservation and management of marine ecosystems (Walker, 2021).* *Even though SDG 14 is the only goal directly addressing plastic pollution, the other goals and targets are still in some way interlinked to plastic pollution (Kumar et al., 2021a).* ***SDG 15: Life on Land*** *Target 15.1 aims to ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems (The Global Goals, 2024b). Plastic pollution on land, including in rivers, lakes, and terrestrial environments, can have significant adverse effects on wildlife, habitats, and ecosystems (Kumar et al., 2021a), making this goal relevant to addressing plastic waste.*

2.6.3 Regional and sub-regional frameworks governing marine pollution and plastic waste within the African context

This section explores existing regional and sub-regional frameworks governing marine pollution and plastic waste within Africa (Figure 2-8, Table 2-6).

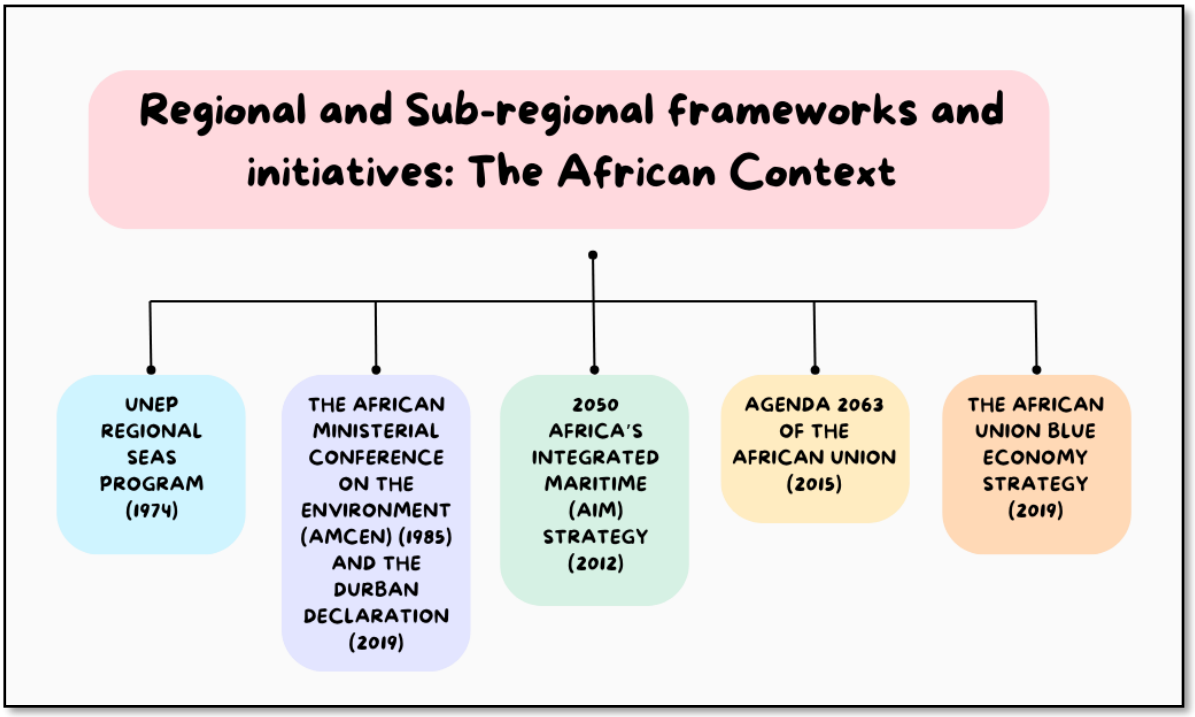


Figure 2-8: Regional and sub-regional frameworks governing marine pollution and plastic waste within the African context. (Source: Author's compilation).

Table 2-6: Regional and Sub-regional frameworks and initiatives governing marine pollution and plastic waste within the African context. (Source: Adapted from Manyara *et al.*, 2023).

Legislation/Framework	Relation to the marine environment and plastic waste
UNEP Regional Seas Program (1974)	*The UN Regional Seas Programme is the key regional framework for protecting the ocean. It was set up in 1974 under the auspices of the UN Environment Programme (UNEP). Today, the Regional Seas Programme includes a total of 18 Regional Seas, several of which have adopted action plans specifically targeting marine litter, plastic debris, and microplastics (UNEP, n.d). From the 18 Regional Seas, there are four Regional Seas initiatives governing the continent of Africa, the Abidjan Convention, Nairobi Convention, Jeddah Convention, and the Barcelona Convention (UNEP, 2015b). These conventions have been*

Legislation/Framework	Relation to the marine environment and plastic waste
	actively investigating methods to consolidate and utilise the potential of the blue economy within these regions.
The African Ministerial Conference on the Environment (AMCEN) (1985) and the Durban Declaration (2019)	*The African Ministerial Conference on the Environment (AMCEN) is a forum convened by the African Union in 1985 to address environmental issues and promote sustainable development across the continent (AMCEN, 2006). AMCEN serves as a platform for dialogue, coordination, and cooperation on a wide range of environmental issues affecting Africa, including biodiversity conservation, climate change mitigation and adaptation, desertification and land degradation, water resource management, pollution control, and sustainable development. During the 17th session of AMCEN in 2019, emphasis was placed on addressing plastic pollution and marine litter prevention. These topics were central to the Ministerial Durban declaration, which highlighted themes related to the circular economy, the Blue Economy, and combatting plastic pollution (Sadan & de Kock, 2021; Manyara et al., 2023).*
2050 Africa's Integrated Maritime (AIM) Strategy (2012)	*The 2050 Africa's Integrated Maritime Strategy is a long-term strategic framework developed by the African Union to guide the sustainable development and management of the continent's maritime resources (AU, 2012). The Strategy encompasses measures aimed at addressing plastic pollution in Africa's maritime domain, and includes the "protection of populations, including AMD heritage, assets, and critical infrastructure from maritime pollution and dumping of toxic and nuclear waste" (AU, 2012:12).*
Agenda 2063 of the African Union (2015)	*Agenda 2063 is a strategic framework for the socio-economic transformation of Africa over the next five decades, adopted by the African Union in 2015 (AU, 2015). While Agenda 2063 may not explicitly mention plastic pollution, its overarching goals of promoting sustainable development and environmental stewardship are relevant to addressing this issue (Manyara et al., 2023).*
The African Union Blue Economy Strategy (2019)	*The African Union Blue Economy Strategy is a comprehensive framework developed by the African Union in 2019 to harness the potential of the blue economy for sustainable development across the continent (AU-IBAR, 2019). The blue economy refers to economic activities related to oceans, seas, lakes, and rivers, including fisheries, aquaculture, tourism, shipping, and marine renewable energy. It also recognises the importance of addressing*

Legislation/Framework	Relation to the marine environment and plastic waste
	environmental challenges, including marine plastic pollution, which threatens the potential and development of blue economy in Africa (AU-IBAR, 2019).

2.6.4 Regional and sub-regional initiatives directly addressing plastic pollution in marine environments within the African context

This section explores existing regional and sub-regional initiatives directly addressing plastic pollution in marine environment within the African context (Figure 2-9, Table 2-7).

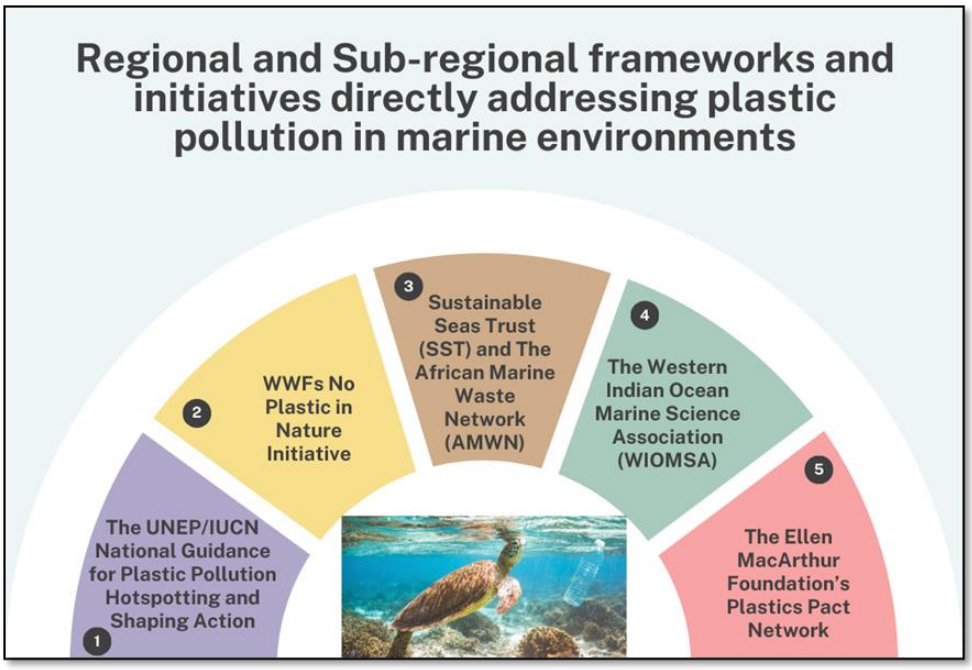


Figure 2-9: Regional and sub-regional initiatives directly addressing plastic pollution in marine environments within the African context. (Source: Author's compilation).

Table 2-7: Regional and Sub-regional frameworks and initiatives directly addressing plastic pollution in marine environments within the African context. (Source: Adapted from Manyara *et al.*, 2023).

Legislation/Framework	Relation to the marine environment and plastic waste
The UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action	*During the Fourth Session of the UN Environment Assembly in 2019, it was recognised that a harmonised methodology was needed to effectively address the flow of plastics and leakage within the plastics value chain (UNEP, 2020). Consequently, Resolution 6 on marine plastic litter and microplastics was adopted to address this issue. Shortly*

Legislation/Framework	Relation to the marine environment and plastic waste
	thereafter, through collaboration between UNEP and the IUCN, the 'UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action' was implemented. This initiative aims to provide guidance and strategies for identifying and addressing plastic pollution hotspots along the plastic value chain at the national level (UNEP, 2020). This program offers comprehensive tools and methodologies to assess plastic pollution levels, pinpoint key sources and pathways of pollution, and develop targeted action plans to mitigate its impact on marine environments (UNEP, 2020).
WWFs No Plastic in Nature Initiative	*WWF's "No Plastic in Nature" Initiative is a comprehensive approach to addressing the plastic pollution crisis. This initiative targets the entire life cycle of plastics, with the aim to reduce the production of new plastics, increase the recycling and reusing of plastics already within the system, and eliminate the flow of plastics into the environment (WWF, n.d). It has three key pillars: global governance, business engagement, and the promotion of Plastic Smart Cities. To ensure effective implementation across the African region, WWF has developed a regional strategy spanning from 2020 to 2025, enabling its offices in Africa to actively contribute to the goals of the initiative (Manyara et al., 2023).*
Sustainable Seas Trust (SST) and The African Marine Waste Network (AMWN)	*The Sustainable Seas Trust (SST) is a non-profit organisation that addresses marine pollution and promotes sustainable management of marine resources in Africa through research and innovation (SST, 2023). The African Marine Waste Network (AMWN) was launched by SST as one of their main programmes to assist African countries in reducing marine waste and plastic pollution at its source through research, education, and community involvement (Marlin & Ribbink, 2020). In 2019, the AMWN, in collaboration with the Western Indian Ocean Marine Science Association (WIOMSA), launched the 'Zero Plastics to the Seas of Africa' project across several African countries. This project, implemented in Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa, and Tanzania, marked the inception of the first multinational, regional litter monitoring initiative in Africa (Marlin & Ribbink, 2020).*
The Western Indian Ocean Marine Science Association (WIOMSA)	*The Western Indian Ocean Marine Science Association (WIOMSA) is a regional scientific organisation dedicated to promoting and advancing marine research, conservation, and sustainable management of marine resources in the*

Legislation/Framework	Relation to the marine environment and plastic waste
	Western Indian Ocean region (WIOMSA, 2023). Established in 1993, WIOMSA serves as a platform for collaboration and knowledge-sharing among scientists, policymakers, practitioners, and stakeholders working towards the protection and sustainable development of marine and coastal environments in the region (WIOMSA, 2023). As mentioned above, WIOMSA partnered with the SST and their AMWN programme as part of WIOMSA's Marine and Coastal Science for Management programme (Marlin & Ribbink, 2020). The primary goals are "to determine litter baselines, identify litter sources and problem items, guide litter management strategies, and monitor the efficacy of interventions by monitoring litter over time" (Barnardo & Ribbink, 2020:9).
The Ellen MacArthur Foundation's Plastics Pact Network	*The Ellen MacArthur Foundation's Plastics Pact Network is a global initiative aimed at driving collaboration and action to address plastic pollution and promote a circular economy for plastics (Ellen MacArthur Foundation, n.d.). Through the establishment of national and regional "Plastics Pacts," participating entities commit to specific goals and actions to reduce plastic waste, increase recycling and reuse, and transition to a circular economy model for plastics (Ellen MacArthur Foundation, n.d.).*

2.7 South African legal framework for plastic waste management

South Africa has a comprehensive legal framework for waste management that includes various laws, regulations, and policies aimed at regulating waste generation, handling, and disposal (Makgae, 2011; Mukwevho *et al.,* 2022).

Section 24 of the Constitution of South Africa (1996) serves as the overarching legal framework for the nation, guiding and influencing all other legislation (Mukwevho *et al.,* 2022) (see Figure 2-10).

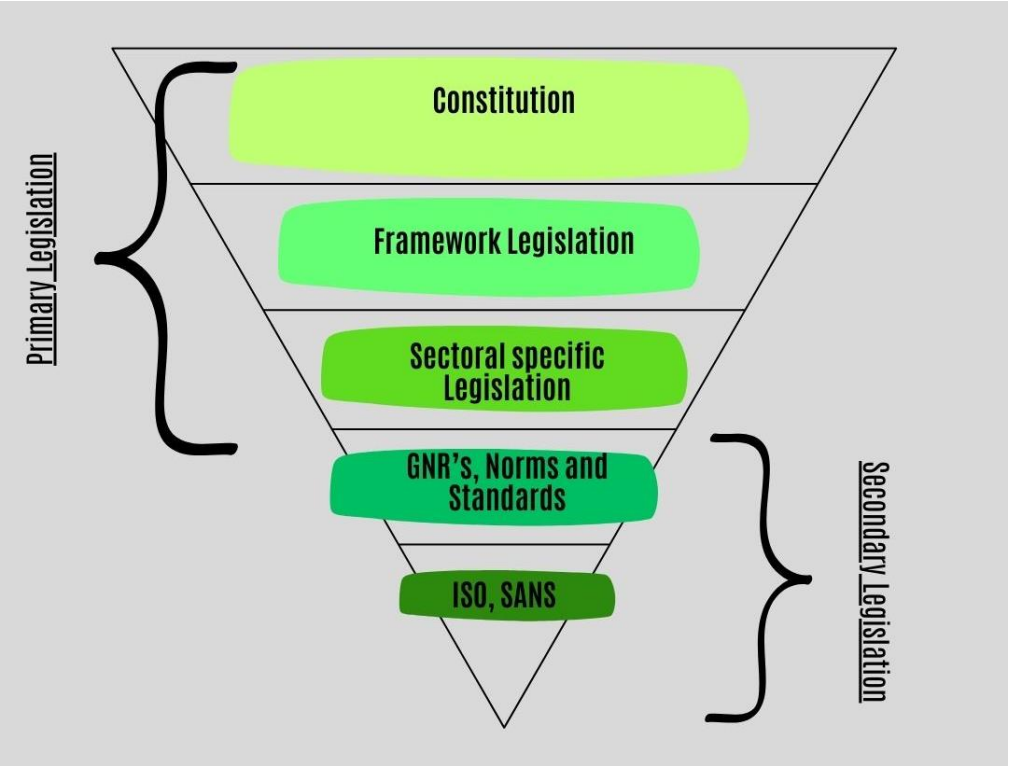


Figure 2-10: South African legal framework. (Source: adapted from Mukwevho *et al.*, 2022).

Section 24 of the Constitution of South Africa (1996) states that:

> *"Everyone has the right -*
>
> *a) to an environment that is not harmful to their health or well-being; and*
>
> *b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that;*
>
> *i. prevent pollution and ecological degradation*
>
> *ii. promote conservation*
>
> *iii. secure ecologically sustainable development and use of natural resources while*
>
> *c) to promote justifiable economic and social development".*

Additionally, Section 2 of the National Environmental Management Act (NEMA) (1998) outlines a framework for cooperative environmental management, providing guiding principles for making decisions regarding activities that may potentially have adverse environmental impacts. This includes provisions for collaborative governance among various organisations and processes for the integration of environmental initiatives across governmental bodies.

Currently, the predominant legislation governing waste in South Africa is the National Environment Management: Waste Act No.59 of 2008. The following sections discuss the

NEM:WA and related regulations, norms and standards, and their applicability to managing plastic waste.

2.7.1 The National Environment Management: Waste Act No. 59 of 2008 (with amendments)

The National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA) provides a comprehensive legal framework that guides both governmental and non-governmental entities in managing their waste activities. The Act aims to manage waste in an environmentally responsible and sustainable manner, and at the same time aims to ensure the well-being and safeguarding of human health (National Environmental Management Act: Waste Act, 2008).

It promotes waste minimisation, reuse, recycling, and environmentally friendly disposal practices, and establishes a waste management hierarchy, prioritising waste reduction and recycling over disposal (Department of Environmental Affairs, 2011). The Act also implements measures and strategies to prevent environmental pollution and the degradation of natural resources, with the goal of promoting environmentally sustainable development (National Environmental Management Act: Waste Act, 2008).

2.7.1.1 The National Waste Management Strategy (2020)

The current National Waste Management Strategy (NWMS) of South Africa of 2020, an updated and revised version of the NWMS of 2011, is a comprehensive policy framework developed by the South African government to guide and coordinate waste management efforts across the country (Department of Forestry, Fisheries, and the Environment, 2020). The NWMS provides a strategic direction for the management of waste in South Africa, emphasising a circular economy approach. The strategy addresses various aspects, including waste reduction, recycling, waste-to-energy, and the creation of green jobs. The NWMS operates as a legislative requirement under NEM:WA, with the primary objective of achieving the goals outlined in the Waste Act. In particular, the strategy outlines the government's strategic approach to reduce littering and illegal dumping, and to "*reducing the production of single-use plastics such as food wrappers, disposable cups, and straws that are currently destroying our marine habitats*" (Department of Forestry, Fisheries, and the Environment, 2020:8). There are Three Strategic Pillars outlined in the NWMS 2020 with Pillar 1: Waste Minimisation, specifically addressing plastic packaging in the South African marine environment. Section 5.1.1 of Pillar 1 states that:

"The Strategic Thrust of this pillar is: Minimising the impact of waste and especially plastic packaging in our coasts, rivers, wetlands and our human settlement environments, by amongst others, diverting waste away from landfill."

2.7.1.2 Plastic Bag Regulations

The South African government introduced the *Plastic Carrier Bags and Plastic Flat Bags Regulations* (GNR. 625 of 6 May 2003), or otherwise known as the Plastic Bags Regulations, which imposed a ban on the production of thin-film plastic grocery bags (Department of Environmental Affairs and Tourism, 2003). The government's decision to implement such restrictions came from concerns about the careless disposal of these bags (Scholtz, 2022). Additionally, because of their lightweight nature, plastic bags tend to be carried by the wind, contributing to environmental pollution (Dikgang *et al.*, 2012). The standards and specifications for plastic bag production were promulgated in 2003 (GN 867 in GG25082 of 20 June 2003) and are found in regulations 4 and 5 which stipulate the new limits set on the thickness of plastic bags, construction, as well as the printing requirements of plastic bags. At the same time, a fixed price for plastic bags were set in an effort to reduce the waste problem by encouraging plastic bag reuse (Dikgang *et al.,* 2012).

The amendments to the Plastic Carrier Bags and Plastic Flat Bags Regulations, published in Government Gazette 44421 (Notice No. 317) and implemented on 7 April 2021 under NEM:WA, focus on promoting circular economy principles and enhancing plastic waste management in South Africa (Department of Forestry, Fisheries, and the Environment, 2021). These amendments prescribe minimum recycled content requirements for plastic bags, gradually increasing from 2023 to 2027. Plastic bags must contain a minimum of 50% post-consumer recyclate by January 2023, reaching 100% recyclate by January 2027. The regulations prohibit the manufacture, trade, or distribution of plastic bags that do not comply with the specified recycled content requirements. Violators may face fines up to R5 million or imprisonment (Department of Forestry, Fisheries, and the Environment, 2021).

2.7.1.3 Waste Management Licensing

The Act requires waste management activities to be licensed and governs South Africa's main waste licensing regulations, ensuring compliance with environmental standards (Department of Environmental Affairs, 2009). The main objective of waste management licensing is to oversee and regulate specific waste management activities that have the potential to negatively impact the environment (ENVASS, 2023). Licensing empowers authorities to regulate and monitor waste generators, transporters, and disposal facilities (ENVASS, 2023).

Under the Waste Act, certain waste management activities require a waste management licence from relevant authorities (Department of Environmental Affairs, 2009). The licensing process involves an assessment of the potential environmental impacts of the proposed activities and

compliance with specified standards and regulations (ENVASS, 2023). Licensing empowers authorities to regulate and monitor waste generators, transporters, and disposal facilities (ENVASS, 2023). There are certain activities and regulations related to the treatment, recycling, and disposal of waste, including plastic waste. GNR.921 of 29 November 2013 pertains to regulations regarding the recycling or recovery of waste. This notice outlines specific requirements and standards for the recycling industry, aiming to promote sustainable waste management practices and reduce environmental pollution (Department of Environmental Affairs, 2013b). It includes provisions related to the collection, sorting, shredding, grinding, crushing, screening, bailing, and recycling of general waste, including plastic waste, as well as guidelines for compliance and enforcement measures (Department of Environmental Affairs, 2013a).

2.7.1.4 Industry Waste Management Plans (InWMP)

South Africa's Industry Waste Management Plans (InWMPs) are sector-specific strategies developed to address the management of waste generated by different industries. These plans are part of the broader framework established by NEM:WA, which emphasises the importance of industry participation in waste management. The InWMPs allows different industries to highlight their unique waste management challenges, requirements, and opportunities (Department of Environmental Affairs, 2011). These plans are developed through a collaborative process involving industry representatives, government agencies, environmental experts, and other stakeholders, focusing on achieving the goal to reduce the amount of waste generated and improving waste recycling and reuse (Roos & van Rooyen, 2022). While there may not be a dedicated IndWMP exclusively for plastics, plastic waste can still be regulated and managed within the framework of broader waste management plans, such as those for the paper and packaging industries. This involves reporting on the quantities and types of waste generated, as well as the amount of waste reused, reduced, or recycled, and the amount disposed of. It also encompasses the implementation of the waste management hierarchy, pollution prevention measures, EPR schemes, awareness campaigns, among other things (Department of Environmental Affairs, 2017a).

2.7.1.5 Extended Producer Responsibility (EPR) regulations

Extended Producer Responsibility (EPR) in South Africa mandates that manufacturers, importers, and brand owners take significant responsibility for the post-consumer lifecycle of their products and packaging (Nahman, 2010). Governed by specific regulations, producers must design products for recyclability, submit waste management plans, and financially contribute to recycling initiatives. This approach aims to shift the burden of waste management onto producers,

promoting a circular economy and sustainable practices (Bünemann & Brinkmann, 2019; Van Rossem *et al.*, 2006).

GNR.1187 provides the EPR regulations for paper and packaging in South Africa and outlines the responsibilities of producers, importers, brand owners, and retailers in managing the life cycle of their products, particularly regarding their end-of-life disposal. This Notice pertains to waste originating from the use of plastic packaging, biodegradable and compostable plastic packaging, single-use plastic products, single-use biodegradable plastic, and single-use compostable plastic products by consumers or end-users (Department of Environment, Forestry, and Fisheries, 2020). These regulations require these entities to take responsibility for the collection, reuse, recycling, recovery, or safe disposal of the packaging waste generated by their products. The producers are responsible for developing an EPR scheme and establishing a producer responsibility organisation as well (Department of Environment, Forestry, and Fisheries, 2020). In 2021 the WWF South Africa, the IUCN South Africa, as well as the DFFE came together with the goal to encourage and assist the shift towards a circular plastics economy in South Africa, by offering suggestions for a compulsory EPR policy dedicated specifically to plastic packaging (Arp, 2021).

2.7.1.6 Norms and standards for the disposal of waste to landfill

The norms and standards outlined in the National Environmental Management Act of 2008 aim to provide a national approach to the management of waste. Government Notice R. 636 of 23 August 2013, the *National Norms and Standards for Disposal of Waste to Landfill*, elaborates on various aspects of waste management, including diversion of waste from landfill (Department of Environmental Affairs, 2013c). These regulations provide guidance on the implementation of the Waste Act and set specific targets and requirements for waste diversion. Regarding waste with a high calorific value, such as plastics, these regulations may include provisions encouraging or mandating the separation, collection, and recycling of such materials (Department of Environmental Affairs, 2019). Recycling facilities and processes that convert waste plastics into energy or other valuable products may also be incentivised or supported under these regulations.

2.7.1.7 SANS 1728: Guidance on Labelling of Degradable Plastic

The South African Bureau of Standards (SABS) developed the South African National Standard (SANS) 1728 in 2019 to address the marking and identification of degradable plastic packaging (Department of Trade and Industry, 2019). SANS 1728 provides guidelines and requirements for ensuring that claims made about the degradability of plastics are accurate and consistent (Department of Trade and Industry, 2019). This includes specifications for the type of labelling, the information to be included on the label, and requirements for testing or certification to verify

the degradability of the plastic product (Facts SA, 2020; Crown Publications, 2023). These requirements are important for ensuring transparency and accountability in the marketing and use of degradable plastics, as well as helping consumers make informed choices about the products they purchase (Facts SA, 2020).

2.8 South Africa's legal framework for marine protection/protected areas

The IUCN defines a marine protected area (MPA) as*: "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment"* (IUCN, 1988:18). Kriegl *et al.* (2021) defines an MPA as a designated area of the ocean or coastal waters that is managed and protected to conserve marine ecosystems, biodiversity, habitats, and species through regulations and management measures to restrict certain human activities within their boundaries.

The history of marine area restriction and protection in South Africa traces back to 1652 and, in the 1960s, the South African government took significant steps by supporting the IUCN in establishing formal MPAs (Kriegl *et al.*, 2021). Shortly thereafter, the establishment of Tsitsikamma National Park became the country's first MPA in 1964 (Lombard *et al*., 2020) and by 2020, South Africa declared 42 MPAs (see figure 2-10), encompassing 5% of its ocean territory and extending protection over 10% of the country's Exclusive Economic Zone (EEZ) (Two Oceans Aquarium Foundation, 2020; Adams & Kowalski, 2021).

South Africa's legal framework for marine protection and the establishment of protected areas in its waters is multifaceted and includes various laws, regulations, and policies aimed at conserving marine ecosystems and biodiversity (Mann-Lang, 2021). The following sections outline the legal framework applicable to the protection of the marine environment and biodiversity.

2.8.1 The National Environmental Management: Protected Areas Act (Act 57 of 2003)

The National Environmental Management: Protected Areas Act (Act 57 of 2003) (NEM:PAA) aims to conserve South Africa's biodiversity and heritage by establishing a framework for the creation and management of protected areas. Since 2014, this legislation provides the overarching framework for the establishment, management, and regulation of protected areas, including national parks, nature reserves, and MPAs, in South Africa (NEM:PAA, 2003). It outlines procedures for declaring protected areas, their management objectives, and mechanisms for stakeholder engagement (SANBI, 2018). NEM:PAA has been amended three times, with Act No 21 of 2014: The National Environment Management: Protected Areas Amendment Act, 2014

focusing specifically on providing management of MPAs and authorising the declaration of MPAs, among other things (Department of Environmental Affairs, 2014).

2.8.2 The Marine Living Resources Act (Act 18 of 1998)

The Marine Living Resources Act (MLRA) governs the management, conservation, and sustainable use of marine living resources in South Africa's exclusive economic zones (EEZ) and territorial waters (South African Government, 1998). It includes provisions for the establishment and management of MPAs, aiming to conserve marine living resources and protect the marine environment against threats such as overfishing, pollution, and overexploitation, while simultaneously ensuring continued access to these marine living resources for the population (South African Government, 1998).

2.8.3 The National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)

The National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) (NEM:ICMA) is aimed at addressing the integrated management of the coastal zone in South Africa, including marine and terrestrial environments. It provides a framework for the sustainable management of coastal resources, taking into account environmental, social, and economic factors (NEM:ICMA, 2008). This includes the development of Integrated Coastal Management (ICM) Plans for each coastal region; protection of coastal resources; and promotes sustainable development, conservation, and access to coastal resources while addressing coastal erosion, pollution, and habitat degradation (NEM:ICMA, 2008).

2.8.4 National Environmental Management: Biodiversity Act (Act 10 of 2004)

The National Environmental Management: Biodiversity Act (NEM: BA) provides mechanisms for conserving and managing biodiversity in South Africa, including marine biodiversity, within the framework of NEMA (1998). It includes provisions for the protection of threatened species, ecosystems, and genetic resources, which intersects with marine conservation efforts, and includes the creation of a South African National Biodiversity Institute (SANBI), and the responsibilities thereof (NEM:BA, 2004).

2.8.5 Marine Spatial Planning Act (Act 16 of 2018)

This Act provides the framework for marine spatial planning (MSP) in South African waters and is a comprehensive approach to managing human activities and conserving natural resources in the marine environment (Government Gazette, 2019). MSP integrates various uses such as

fishing, shipping, tourism, and conservation to balance ecological, social, and economic objectives (Rivers *et al.,* 2023). South Africa's vision for MSP is "*a productive, healthy and safe ocean that is accessible, understood, equitably governed and sustainably developed and managed for the benefit of all*" (Department of Environmental Affairs, 2017b:3) and is supported by various principles to achieve those objectives. Key to MSP is stakeholder engagement and emphasising ecosystem-based management. MSP aims to protect marine biodiversity, including the establishment and management of MPAs (see Figure 2-11) (Rivers *et al.,* 2023; Department of Environmental Affairs, 2017b). Additionally, MSP addresses sustainable coastal development, seeking to balance infrastructure needs with environmental protection.

As previously mentioned, Struisbaai is situated between two MPAs. The MPAs adjacent to the study area are identified in Figure 2-11 by the following ID numbers: 20 (Agulhas Mud MPA) and 21 (De Hoop MPA). These MPA areas play a crucial role in conserving the marine environment and are integral to the overall MSP framework.

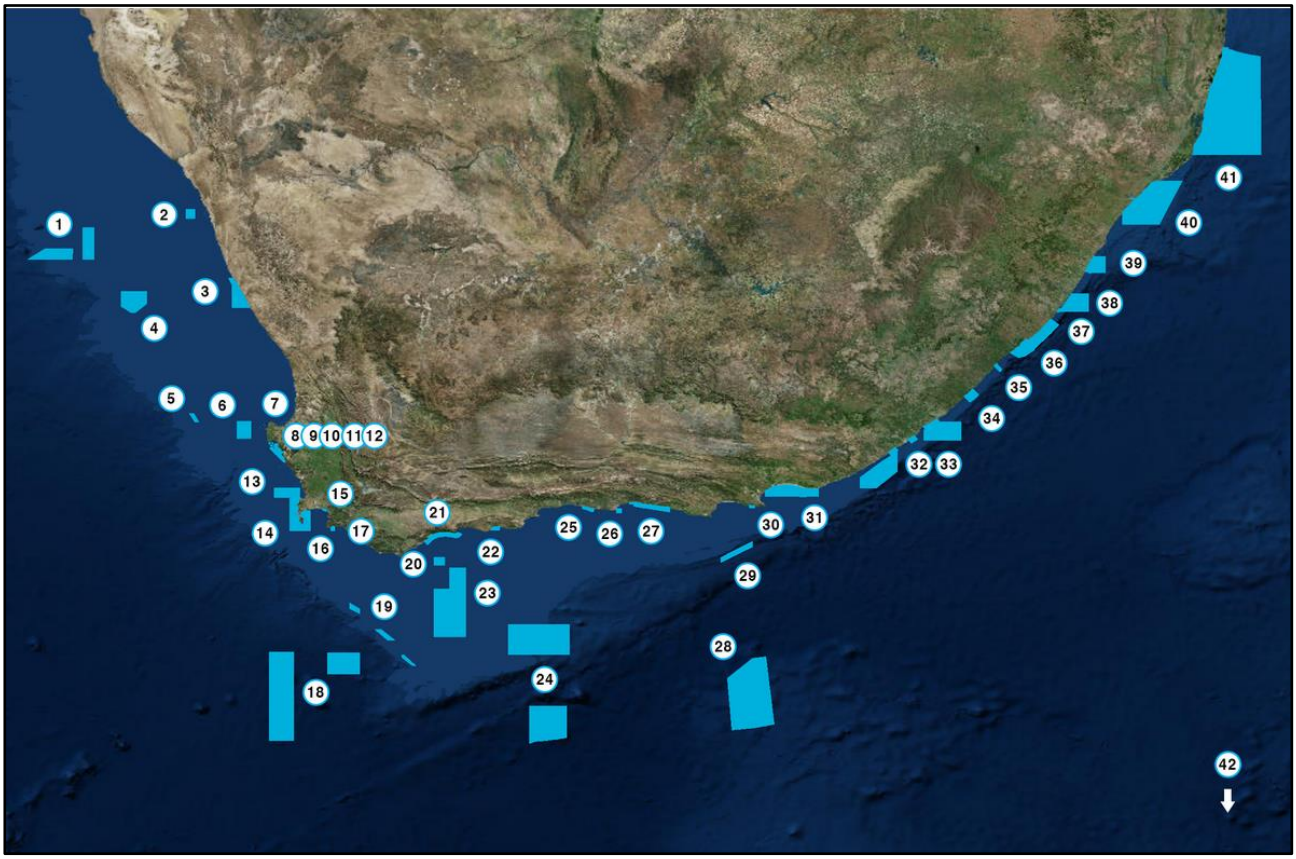


Figure 2-11: Map South Africa's Marine Protected Areas. (Source: South Africa's MPA's, n.d).

2.9 Framework for plastic waste management and protected areas management in the Western Cape Province

The Western Cape Province integrates several strategies to address plastic pollution while ensuring the conservation and sustainable management of protected areas. The following section provides an overview of some of the strategies implemented in the Western Cape:

2.9.1 Western Cape Provincial Coastal Management Programme (2016)

The Western Cape Provincial Coastal Management Programme (2016) is a comprehensive strategic document developed by the Western Cape government to guide the sustainable management and conservation of the coastal zone in the province (Department of environmental Affairs and Development Planning, 2016). This programme outlines key objectives, policies, and actions aimed at promoting the integrated management of coastal resources, addressing resource degradation, promoting sustainable development, highlighting the importance of education and awareness of the public, includes all stakeholders and role players and their responsibilities within the programme, while keeping the programme aligned with legislation and guidelines to ensure the most effective governance of the Western Cape's coastal areas (Department of Environmental Affairs and Development Planning, 2016).

The document is divided into nine different priority areas with clear goals and objectives for coastal management detailed in a five-year programme. Priority area 5 specifically focuses on "land-and-marine-based sources of pollution and waste" and aims to reduce the adverse effects that pollution and waste has in marine ecosystems. The programme aims to achieve this through the implementation of new waste management procedures that will prevent, reduce, and regulate the emissions of pollution and waste into marine environments (Department of Environmental Affairs and Development Planning, 2016)

2.9.2 Western Cape Integrated Waste Management Plan (2023-2027)

The Western Cape Integrated Waste Management Plan 2023-2027 (WCIWMP) is a strategic document developed by the Western Cape government in accordance with the requirements of Section 12 of NEM:WA to guide waste management practices and initiatives in the province over short, medium, and long term time frames (Department of Environmental Affairs and Development Planning, 2023). This plan is developed by the Department of Environmental Affairs and Development Planning (DEA&DP) in the Western Cape and outlines objectives, strategies, and actions aimed at promoting sustainable waste management practices, reducing waste generation, and minimising the environmental impact of waste (Department of Environmental Affairs and

Development Planning, 2023). The WCIWMP aligns with various international, national, and provincial policies, such as the global SDGs and the WCIWMP is designed to correspond with the principles outlined in the NWMS of 2020, promoting the transitioning towards a circular economy and following the waste management hierarchy (Department of Environmental Affairs and Development Planning, 2023).

2.10 Plastic waste management and protected areas management in the Struisbaai area

The following sections provide a brief overview of waste management in the case study area.

2.10.1 Waste management practices in Struisbaai and Struisbaai Harbour

Struisbaai is located between two protected areas, Agulhas National Park and De Mond Nature Reserve. De Mond Nature Reserve falls under the authority of the Western Cape Nature Conservation Board (CapeNature), and this area has also been declared a World Heritage Site (CapeNature, 2023). The area where Agulhas National Park has been established consists of privately owned property, declared Mountain Catchment areas, and other protected areas (SANParks, 2020). The National Park falls under the authority of the South African National Parks (SANParks), CapeNature, the Eastern Cape Parks and Tourism agency, as well as the Department of Environment, Forestry, and Fisheries. Agulhas National Park also forms part of the Cape Floral Region Protected Areas World Heritage Site (SANParks, 2020). Just South of Cape Agulhas approximately 40 km offshore, lies the Agulhas Mud Marine Protected Area (Marine Conservation Institute, 2024).

Cape Agulhas Municipality (CAM) is responsible for the collection of waste in Struisbaai and certain areas within the harbour and discards the waste at the local landfill site or at the Bredasdorp landfill site (Cape Agulhas Municipality, 2022). CAM is also responsible for taking recyclable material to the nearest recycling facility in Napier. The Department of Forestry, Fisheries, and the Environment (DFFE) is responsible for waste management in a different sector within the same harbour, making waste management practices much more challenging due to the different legislation and jurisdictions within the same area. Since the harbour is the main attraction for nearly all tourist activities, it is also the place where most waste is generated and discarded.

Cape Agulhas Municipality, located within the Overberg District of the Western Cape, stands out as the southernmost municipality on the African continent (Cape Agulhas Municipality, 2023b). Covering a diverse land area of 2 411 km² and around 178 km of coastline, it encompasses nine urban settlements, including Bredasdorp as its administrative centre, as well as picturesque coastal towns such as Struisbaai, Suiderstrand, Arniston/Waenhuiskrans, and L'Agulhas, where the Atlantic and Indian Oceans meet at the most southern tip of Africa. Is also includes rural areas

and towns situated more inland, such as Elim, Napier, Klipdale, and Protem (Cape Agulhas Municipality, 2023b).

CAM plays a pivotal role in waste management practices in Struisbaai, ensuring the effective handling and disposal of waste within the community (Cape Agulhas Municipality, 2023a). CAM oversees various aspects of waste management, including waste collection, recycling initiatives, landfill management, and public education campaigns (Cape Agulhas Municipality, 2023a). Through strategic planning and implementation, CAM works to minimise the environmental impact of waste while promoting sustainable practices among residents and businesses in Struisbaai, including the provision of waste collection services, the establishment of recycling facilities, and the enforcement of waste management regulations to maintain a clean and healthy environment (Cape Agulhas Municipality, 2023a).

The waste management practices in Struisbaai, overseen by the Cape Agulhas Municipality, involve a structured collection system (Cape Agulhas Municipality Solid Waste Management, n.d.). General waste is collected once a week on Mondays and transported to Struisbaai's Drop-off area, whereafter the waste is collected and taken to the Bredasdorp landfill, a small town approximately 27 km inland from Struisbaai. Households use wheelie bins specifically for general waste, excluding green waste, construction debris, or hazardous materials (Cape Agulhas Municipality Solid Waste Management, n.d.). Recycling is encouraged through the use of clear bags, collected weekly on Thursdays and sent to a recycler for sorting. Street sweeping is every second month through the Expanded Public Works Programme (EPWP), and this programme is also tasked with cleaning illegal dumping sites. Litter picking occurs twice monthly in residential areas and weekly along the beach (Cape Agulhas Municipality, 2023b). Litter bins are emptied three times a week, and additional clean-up projects focus on the beach area. Stormwater drains are regularly cleaned to prevent blockages, and complaints in the harbour areas are addressed promptly within a day of reporting due to the large influx of tourists (Cape Agulhas Municipality Solid Waste Management, n.d.).

2.10.2 Integrated Waste Management By-Law, 2021 for the Cape Agulhas Municipality (CAM)

Cape Agulhas Municipality is currently compliant to the National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) (Department of Environmental Affairs, 2017c) and the National Environment Management: Waste Act (NEM:WA), 2008 (Act 59 of 2008) (Department of Environmental Affairs, 2013b) which outlines the broader legislative framework for waste management in South Africa. On 8 April 2022 the Western Cape Government published the

Provincial Gazette Extraordinary 8580, entailing the Integrated Waste Management By-Law, 2021 for the Cape Agulhas Municipality (CAM) (Cape Agulhas Municipality, 2022).

The document is a by-law detailing waste management practices and regulations in Struisbaai, Western Cape, South Africa. It outlines the responsibilities of the Municipality and waste generators, the types of waste management services provided, approved receptacles, separation of waste streams, submission of waste management plans for certain activities, and the requirements for handling different types of waste (Cape Agulhas Municipality, 2022).

2.10.3 Waste management practices in Agulhas National Park: the role of SANParks

Waste management practices within Agulhas National Park are primarily handled by SANParks (South African National Parks) (SANParks, 2020). SANParks is tasked with implementing and overseeing effective waste management strategies to preserve the park and protect its diverse ecosystems (SANParks, 2020) through management plans. Although the Agulhas National Park Management Plans outline various management strategies for tourism, development, biodiversity and ecosystem protection, cultural heritage management, and infrastructure, the management plan does not address waste or waste management in much detail. The Agulhas National Park Management Plan provides for broad actions related to "*waste recycling and minimisation where possible*" (SANParks, 2020:92) and "increased recycling of waste" (SANParks, 2020:122) in relation to mitigating carbon footprint overtime. The management plan also states that, throughout SANParks, other programmes are being implemented, including waste management programmes (SANParks, 2020).

2.10.4 Waste management practices in De Mond Nature Reserve: the role of CapeNature

In De Mond Nature Reserve, waste management practices are overseen by CapeNature (van Niekerk *et al.,* 2012). De Mond Nature Reserve does not have an official waste management practice report, but a field ranger working at De Mond provided the researcher with a personalised report about the current waste management practices (see Figure 2-12):

Waste Management Practice Report for De Mond Nature Reserve

Executive Summary

This waste management practice report outlines strategies and recommendations for effective waste management in De Mond Nature Reserve.

The report aims to address the current waste management practices, identify areas for improvement, and provide actionable steps to minimise waste generation and promote sustainability within the reserve.

Introduction

De Mond Nature Reserve is a biodiverse ecosystem that attracts visitors and researchers from around the world. As the number of visitors increases, so does the generation of waste within the reserve. Proper waste management is essential to preserve the natural beauty and integrity of the reserve while minimising its environmental impact.

Current Waste Management Practices

1. Waste Collection:

Waste bins are strategically placed throughout the reserve for visitors to dispose of their waste. Regular collection by maintenance staff ensures that the bins do not overflow.

2. Recycling:

Limited recycling facilities are available within the reserve, mainly for common materials such as plastic bottles and aluminium cans.

3. Composting:

Organic waste from the reserve's facilities is composted to reduce landfill waste and create nutrient-rich soil for landscaping.

4. Education:

Visitors are provided with information on waste disposal practices through signage and educational materials.

Areas for Improvement

1. Increased Recycling:

Expand recycling facilities to include a wider range of materials, such as paper, cardboard, and glass.

2. Waste Auditing:

Conduct regular waste audits to identify the types and quantities of waste generated within the reserve and assess opportunities for reduction.

3. Comprehensive Waste Management Plan:

Develop a comprehensive waste management plan that outlines goals, strategies, and responsibilities for waste reduction and recycling initiatives.

4. Partnerships:

Collaborate with local waste management organisations to enhance recycling efforts and explore innovative waste reduction solutions.

Proposed Action Plan

1. Implement a Three-Stream Waste System:

Introduce separate bins for general waste, recyclables, and organic waste to encourage proper waste sorting.

2. Staff Training:

Provide training for staff on proper waste management practices, including sorting, recycling, and composting procedures.

3. Community Engagement:

Organise community clean-up events and educational workshops to raise awareness about waste management and environmental conservation.

4. Monitoring and Evaluation:

Establish key performance indicators to track progress towards waste reduction goals and regularly review and adjust strategies as needed.

Conclusion

Effective waste management is crucial for maintaining the ecological balance and sustainability of De Mond Nature Reserve. By implementing the proposed strategies and recommendations outlined in this report, the reserve can minimise its environmental footprint, preserve its natural beauty, and serve as a model for sustainable waste management practices in protected areas.

Figure 2-12: De Mond Nature Reserve current waste management practices. (Source: Saptou, 2024).

2.11 Chapter summary

It is evident that plastic marine pollution is a growing global environmental concern that transcends national and international boundaries and affects coastlines and oceans around the world. This chapter provided a comprehensive examination of various aspects related to plastic waste, encompassing its historical context, composition, types, and sizes. The review explored the sources and pathways through which plastic waste enters the ocean, offering insights into both land-based and sea-based sources. Furthermore, the chapter critically analysed approaches to address plastic waste, with a particular focus on command and control, civil, and market-based strategies. Additionally, the legal frameworks governing plastic waste management at the international, regional, and subregional levels were explored, alongside an in-depth examination of the South African legal framework for plastic waste and marine protected areas. The chapter also provided legislation in the Western Cape Province concerning plastic waste management and protected areas. Chapter 3 provides the methodology used in this study to address the research objectives outlined in chapter 1.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter provides the methodology used to investigate the research aim - investigating plastic waste and waste management practices within the Agulhas National Park, focusing on Struisbaai Harbour as the case study area. The chapter outlines the research design, the case study selection criteria, gives a brief introduction to the study area, outlines the survey questionnaire and data sampling, population, and data analysis, as well as the ethical considerations and limitations of the study.

3.2 Research design

The study followed a mixed-methods approach following an exploratory case study design (focusing on waste management practices within Struisbaai Harbour). A mixed-methods approach combines both quantitative and qualitative research methods (Schoonenboom & Johnson, 2017) and includes the collection and analyses of both numerical data (quantitative) and non-numerical data (qualitative), assisting the researcher with an integration of the results to strengthen the conclusion (Guetterman *et al.,* 2015). Qualitative and quantitative data collection methods were used for this study because part of the study depends on quantitative data (such as the number of recycling bins and the quantity of plastic waste within the harbour), while the study is also reliant on qualitative data, such as public perceptions (through interviews) and document review to establish waste management practices. Methods of data collection in relation to the research objectives are provided in Table 3-1.

The following sub-sections describe the quantitative and qualitative components of the mixed methods approach followed for this research.

3.2.1 Quantitative research methods

Quantitative research is often used to investigate questions that arise from qualitative research or produces questions that should be investigated through qualitative research (Tenny *et al.,* 2022). Quantitative research focusses on a limited number of concepts, and the researcher is not involved in the data gathering process, but rather keeps a distance from the data collection through the development and implementation of research instruments (Botma *et al.*, 2010). The researcher also aims to attain as much control over the research implementation phase as possible and is fully engaged in the setting and participants, while staying objective (Mertler, 2016). Numbers are the fundamental element of the data analysis and are analysed statistically with the goal of applying results in general to larger contexts (Sheard, 2018). Quantitative

research can be structured in various ways based on the desired outcomes of the study (Botma *et al.*, 2010). These research designs could be any of the following:

- Descriptive designs (What is?)
- Time-dimensional designs
- Case study designs
- Correlation designs (What is the relationship?)
- Quasi-experimental designs
- Experimental designs (What is the effect of the independent variable on the dependent variable?)

These design structures are arranged from the design that provides the weakest evidence to the design that provides the strongest evidence in research (Botma *et al.*, 2010). When deciding on a design to follow, the researcher must take several things into consideration, such as:

- The purpose of the study;
- The research question/s and hypotheses (which indicates the research population and the context of the study);
- The concepts and variables that will be measured and how they will be measured;
- Ethical factors;
- Theoretical factors;
- Practical deliberations (time constraints, participant availability, funding availability, information resources).

The result outcomes should provide the strongest evidence to answer the research question/s (Creswell, 2009). The researcher should carefully examine all available information before choosing a research design as the wrong design could lead to no concrete results (Maree, 2016).

3.2.2 Qualitative research methods

Qualitative research design is a methodological approach used to explore, interpret, and understand phenomena in their natural context, emphasising the subjective nature of human experiences (Botma *et al.,* 2010; Merriam, 2009). This design is characterised by an in-depth exploration of social phenomena, and, unlike quantitative research that focuses on numerical data and statistical analysis, qualitative research relies on non-numerical data such as words, images, and narratives to generate detailed insights and experiences of individuals within a specific context (Creswell & Creswell, 2017; Patton, 2015). One of the key features of qualitative research design is its use of open-ended and flexible data collection methods (Tenny *et al.* 2022). These

methods often include techniques such as interviews, focus groups, participant observation, and document analysis (Busetto *et al.,* 2020).

For this study, a mixed-method approach was applied involving both qualitative and quantitative methods of data collection (Table 3-1).

Table 3-1: Overview of the research design.

Research objective	Data collection	Justification
RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour.	Observations and waste characterisation supported by literature review.	Determining plastic waste management practices within a study area is crucial for several reasons, as supported by Nxumalo *et al.* (2020), Adeniran (2022), and Abdullah (2023). For RO1 and RO2, observations of quantities and nature of plastic waste; waste management practices; and waste management infrastructure; waste categorisation, and document review were chosen as the data collection methods due to their complementary strengths in assessing the extent and nature of plastic waste pollution in Struisbaai Harbour. Observations provide real-time, on-site insights (Maree, 2016), capturing the immediate presence, nature, and quantities of plastic waste through direct visual inspection. This method allows for the identification of pollution patterns and hotspots within the harbour. On the other hand, document review uses existing records, reports, and studies, offering historical context and trends over time (Dalglish *et al.,* 2020).
RO2: Determining plastic waste management practices in Struisbaai Harbour.	Observations and document review.	

Research objective	Data collection	Justification
RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour.	Survey questionnaires.	According to Babbie (2008), survey research gathers original data when the population size is too substantial to engage directly. The study used a qualitative approach through survey questionnaires with close and open-ended questions to gain insight into the public perceptions of the plastic waste and waste management practices within Struisbaai Harbour. Survey questionnaires were used for this study as this is an effective tool for gathering information from the respondents to understand their knowledge, opinions, attitudes, and behaviours (Ranganathan & Caduff, 2023; Miguel *et al.,* 2024).
RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai.	Literature review (see also Chapter 2). Document review and evaluation.	Document analysis is a qualitative research method that systematically examines and interprets various documents, printed or electronic, to gain insights into the research topic (Bowen, 2009). Documents serve as valuable tools in both data collection and analysis, offering insights to address research questions (Dalglish *et al.,* 2020).

3.3 Case study area

To explore the plastic waste and waste management practices within the Agulhas National Park, Struisbaai Harbour was selected as the case study area. The following sections, Section 3.3.1 and Section 3.3.2 provide the justification for selecting Struisbaai Harbour as the case study area

and provide a brief description and aerial map of the Agulhas National Park, Struisbaai and the Harbour area.

3.3.1 Justification for selecting Struisbaai as the case study area

A case study is a detailed and in-depth analysis of a specific individual, group, event, situation, or place in its real-life context (Crowe *et al.,* 2011). It involves comprehensive research and examination to understand the complexities and context surrounding the subject of the study (Heale & Twycross, 2017). Case studies are often used in various disciplines to provide insights, draw conclusions, and generate hypotheses (Karlsson, 2016).

The management of plastic waste represents a multifaceted challenge with implications for environmental sustainability, social dynamics, and governance structures. Conducting exploratory case study research can provide valuable insights and contribute to a comprehensive understanding of the complexities associated with plastic waste management within the broader environmental, social, and governance frameworks. Agulhas National Park and, more specifically Struisbaai Harbour, was chosen as a case study area based on the following criteria:

a) SANParks did not grant permission to conduct fieldwork and observations within the Agulhas National Park itself. Struisbaai, which is situated in close proximity to the park, is a public area and no restrictions on doing fieldwork existed in this area. The Cape Agulhas Municipality (CAM) was also supportive towards the research taking place in the Struisbaai harbour area, as well as the Department of Forestry, Fisheries, and the Environment (DFFE).
b) Struisbaai is situated between two MPAs (De Hoop MPA and Agulhas Mud MPA), a National Park (Agulhas National Park), as well as a nature reserve area (De Mond Nature Reserve).
c) The governance structures for waste management within Struisbaai Harbour are divided into three different spheres (CAM, the DFFE, and a private sector), making Struisbaai an interesting and challenging area.
d) The current waste management regulations and practices within the harbour need to be examined and evaluated, as there has been little to no research conducted in this area to determine the effectiveness of the waste management systems in place.
e) Struisbaai has high tourism and recreational activity throughout the year, with a significant surge during the December holidays. The increased number of people can place significant strain on existing waste management systems. The tourism activities in the area provide a unique and interesting context to investigate tourists'

perceptions of plastic waste and waste management practices within Struisbaai Harbour.

3.3.2 Description of the case study area

Agulhas National Park lies about 260 km southeast of Cape Town and 37 km south south-west of Bredasdorp, situated on the Agulhas Plain in the Overberg region of the Western Cape Province. It extends approximately 45 km along the coast, from Pearly Beach (S 34º 35', E 19º 21') in the west to L'Agulhas (S 34º 49', E 20º 03') in the east and extends between one and 25 km inland from the coastline. The park lies in the southernmost tip of Africa with the Atlantic Ocean to the west and Indian Ocean to the east, meeting at this point (SANParks, 2020). The park consists of twenty accommodation units with 68 beds person capacity in total:

- Agulhas rest camp (10 chalets and 5 family chalets with a total capacity of 40 beds);
- Bergplaas guest house (10 beds);
- Lagoon house guest house (8 beds);
- Rhenosterkop (1 cottage, 2 family cottages with a total capacity of 10 beds)

The mission of Agulhas National Park is *"To implement and promote the conservation and sustainable use of the globally unique terrestrial, freshwater and marine biodiversity and cultural heritage of the Agulhas Plain. Building on the spirit of place of the Southernmost Tip of Africa, to unlock benefits together with local communities, now and in the future"* (SANParks, 2020: 14).

Struisbaai is a small fisherman's village situated within the Overberg region in the Western Cape (Overberg, 2023), approximately 5 km from L'Agulhas (Xplorio, 2023), where the Indian and Atlantic Ocean meets at the Southernmost point of Africa (Suemtravels, 2017; South Africa Tours and Travel, 2023) (Figure 3-2). The beach at Struisbaai is the longest natural beach in the Southern Hemisphere and spans 14 km in the direction of Waenhuiskrans (Cape Agulhas Municipality, 2021). In 2021/2022, the Duiker Street Beach in Struisbaai was awarded Blue Flag Status, meeting international standards for cleanliness and safety. This recognition has made it a popular destination for tourists, particularly in the warm summer season.

Struisbaai is a secondary economic hub (Cape Agulhas Municipality, 2021) and is well known for its harbour, which is one of the last remaining historical and cultural fishing harbours with public access in South Africa (Struisbaai Accommodation, 2013). First constructed in 1959, the harbour was later expanded in 1990 (Van Eeden, 2019). The harbour allows tourists to watch the traditional fisherman bring in their catch of the day in their "chukkies" (small fishing boats), as well as buy fresh fish from the traditional fishermen off the harbour jetty (Cape Agulhas Municipality,

2023b). It is also the launching place for boats, jet skis, and kayaks, as well as the local surfer and fishing spot (Figure 3-1 A, B). The harbour is connected to the main beach with a wooden boardwalk (known as the promenade) and stretches to the southern side of the harbour, where it ends approximately 300 m into a green area (Figure 3-1E). Since the harbour is the main attraction for nearly all tourist activities (Figure 3-1) in the Struisbaai area, it is also the place where most waste is generated and discarded.

Figure 3-1: **Struisbaai. A) Parry the stingray; B) a busy day in the harbour; C) Duiker Street Beach; D) buying fresh fish off the harbour jetty; E) the wooden boardwalk; F) Struisbaai harbour and the "chukkies". (Source: Author's photos).**

Struisbaai experiences frequent strong wind conditions throughout the year, as depicted in Figure 3-2 (Windy.App, n.d.). Therefore, proper disposal of waste along the coastal area is imperative to prevent waste from blowing into the ocean and polluting surrounding marine ecosystems. Seagulls play a significant role in pollution in Struisbaai by tearing open refuse bags and scavenging from open dustbins, leading to the scattering of waste throughout the environment.

Struisbaai has an abundance of wildlife such as Parry, the local stingray (Figure 3-1A), otters and dolphins, as well as whales that come to breed and calf in the safety of the natural harbour and can be spotted from May until August. The annual Geelstertfees (Yellowtail Festival) and the Two Oceans Blue Marlin tournament (Chas Everrit, 2021) are one of the biggest tourist attractions in Struisbaai.

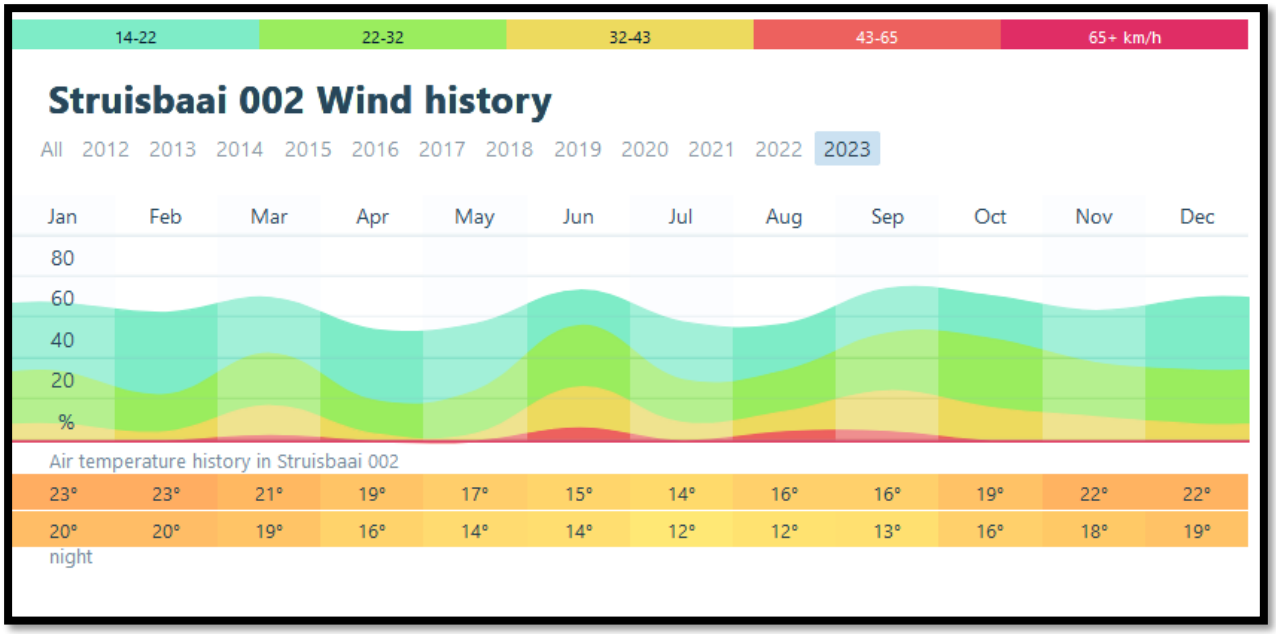


Figure 3-2: Struisbaai wind history for 2023. (Source: Windy.App, n.d).

The Cape Agulhas Municipality (CAM) manages waste collection in Struisbaai and specific areas within the harbour, disposing of the waste at the local landfill site (Cape Agulhas Municipality, 2023a). Additionally, CAM transports recyclable materials to the nearest recycling facility in Napier. The Department of Forestry, Fisheries, and the Environment (DFFE) oversees waste management in another sector of the same harbour (see Figure 3-3). In this area, a private sector entity is responsible for its own waste management, although CAM still handles refuse removal for both the private sector and the DFFE.

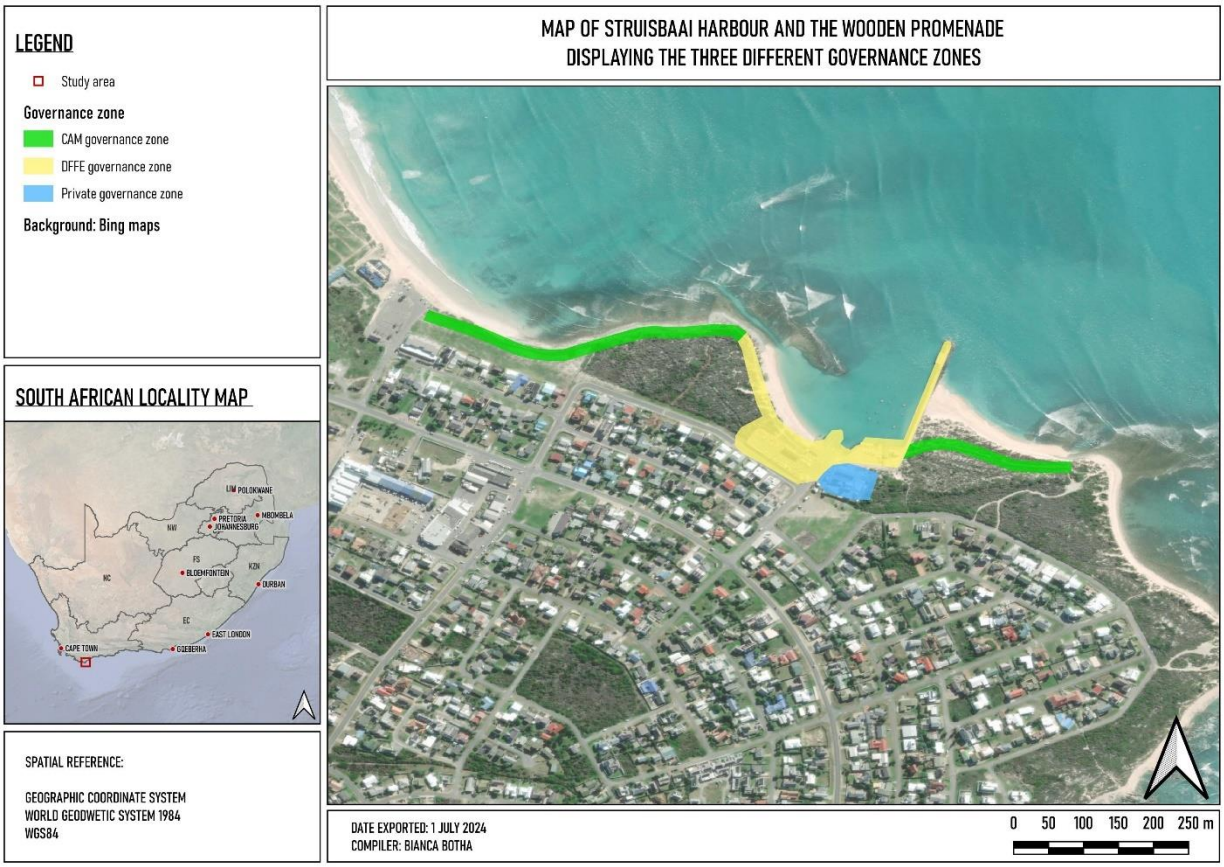


Figure 3-3: Map of Struisbaai Harbour and the wooden promenade displaying the three different governance zones.

3.4 Data collection

Both primary data (through observations and surveys) and secondary data (through literature and document review) were collected for this research. The primary data for this study were collected between 19 December 2023 and 2 January 2024 over a period of 26 days.

The methods of data collection are outlined in the following sub-sections.

3.4.1 Literature review

The purpose of reviewing literature was to comprehensively review and synthesise existing research on the topic. This involved identifying gaps in knowledge, establishing theoretical frameworks, assessing trends and patterns, and providing a contextual background for the research (Paré *et al.,* 2015). The literature review assisted the researcher in defining the type of data that needed to be collected, such as specific types of waste, waste management practices, public perception indicators, and governance elements. Insights from the literature guided the

researcher in designing the survey questionnaire. Additionally, theoretical insights informed the analysis of the collected data, supporting its interpretation and helping to draw informed conclusions.

The literature review related to the research objectives of the study in the following ways:

- **RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour.** The literature study helped contextualise the observed data by identifying similar studies on plastic waste pollution, understanding the common sources and types of plastic pollutants, and highlighting methods for quantifying and categorising waste.
- **RO2: Determining plastic waste management practices in Struisbaai Harbour.** By reviewing existing literature on waste management practices, the researcher gained valuable insights into the strategies and practices currently applied within Struisbaai Harbour.
- **RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour.** Understanding public attitudes and behaviours toward plastic waste and its management requires knowledge of social and psychological factors influencing perceptions. The literature study offered a theoretical framework and previous research studies that guided the design of the survey questionnaire used in this study.
- **RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai.** The literature study provided an overview of existing governance and legislative measures at local, national, and international levels. By reviewing relevant policies and regulations, the current frameworks in Struisbaai were evaluated and improvements can be proposed based on best practices identified in the literature.

The literature study used keywords such as “marine pollution”, “plastic waste”, “waste management”, “waste management practices”, “Struisbaai”, and “Agulhas National Park”. To perform the literature study, scientific and academic publications, books, published theses, and dissertations, as well as other related sources, will be explored. Several online databases will be used to conduct the research, including Google Scholar, Elsevier, Science Direct, and Scopus, as well as the online and on-campus library of the North-West University at the Potchefstroom Campus.

3.4.2 Observations

Observations in research refer to the systematic process of recording, analysing, and interpreting behaviours, events, or phenomena as they naturally occur (Fix *et al.,* 2022). Compared to other qualitative methods, observation involves a lower level of control over the study environment, requiring the researcher to adapt to the context and interactions without influencing or manipulating unfolding events (Ciesielska *et al.,* 2018). This method proves especially useful in exploratory research where little is known about the subject, generating new insights and hypotheses. Yin (2014) identified two types of observations. Direct observations in research refer to the systematic process of recording and analysing behaviours, events, or conditions as they occur naturally in their typical settings without the interference of experimental conditions (Cleave, 2023). In participant observation, researchers immerse themselves into a specific setting to study a phenomena by directly interacting with participants (Ciesielska *et al.,* 2018). Direct field observations were used for the purpose of this study.

The study used an observational method to address RO1 and RO2. Observation allowed the researcher to study the extent and nature of plastic waste within the case study area, providing authentic and reliable data while capturing detailed information about the surrounding context and processes. The availability, location, and number of waste bins were also considered. Additionally, observation assisted the researcher in evaluating waste management practices in real-time, providing an indication of current waste management practices within the study area.

Sections 3.4.2.1 and 3.4.2.2 elaborate on the observational methods followed for plastic waste quantification and categorisation, and waste infrastructure, respectively.

3.4.2.1 Plastic waste quantification and categorisation

According to Oelofse *et al.* (2016), conducting waste composition characterisation studies serves several purposes, such as developing solid waste management plans, designing waste management facilities, informing alternative waste treatment technologies, and providing a standard for observing waste recycling and diversion goals. In this research, waste quantification and characterisation were used to:

- Identify the composition of waste generated and improperly discarded by people in the study area;
- Determine the composition of the waste streams in the study area;
- Measure the quantity and composition of all waste streams; and

- Determine the quantity and composition of plastic waste to validate self-reported data from observations.

This study was conducted during South Africa's summer season, which experiences an increased number of tourists entering the country (Department of Tourism, 2022). Waste quantification and categorisation took place over a period of 9 days, on 19, 20, 21, 22, 27, 28 and 29 December 2023, as well as on 1 and 2 January 2024. Due to its location and various activities, Struisbaai has become a popular destination for local as well as international tourists. Struisbaai has high tourism and recreational activity throughout the year, with a significant surge during the December holidays. The data collection time frame and dates were selected based on the influx of tourists into the area over the Christmas holiday season and the celebration of New Year, as the increased number of tourists provided an opportunity for an increased number of potential respondents (compared to out of season).

The researcher used direct field observations to collect data on all types of visible waste (plastic, glass, metal, paper, rubber, fishing gear, and others). The researcher did not collect any food waste or other organic waste materials (plant/animal materials, such as dead fish or animal faeces). The sampling area included the wooden promenade to both sides of the harbour, as well as the harbour and jetty area of Struisbaai.

The waste items were collected in garbage bags and then taken to a secure area for sorting and quantification (Figure 3-4). Plastic waste was specifically separated from the non-plastic waste streams and sorted into different categories according to the type (single-use plastics, packaging material, etc.), to determine the amount of plastic waste (also relative to other waste types) in the study area. Waste items were separated into the following categories:

- Plastic waste (soft drink bottles, water bottles, plastic bags, plastic spoons, food containers, candy wrappers);
- Glass waste (beer bottles, wine bottles, champagne bottles);
- Paper and cardboard waste (ice cream cone holders, paper plates, takeaway cartons, cigarette packets, tissues, wet wipes);
- Metal waste (drinking cans, foil, bottle caps, fishhooks);
- Textiles and rope (clothes, rope); and
- Wood.

Each individual piece of waste was counted and categorised into different waste categories. Thereafter, Microsoft Excel was used to capture the data for further analysis and to provide comparisons in terms of the types of waste gathered per day and the amount of waste gathered per day (City of Cape Town, 2018). Daily accumulation rates were determined using the data from the daily sampling results. After quantification and categorisation, the waste was placed back into garbage bags and transported to the drop-off zone in Struisbaai.

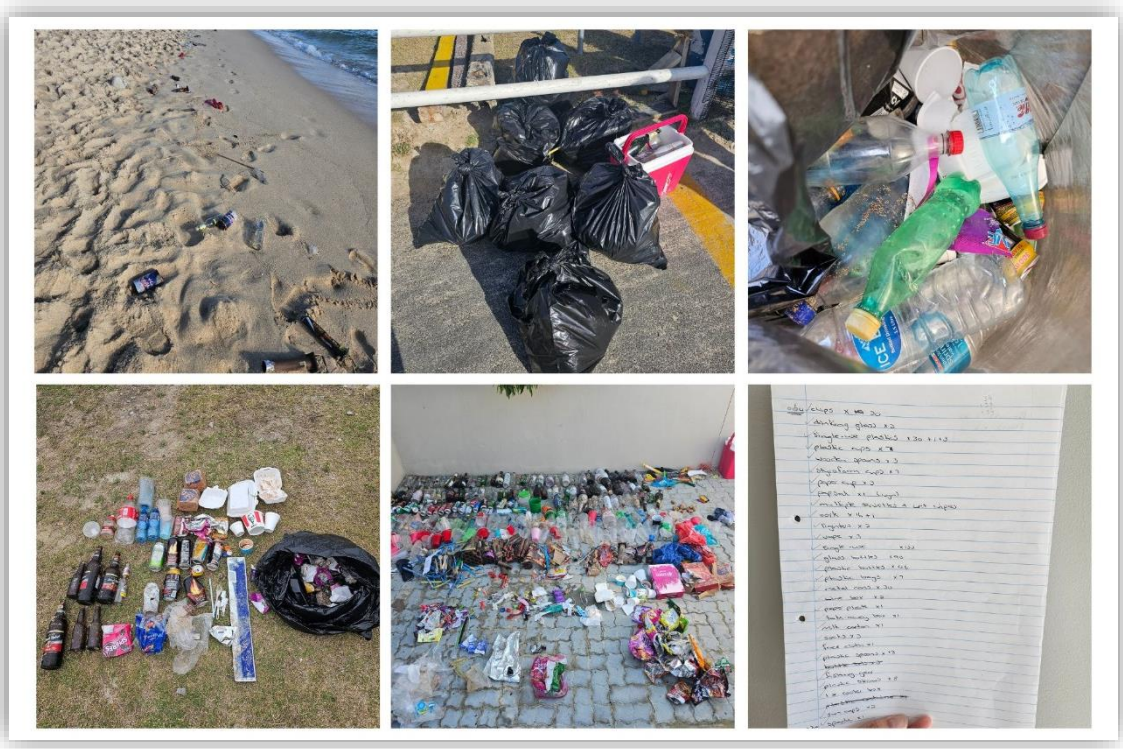


Figure 3-4: Waste collection, sorting, and quantification. (Source: Author's photos).

3.4.2.2 Waste management infrastructure

The researcher used direct field observations to collect data on the current waste management infrastructure in the study area. Proper waste infrastructure in coastal areas is vital to prevent waste from entering marine environments and implementing adequate waste infrastructure can contribute to a healthy ecosystem and a good social and economic environment for the community (Herdiansyah *et al.,* 2021).

The researcher examined waste infrastructure within the research area, including waste disposal bins (trash cans), recycling bins, and skips. The following criteria were noted during the direct field observations:

- Physical condition and functionality of bins and/or skips (good condition, broken);

- Covering of bins and/or skips (functioning lids, broken lids, no lids);
- Capacity of bins (sufficient capacity, overflowing);
- Accessibility of bins (easily accessible by the public, inaccessible);
- Placement of bins (relative to areas that it can pollute, i.e. close to the ocean);
- Distance between the bins;
- Presence of signage or instructions for proper disposal and/or recycling;
- Frequency of waste collection from bins and/or skips;
- Condition and cleanliness of the area surrounding bins and/or skips.

The observations were supported through photographic evidence to supplement the data gathered (Dzawanda & Moyo, 2022). The researcher recorded the GPS coordinates of each bin, documenting the exact location and condition of the waste infrastructure. This provided a comprehensive understanding of the waste management system in the research area.

3.4.3 Survey questionnaires

RO3 focused on understanding public perceptions of plastic waste and waste management practices within the study area. This objective aimed to gather insights into how the public (residents and tourists) perceive the issue of plastic waste and their attitudes towards existing waste management practices. By engaging with the community through survey questionnaires with open-ended and closed-ended questions, the researcher attempted to evaluate the level of awareness and concern about plastic pollution among different demographic groups. The study explored factors such as the public's perceptions of waste management systems, their recycling habits, plastic consumption, and their views on the effectiveness of current waste management strategies. It also aimed to identify any barriers to proper waste disposal and recycling, such as lack of infrastructure, inadequate information, or behavioural tendencies. Additionally, RO3 investigated the public's willingness to adopt more sustainable practices and reducing plastic waste consumption.

3.4.3.1 Developing and piloting the survey questionnaire

The survey questionnaire was prepared based on existing research on plastic waste and plastic pollution (Areia *et al.,* 2023; Bettencourt *et al.,* 2023; Essuman, 2017; Hartley *et al.,* 2018; Herdiansyah *et al.,* 2021; and van Oosterhout *et al.,* 2022) and the questions were adapted to be suitable and appropriate to the research scope. The survey questionnaire was prepared in English and is included as **Annexure A**.

The survey questionnaire was developed with various types of questions, including multiple-choice, Likert scale, and open-ended questions (See Table 3-2).

Table 3-2: Types of questions used for the development of the survey questionnaire (Source: Adapted from Botma *et al.,* 2010:136; Dörnyei, 2003).

<table>
<tr><th>Type of question</th><th>Response set that must be developed with pre-coding</th></tr>
<tr><td>Multiple choice</td><td>Criteria: three to seven response options are offered.
Age: 18-25 ☐
26-35 ☐
36-45 ☐
46-55 ☐
56-65 ☐
Older than 65 ☐
Important:
• Do not give too many choices
• Alternatives must represent all possibilities</td></tr>
<tr><td>Open-ended</td><td>Criteria: Invites a response without giving any options.
“In your opinion, what are the opportunities for plastic…”</td></tr>
<tr><td>Likert scale</td><td>Criteria: These consist of a stimulus statement which people respond to by indicating how much (or little) they agree with it.

“I think plastic waste is a major issue affecting the natural environment in and around Struisbaai”.

<table><tr><th>Strongly disagree</th><th>Disagree</th><th>Neutral</th><th>Agree</th><th>Strongly agree</th></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table></td></tr>
</table>

The questionnaire was divided into four different sections, with each section targeting a different subject to meet the requirements of the research objectives (**Annexure A**).

The survey questionnaire started with background information on the study, the researcher's ethics number, a disclaimer that no personal information will be used in the study and required the participant's consent prior to the commencement of the questionnaire.

Section 1 required the participants to complete basic socio-demographic information, so that the researcher could evaluate the characteristics of the population. The socio-demographic profile included questions such as age, gender, country of origin, the reason for visiting Struisbaai, how often the participant has visited Struisbaai, and how often the participant goes down to the harbour and walks along the promenade. This information was gathered to determine the representative nature of the survey participants and was not used in further analysis.

Section 2 of the survey questionnaire gathered information on the participants' views and opinions of plastic waste in the study area, Struisbaai Harbour. The participants were required to indicate their three top choices for each of the questions posed.

Section 3 of the survey questionnaire aimed to assess participants' perceptions of plastic waste in Struisbaai Harbour. This was achieved through a set of predetermined statements rated by participants on a five-point Likert scale, ranging from strong agreement (5), agreement (4), neutral (3), disagreement (2), to strong disagreement (1).

Section 4 of the survey questionnaire consisted of open-ended questions designed to evaluate the participants' perceptions on plastic waste and waste management practices in the study area. Additionally, it aimed to uncover any existing waste management strategies unknown to the researcher and to gather suggestions and recommendations for improvement from different viewpoints.

Before distributing the survey questionnaire, a pilot survey was conducted to test the clarity of the survey and gather feedback for refinement. A pilot survey can be defined as a '*small study to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study'* (Hassan *et al.,* 2006:70). The pilot survey is a very important part of the research project that enables the researcher to eliminate any potential problems that might be found within the survey questionnaire before the questionnaire is distributed to a larger sample group (Hassan *et al.,* 2006). The pilot survey for this study involved distributing the survey questionnaire to a sample of ten people with varying backgrounds and settings. These individuals included locals, business managers, family members, friends, as well as peers at the North-West University. The survey questionnaire was distributed to determine whether the questionnaire's wording, grammar, types of questions, as well as structure were easy to read and understand by the sample group. A few recommendations were suggested to improve

the clarity of questions and eliminate duplication. The researcher made the necessary adjustments and refinements prior to beginning the data collection process.

3.4.3.2 Selection of research participants

The research aimed to engage a diverse group of public participants, including local community residents, as well as national and international tourists. Key stakeholder groups involved in the study included the tourism industry, guesthouse owners, residents, local businesses, and holidaymakers. Although groups such as the tourism industry and local businesses were not directly targeted, the selected sample provided a broad and representative perspective on public perceptions regarding plastic waste and waste management practices in Struisbaai Harbour. Expanding the survey in future research to include these stakeholder groups could provide more industry-specific insights, enhancing the understanding of how different sectors contribute to or are affected by waste management practices.

Participants were selected through non-probability, convenience sampling and based on their willingness to take part in the study. Convenience sampling, also known as accidental sampling, is a non-probability sampling technique where the researcher selects subjects based on their availability, accessibility, willingness to participate, and geographical proximity to the case study area (Etikan *et al.,* 2016). The objective was to maximise participant involvement in the survey questionnaire to ensure a diverse representation of perceptions regarding plastic waste and waste management practices in Struisbaai Harbour.

The researcher was unable to calculate the target survey population due to the significant fluctuations in tourist numbers caused by the COVID-19 pandemic travel restrictions (Western Cape Government, 2023). Tourism in Struisbaai experienced a sharp decline from 2020 to 2022 and only began to recover in 2023. Consequently, the researcher based the target survey population on Dörnyei's (2007) recommendations. Dörnyei suggests that, for descriptive population studies, between 1% and 10% of the population should be sampled, with a minimum of 100 participants as a general guideline. To allow for sufficient participants for reasonable statistical analysis, the targeted survey population for this study was 150 participants.

3.4.3.3 Distributing the survey questionnaire

Distribution of the survey questionnaire took place over a period of 28 days and the researcher started distributing the questionnaires on 18 December 2023 until 15 January 2024. One other individual (a research assistant) was trained to assist the researcher with distributing the survey questionnaire. The researcher administered the survey by combining two delivery methods:

pencil-and-paper and online. This combination of methods was used to increase the response rate to the survey (Young, 2015).

The approach involved the research team approaching individuals and groups in the harbour, wooden promenade, and on the beach, as well as engaging with them face-to-face. The research team introduced themselves, provided background information to the study and the questionnaire, and asked the individuals and groups whether they would like to participate. When consent was given, the research team provided the participant(s) with a questionnaire. The research team had a total of nine clipboards with the questionnaire attached. The research team handed out the nine clipboards and waited for the participant(s) to finish with the questionnaire before approaching the participant(s) to retrieve the clipboards and the completed questionnaires.

The survey questionnaire was also distributed to various small businesses, restaurants, guesthouses, and coffee shops, although the research team found that face-to-face interaction with potential participants was the most effective. The researcher created an online survey on Google Forms and distributed flyers and business cards with a quick response (QR) code linked to the survey questionnaire. Additionally, the researcher created a WhatsApp link to share the survey questionnaire if respondents preferred this option.

At the end of the data collection, 204 hard copy survey questionnaires were completed, along with 17 online questionnaires, totalling 221 responses. Among these, 11 were deemed incomplete and were therefore excluded from the study, leaving a final count of 211 questionnaires used for analysis. This exceeded the targeted 150 participants.

3.4.4 Document review

Document review is a qualitative research method that involves the systematic examination and interpretation of various types of documents, both electronic and printed, to uncover insights into the research topic (Bowen, 2009). It uses existing records, reports, and studies, offering historical context and trends over time (Dalglish *et al.,* 2020). Document and literature review formed a significant part of this study, especially in reviewing waste management documents and legislative frameworks for the waste management practices found within the case study area.

When developing other data collection tools for evaluation, reviewing existing documents can provide valuable insights (CDC, 2018). By thoroughly understanding the topic or theme being evaluated, it becomes easier to better formulate questions for interviews and questionnaires and develop an effective observation guide. By reviewing documentation on waste management practices in Struisbaai, the researcher was able to determine whether current waste management practices in the study area were effective and comprehensive. The researcher also determined

though document review whether compliance to current waste management practices was adhered to and identified any gaps or inconsistencies (DCW, 2024).

The researcher reviewed documents such as reports, policy papers, records, websites, waste management plans, government notices, legislation, journals, and any other applicable sources for this study. Documents were selected based on their relevance and credibility to this research study. The documents were collected through several online databases, such as Google Scholar, Research Gate, Elsevier, and Science Direct. Other methods included informal correspondence with the manager of CAM and field rangers from De Mond Nature Reserve, who provided the researcher with relevant documents. Specific data points relevant to the research questions were extracted from the documents and recorded by the researcher. The findings from the document review were integrated with data from the survey questionnaires to provide a comprehensive analysis.

3.5 Data analysis

According to Dawit (2020), data analysis involves examining data to identify patterns and convert information into meaningful insights that can be understood either qualitatively or quantitatively. It also involves breaking down complex factors into simpler components and reorganising them for interpretation. According to Kothari (2004), it includes comparing outcomes across different groups and assessing whether research goals are met. Regardless of whether the data is qualitative or quantitative, analysis aims to describe, summarise, identify relationships and differences between variables, and forecast outcomes. Data analysis for a mixed-method study involves using statistical analysis to evaluate and interpret data, as well as focusing on the interpretation of the content (Botma *et al.,* 2016).

The following sub-sections describe the analysis of data collected through the various data collection methods outlined in Section 3.4. The qualitative and quantitative data were analysed separately.

3.5.1 Analysis of data from observations

Since the observational data were collected from various sections of the study, it was analysed through multiple datasets. For RO1 and RO2, observations, waste categorisation, and document review were chosen as the data collection methods due to their complementary strengths in assessing the extent and nature of plastic waste pollution in Struisbaai Harbour. The observational data were divided into different subcategories, and each was analysed and is discussed in the following subsections.

3.5.1.1 Data on plastic waste characterisation

Quantitative data was gathered through a waste characterisation study to evaluate the composition, characteristics, and quantity of waste generated and improperly disposed of in the Struisbaai Harbour and promenade area. The analysis began with categorising and quantifying each piece of waste into specific waste streams. This data was then captured in Microsoft Excel, where it was analysed to determine daily waste quantities and types. Descriptive statistics and comparative analysis were used to summarise and compare the data, identifying trends and patterns.

3.5.1.2 Data on waste management infrastructure

The researcher did a direct field observation and noted where the bins are located and the distances between the bins. Data is described in narrative sections of text. No further statistical analysis was done.

3.5.2 Analysis of data from survey questionnaires

The researcher manually transcribed each hard copy survey questionnaire into Google Forms. Thereafter Microsoft Excel was used to capture the data. Frequency tables were used to analyse responses to Likert-scale questions. Graphs were also used to analyse individual discussions per question (see Annexure A, Sections 1, 2 and 3).

Section 4 of the survey questionnaire included open-ended questions to gather detailed data from participants. In qualitative research, data can be analysed using various established methods, including content analysis, thematic analysis, open coding, narrative analysis, discourse analysis, and phenomenological analysis (Humble & Mozelius, 2022). According to Braun and Clarke (2006), thematic analysis is a qualitative research method used for identifying, analysing, and reporting patterns (themes) within data, and can either be used inductively or deductively. Inductive thematic analysis generates codes directly from the data (Boyatzis, 1998), while deductive thematic analysis involves using predefined codes established before data collection (Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006). For the open-ended responses, an inductive thematic analysis was used since the identified patterns were strongly linked to the data itself (Braun & Clarke, 2006). To analyse the responses effectively, a coding system was developed (see Figure 3-5). Each response was reviewed and assigned a specific code based on identified themes and patterns. Responses that shared similarities with the predefined codes were categorised accordingly, ensuring consistent and systematic analysis. The coding system included the following categories:

CATEGORIES

CUI	Cleanup Initiative
CF	Contributing Factors
E	Education
F	Fines
GG	Go Green
HB	Human Behaviour
I	Incentives
ME	Marine Environment
P	Participants
WB	Waste Bins
WM	Waste Managment
NL	No Litter

SINGLE SUB - CATEGORIES

PL	**Plastic**
01	Plastic Use Recycle
02	More Bins
03	Bigger Bins
04	Recycle Bins
05	Waste Bins

SUB - CATEGORIES

B	**Bins**
01	No Bins
02	More Bins
03	Bigger Bins
04	Recycle Bins
05	Not enough waste bins
06	Vandalism of Dustbins
08	Overflowing Bins
CI	**Community Involvement**
01	Beach Cleanups
02	Cleanup Crew
03	Community Projects
04	Social Responsibility
05	Private Initiatives
06	Ignorance
07	Reward System
08	Work Opportunities
09	Plastic Alteratives
10	Recycling Projects
ED	**Education**
01	Awareness Campains
02	Education in Schools
03	Lack of Education
04	Social Media

MA	**Management**
01	Private Management
02	Better Management
03	Management
GO	**Governance**
01	Municipal
02	Corporate
03	Induvidual
04	Influx or Tourist
05	Local Police
06	Regular emptying of bins

Figure 3-5: Code used in analysing the responses of Section 4 of the questionnaire. (Source: Author's own compilation).

3.5.3 Analysis of data from document review

For this study, the researcher reviewed documents such as reports, policy papers, records, websites, waste management plans, government notices, legislation, journals, and any other applicable sources. Specific data points relevant to the research questions were extracted from the documents and recorded by the researcher (See Section 3.4.4.). The findings were integrated with data from the survey questionnaires to provide a comprehensive analysis. The researcher identified recurring themes, patterns, and trends across the documents, summarised the key findings, and analysed its relationship to the research questions (Bowen, 2009). The findings were then compared across different documents to identify similarities and differences.

3.6 Ethical considerations

In conducting this research, ethical considerations were needed as the study involved humans to evaluate their perceptions of plastic waste and current waste management practices in Struisbaai Harbour. The research proposal was submitted to the North-West University (NWU) Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC) to assess potential risks associated with the methodology approach. Following a thorough evaluation, the Committee approved the study with minimal risk, and ethical clearance was granted under reference number NWU-01260-23-A9. This clearance ensures that the study adheres to ethical guidelines and safeguards the well-being and rights of participants involved in the research process.

Throughout the study, the following ethical considerations were carefully observed and adhered to:

- Participation in the study was voluntary and participants were given the autonomy to make informed decisions regarding their involvement, with the assurance that their participation would remain anonymous. No sensitive information was gathered.
- Prior to completing the survey questionnaire, participants were required to provide informed consent, and they retained the right to withdraw their consent at any point during the survey questionnaire.
- Participants were required to be 18 years of age or older to participate and vulnerable groups were not included in the study. The study involved a population of international and national tourists, as well as local community residents. Additionally, participants did not receive any incentives for their involvement.
- The records from this study were kept as confidential as possible.
- No individual identities have been used in any reports or publications resulting from the study.
- All transcripts have been given codes (e.g. Participant 1) and stored separately from any names or other direct identification of participants.

- The information obtained through the survey was used exclusively for this study and for no other purpose.

3.7 Methodological assumptions and limitations

Methodological assumptions are defined by Botma *et al.* (2010:287) as "*what the researcher believes good science practice is and may be implied or explicitly stated*". It is the underlying principles and beliefs that guide the design, conduct, and interpretation of a research study. These assumptions form the foundation upon which the research methodology is built, and influence various aspects of the research process, including the choice of research methods, data collection techniques, and data analysis procedures.

Assumptions related to this research included:

- All questionnaires distributed to potential participants were expected to be returned to the researcher.
- It was assumed that participants would answer all questions completely and to the best of their ability.
- Honest and truthful responses were anticipated from all participants, ensuring the integrity of the data collected.
- It was assumed that participants had a thorough understanding of the questions, enabling them to provide accurate and meaningful responses.

Methodological limitations are the constraints and weaknesses in a research study's design, methods, or approach that impact the validity, reliability, generalisability, and overall quality of the results (Viera, 2023). These limitations are often unavoidable and beyond the control of the researcher but should be acknowledged to provide a transparent understanding of the study's scope and its potential impact on the findings (Viera, 2023).

The limitations of the research included:

- Despite the researcher specifically choosing the peak holiday season to increase the number of potential participants and tourists, some respondents may have been less willing to participate in research during this time (preferring to be undisturbed during their leisure time).
- Despite the researcher's data collection efforts, a clean-up team also cleaned the promenade and harbour area every other day, complicating waste quantification.
- The geographical scope of the study area was also a limitation encountered. Since the survey took 10 to 15 minutes to complete, it was easier to target people sitting on the beach or lounging around the harbour. This made it difficult to approach individuals walking on the promenade, narrowing the population sample.
- Eleven (11) questionnaires were deemed incomplete and were excluded from the study.

- Communication problems between authorities and the researcher prolonged the research process and limited the information made available to the researcher. Due to these issues, it was difficult to determine whether legislative documents that were requested by the researcher (such as an integrated Waste Management Plan) were withheld or did not exist.

- There was no communication about the schedule of the clean-up crew. Therefore, the researcher did not know when they had already gone to pick up litter and the waste collection data could have been influenced by this.

3.8 Chapter summary

Chapter 3 outlined the methodology used in this study, which adopted a mixed-method approach combining both qualitative and quantitative research methodologies. The researcher actively engaged in data collection through semi-structured survey questionnaires, gaining insight into participants' perceptions on plastic waste management within Struisbaai Harbour. Additionally, observation was used to quantify and determine the extent of plastic waste found in the harbour and promenade area. This study followed a case study approach, using non-probability convenience sampling to select participants. Survey questionnaires served as the primary sampling method, supplemented by document analysis and observational techniques. The following chapter presents the results and discussion of the data collected as outlined in Chapter 3, providing a detailed analysis of the findings.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This study aimed to explore plastic waste and related waste management practices surrounding the Agulhas National Park with the case study of Struisbaai Harbour. This chapter discusses the results of the research. As detailed in Chapter 3, data was collected using non-probability sampling, specifically convenience sampling, with survey questionnaires as the sampling method, as well as document analysis and observations. The chapter is divided into four sub-sections, with Section 4.2 providing the socio-demographic profile of survey participants, Sections 4.3 to 4.6 outlining the results related to the four research objectives (RO1 to RO4), and Section 4.7 providing a chapter summary.

4.2 Socio-demographic profile of survey participants

Data collection involved distributing survey questionnaires to a sample population in Struisbaai, specifically targeting individuals (residents and tourists) and businesses in and around the harbour area. The targeted sample size was 150 participants. A total of 211 survey questionnaires were deemed to be valid and complete. The basic socio-demographic information of the 211 survey participants is provided in Table 4-1.

Table 4-1: Socio-demographic profile of the participants (n=211).

Socio-demographic profile	Number	% of sample
Age		
18-25	43	20%
26-35	32	15%
36-45	31	15%
46-55	46	22%
56-65	36	17%
Older than 65	23	11%
Gender		
Male	102	48.5%
Female	106	50.0%
Other	3	1.5%
Country of origin		
South Africa	198	94%
Germany	3	1%
Zimbabwe	2	1%
United Kingdom	1	1%
Did not specify	7	4%
Reason for current visit to Struisbaai		

Socio-demographic profile	Number	% of sample
Resident	62	29%
Work	6	3%
Holiday	141	67%
Education	0	0%
Other	2	1%
How often the participant has visited Struisbaai		
First-time visitor	22	10%
2nd – 5th time	29	14%
6th – 10th time	13	6%
More than 10 times	82	39%
Resident	65	31%
How often the participant goes to the harbour and walks along the promenade		
First-time visitor	24	11%
Daily	70	33%
Weekly	51	24%
Monthly	31	15%
Rarely	35	17%

As shown in Table 4.1, the participants were 48.5% male, 50.0% female, and 1.5% who did not specify their gender. The gender profile of participants in this research corresponds with a prior study conducted by Essuman (2017) within a coastal region. According to Smith (2008) females are typically more inclined to participate in survey questionnaires.

Individuals under the age of 18 were intentionally excluded from the research. The participants' ages ranged from 18 to over 65 years, with the largest group being ages 46 to 55 (22%), followed by ages 18 to 25 (20%). Approximately 30% of the respondents were between the ages of 26 and 45, while 28% were aged 56 or older.

The participants originated from several countries, predominantly South Africa (93.8%), with smaller representations from Germany (1.4%), Zimbabwe (1.0%), the UK (0.5%), and 3.3% who did not specify their country of origin.

Most participants were either on holiday in Struisbaai (66.8%) or were permanent residents (29.9%), with a small percentage visiting Struisbaai for work (3.0%).

Most of the participants have visited Struisbaai more than ten times (38.9%), while 10% of respondents were first-time visitors to the area. Additionally, most participants reported going to the harbour and walking along the promenade daily (33.6%) or weekly (24.0%).

4.3 Results related to RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour

The results were obtained through observations, which included waste collection, waste quantification and categorisation (see Section 3.4.2.1).

4.3.1 Waste quantification and categorisation results

This section presents the results from the waste collection, quantification, and categorisation study, detailing the number and type of each waste particle collected over the data collection period and this is outlined in Table 4-2.

The Struisbaai harbour and wooden promenade area surrounding the harbour were the focus for this part of the study. The aim was to determine the extent (quantities and nature) of plastic waste pollution by counting and categorising the waste found within the study area.

The aim of the waste quantification and categorisation study was to support the self-reported data in understanding the extent of plastic waste pollution. Waste quantification and categorisation took place over a period of nine days, on 19, 20, 21, 22, 27, 28, and 29 of December 2023, as well as on 1 and 2 January 2024.

4.3.1.1 Waste categorisation results

All waste types were included in the waste categorisation, with plastic waste being separately categorised and quantified according to different categories, as suggested by Cheshire and Adler (2009). In certain instances, waste items were too difficult to count individually and were therefore recorded as “multiple”, for example: wet wipes, cigarette buds, ice cream cone holders, etc. The waste categories have been combined to simplify comparisons for the waste characterisation and quantification and is presented in Table 4-2 (see Annexure B for the detailed breakdown of the waste categorisation and counting) with the results organised by the data collection dates. Daily accumulation rates were determined using the data from the daily sampling results.

Figure 4-1 displays the percentage of plastic waste collected per collection day. This was achieved by calculating the total waste (number of items) collected per day and dividing the total by the amount of plastic waste collected per day and expressed as a percentage. Figure 4-1 summarises the totals that can be seen in the last row of Table 4-2.

Table 4-2: Waste categorisation results.

Waste type	19/12/2023	20/12/2023	21/12/2023	22/12/2023	27/12/2023	28/12/2023	29/12/2023	01/01/2024	01/02/2024
Plastic waste (plastic bottles, lids, cups, spoons, food containers, straws, sweet wrappers)	24	25	26	49	28	60	128	311	145
Glass waste (beer bottles, champagne bottles)	9	7	4	13	11	10	6	92	29
Paper waste (cigarette packets, sheets of paper, fast food packaging, paper plates)	9	4	10	6	8	7	17	33	26
Metal waste (cans, lids, foil, chips packets)	15	19	6	29	28	15	39	52	96
Textiles and rope (clothes, rope)	2		1				4	4	4
Wood				1				20	3
Polystyrene (ice cream cups, fast food packaging)	4	9		6	13	10	16	8	34
Total waste count	63	64	47	104	88	102	210	520	337
Plastic as % of total waste	38%	39%	55%	47%	32%	59%	61%	60%	43%

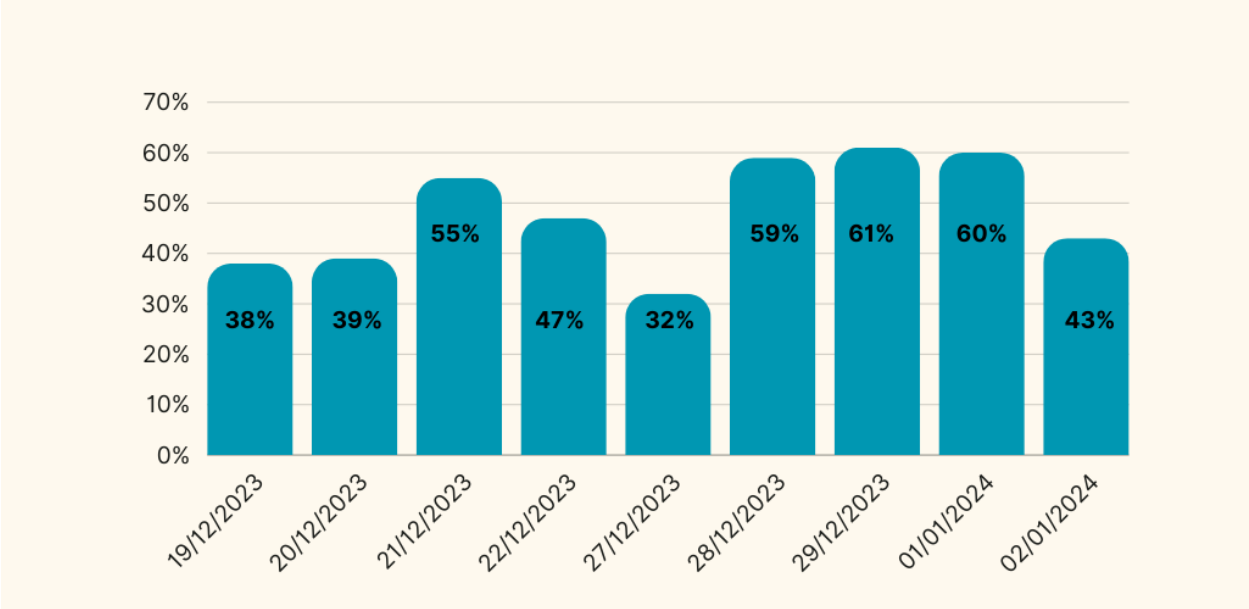


Figure 4-1: The total amount of plastic waste collected per day as a percentage.

DEC		BREDASDORP	NAPIER	WAENHUISKRANS / ARNISTON	STRUISBAAI NORTH	STRUISBAAI	L'AGULHAS	SUIDERSTRAND	PROTEM & KLIPDALE
2	TUES	Bredasdorp High School Area	Businesses	Collection		Collection	Collection		
3	WED	Bredasdorp Primary School Area			Collection			Collection	Collection
4	THURS	Zwelitsha, Selfbou, Kleinbegin & Bergsig		Businesses & Recycling	Businesses	Businesses	Businesses		
5	FRI	Recycling	Collection & Recycling		Recycling	Recycling	Recycling	Recycling	
6	SAT	Businesses		Businesses					

Figure 4-2: Cape Agulhas Municipality refuse collection dates 1-6 January 2024 (CAM, 2023c).

It is evident that the amount of waste generated, including plastic waste, increased significantly as the New Year approached, as can be seen in Figure 4-1. On December 19, 2023, there were 9 glass waste items, 63 plastic waste items, and 15 metal waste items. By 27 December 2023, these numbers had risen to 11 glass waste items, 102 plastic waste items, and 28 metal waste items. On 1 January 2024, the waste volume surged dramatically, with 92 glass waste items, 433 plastic waste items, and 52 metal waste items recorded. On 2 January 2024, the volume of glass and plastic waste began to decrease again, with 29 glass waste items, 339 plastic waste items recorded. Surprisingly, the amount of metal waste increased to 96 items.

Between 19 December 2023, and 2 January 2024, waste collection data revealed significant insights. Figure 4-1 shows the percentage of plastic waste items found each day relative to the total waste collected. This percentage was calculated by dividing the number of plastic waste items by the total number of waste items.

On 19 December, 63 waste items were collected, with 24 (38%) being plastic. The next day, on 20 December, waste collection totalled 60 items, with 25 (39%) identified as plastic. A total of 52 waste items were gathered on 21 December, with half (26) being plastic. 22 December saw the collection of 104 waste items, with plastic comprising 49 of them (47%). On 27 December, the collection reached 102 waste items, including 28 plastic items (32%). The next day, 28 December, also had a collection of 102 waste items, but 60 (59%) were plastic. An increase occurred on 29 December, when 205 waste items were collected, with plastic items numbering 128 (61%). The highest collection was on 1 January 2024, with 433 waste items, 311 of which were plastic (60%). The following day, 2 January, 339 waste items were collected, with 145 (43%) being plastic. This data suggests an increase in the number of plastic products used and improperly discarded during the Christmas and New Year holiday period. However, it is important to acknowledge that these findings are based on a limited observation period of 9 days. While the results indicate a potential trend, more long-term observations would be necessary to accurately confirm and identify specific patterns of waste generation during peak tourist seasons. In total, 1 346 waste items were collected and, from that number, 796 were plastic waste items. This equates to 59% of the total waste items being plastic waste. A study conducted by Chitaka and von Blottnitz (2019) in Cape Town, South Africa, concluded that 94.5 to 98.9% of the waste collected was plastic. Another study in the Caribbean and Pacific coast of Colombia found that plastic waste accounted for 30% to 77% of the total waste (Garcés-Ordóñez *et al.,* 2020a). While this study reported a slightly lower percentage of plastic waste in comparison with those of Chitaka and von Blottnitz (2019) and Garcés-Ordóñez *et al.* (2020a), the plastic waste still constituted more than half of the collected waste in both studies.

Among all waste items made from plastic, sweet wrappers (such as Fizzers) were the most frequently collected with a total of 225 items. They were also the most collected waste item across all waste categories. Plastic drinking bottles were the second most collected plastic waste item, with 149 items collected. Chip packets were the second most collected waste item of all the waste categories, totalling 191, while glass bottles were the third most collected waste item, with 181 items (Annexure B). This correlates with a study by Chitaka and von Blottnitz (2019) that also found single-use plastics such as sweet wrappers, snack packets such as chips packets, and plastic bottles to be the most prevalent.

There are several reasons for the dramatic increase in waste generation in the Struisbaai Harbour and promenade area. Struisbaai is a popular tourist destination and was rewarded with the Blue Flag Status (CAM, 2021). Over the New Year period, there is a significant influx of tourists into Struisbaai, as is common in other tourist destinations during specific peak seasons such as beaches in the Colombian Caribbean (Garcés-Ordóñez *et al.,* 2020a). The study recorded a 34% increase in the amount of waste generated and improperly discarded (litter) between 19 December 2023 and 1 January 2024. These findings are similar to those of Garcés-Ordóñez *et al.* (2020a), who found that, with the increase of tourists during high seasons, the macro litter pollution also increased. A study conducted along the Transkei coast of South Africa (Madzena & Lasiak, 1997) found that popular tourist beaches have the most diverse range of waste types.

Struisbaai is a low-density permanent population tourist destination that experiences seasonal tourism, creating an influx of visitors. The town lacks sufficient waste management infrastructure to handle the surge in tourists or the large amounts of waste generated during peak seasons. These findings align with the research by Muñoz and Navia (2015), which highlights the importance of implementing high-standard waste management systems in tourist areas to address the increased waste generation. While Muñoz and Navia did not specifically mention seasonal tourist influxes, their emphasis on tailored waste management programmes is directly relevant to the challenges Struisbaai faces during its tourism peaks.

Struisbaai is known for its New Year's Eve firework shows, held at the harbour and on Duiker Street Beach. Many people gather at the beach and harbour to enjoy the fireworks, often bringing food, drinks, and fireworks themselves, but not always disposing of waste properly. Since 1 January is a public holiday, the authorities responsible for emptying bins in the harbour and promenade, CAM and the DFFE, do not conduct their usual clean-up duties (See Figure 4-2). Starting in 2024, some individuals have dubbed 2 January as "Second New Years", effectively making it another public holiday. This has led to another surge in local tourism. With bins already overflowing, the increased festivities resulted in more waste being generated and left scattered along the beach, harbour, and promenade areas.

There has been limited research conducted on the accumulation, characterisation, and quantification of plastic waste on beaches in small coastal towns in the Western Cape, South Africa. There are similar studies that focused on plastic waste in coastal areas, such as the following: Lamprecht, (2013); Jayasiri *et al.* (2013); Chitaka and von Blottnitz (2019); Garcés-Ordóñez *et al.* (2020a); and Dao *et al.* (2023). However, most of these are in an international context and do not focus on small coastal towns. None of these studies provided comparative contexts for the purposes of discussing RO1.

4.4 Results related to RO2: Determining plastic waste management practices in Struisbaai Harbour

This section discusses plastic waste management practices implemented at Struisbaai Harbour and the wooden promenade. It also presented the results and findings from on-site observations conducted by the researcher, providing insights into the effectiveness and challenges of these practices.

4.4.1 Observation results

While most observations were conducted during the waste quantification and characterisation data collection period, the researcher also made observations before and after this period. The observations were conducted within Struisbaai Harbour and along the promenade on both sides of the harbour. Section 4.4.1 discusses waste management infrastructure, while section 4.4.2 discusses results from document review and informal correspondence.

4.4.1.1 Waste management infrastructure

The researcher observed that, within the study area, there were five waste bins located directly beside each other next to the office building operated by the DFFE. An additional fourteen bins were scattered throughout the area and along the wooden promenade. Of the nineteen waste bins situated in the study area, only one had a functioning lid. Another bin had a turnstile design, which complicates the disposal of larger waste items such as megaplastics and macroplastics, as it is only suitable for smaller waste like mesoplastics and microplastics. As can be seen in Figure 4-4, the rest of the seventeen waste bins were lidless. Two of the waste bins were broken and lying on their sides, making them unusable. Adjacent to the research area, there is a parking lot close to Duiker beach where the promenade ends. In this parking lot, there are fifteen waste bins distributed over an area of 5075 m^2 (where 5075 m^2 is equal to 300 m) (see Figure 4-3). Although all the bins had functioning lids, the openings are too small to properly dispose of larger waste items. The researcher tested and confirmed that a 2-litre Coke bottle can be disposed of

properly without needing to force it through the opening. However, items larger than a 2-litre bottle will not fit, as the opening is round and restrictive in size.

Proper waste infrastructure in coastal areas is vital to prevent waste from entering marine environments. Implementing effective waste systems in these areas is an essential solution for managing waste properly. This statement is supported by the research of Herdiansyah *et al.* (2021), who stipulated that the high amounts of waste generated in coastal areas are directly related to insufficient infrastructure. Implementing adequate waste infrastructure can contribute to a healthy ecosystem and a good social and economic environment for the community (Herdiansyah *et al.,* 2021).

Starting from the first waste bin situated at the beginning of the promenade, the researcher walked approximately 520m before reaching another waste bin. Various types of waste were found improperly discarded daily on the beach, promenade, and harbour area, indicating that the current placement, distribution, and design of waste bins are insufficient to meet the area's needs, particularly during peak tourist times when waste generation is significantly higher.

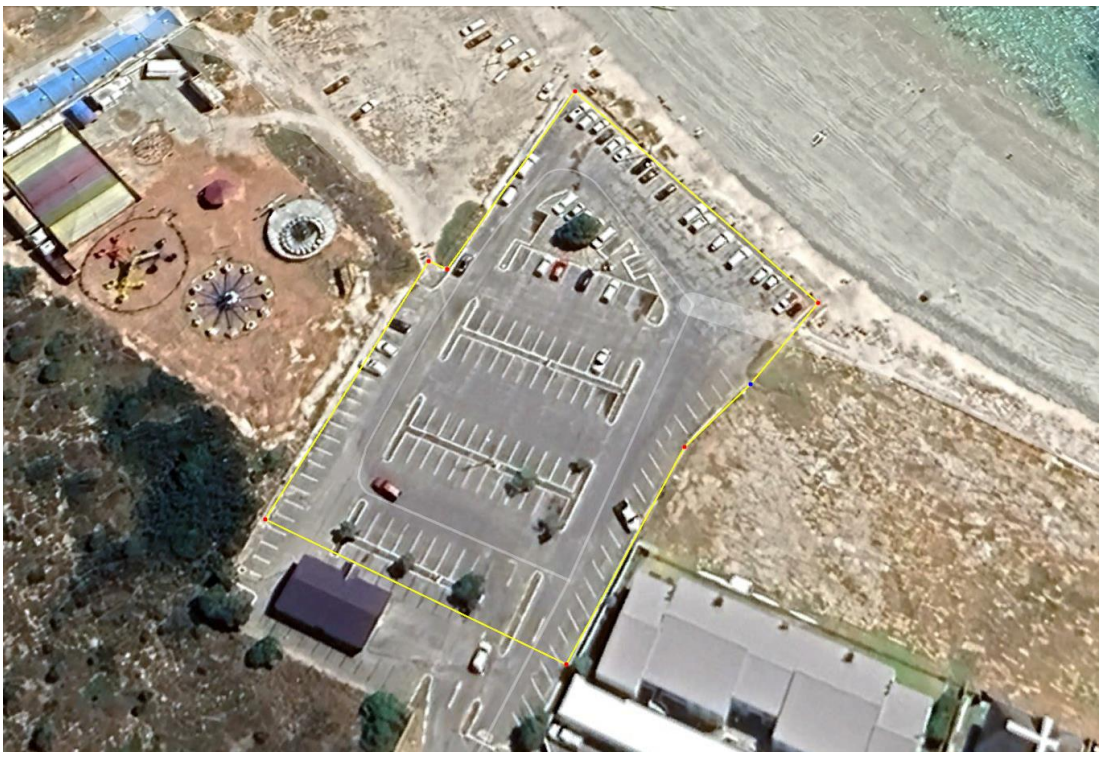


Figure 4-3: Distribution of waste bins in the parking lot at the end of the promenade at Duikers beach. The blue and red dots represent the polygon vertices used to demarcate the area, while the yellow line indicates the boundary within which the waste bins are located (Google Earth, 2024).

4.4.1.2 Littering

The researcher observed several waste items purposefully shoved into the cracks in the wood of the promenade, as well as discarded under the promenade and between the wooden planks, indicating a lack of education, awareness, or concerns about the negative impacts of plastic waste in marine environments. This type of behaviour is linked to intentional littering as noted by Van Doesum *et al.* (2021). Many people are unwilling to walk to the waste bins and instead leave their waste behind on the beach. A study by Schutz *et al.* (2013) showed that the availability and proximity of waste bins significantly influences whether people dispose of their litter properly. Improper disposal not only diminishes the aesthetic appeal of the area, as noted by Tudor and Williams (2003), but also creates significant environmental problems. Strong winds frequently carry improperly discarded waste into the ocean, exacerbating pollution. Additionally, seagulls contribute to the distribution of waste in Struisbaai by scavenging from open dustbins, which leads to further scattering of waste throughout the environment, as highlighted by Baggaley (2018). The harbour wall is a popular place for fishing, but there are no proper disposal bins for discarded fishing gear. Additionally, there is no separation or recycling bins for recyclable materials in or around the harbour and promenade.

During peak tourist season, the amount of waste accumulated within the research area is significantly higher than during the off-season, as supported by Garcés-Ordóñez *et al.* (2020b). It is evident that waste visibility increased as Christmas and New Year approached, with more waste appearing in and around bins, the harbour, and the promenade. This can be seen in Figure 4-5, with the photos taken on 1 and 2 January 2024. The waste primarily consisted of macro and mesoplastics, which are more visible to the human eye, along with some mega and microplastic particles.

Figure 4-4: **Lidless bins in Struisbaai Harbour and along the wooden promenade. (Source: Author's own photos).**

Figure 4-5: Increased waste visibility in the research area. (Source: Author's own photos).

4.4.2 Results from document review and informal correspondence

In Chapter 2, Section 2.10, the researcher provided a thorough background on the current plastic waste management and protected areas management in the Struisbaai area, which will not be repeated here. Through document review and analysis, it was determined that CAM and the DFFE are the two responsible parties to remove, collect, and sort waste in Struisbaai Harbour and the promenade area. However, as of the day of writing, there is little to no documentation available depicting the current waste management practices within Struisbaai Harbour and the surrounding promenade. Despite several efforts, the researcher has been unable to find detailed information regarding the waste management practice reports or documents specific to the Struisbaai Harbour area. This required the researcher to rely on observation, conversations with residents, and informal correspondence to determine these practices. Through informal correspondence and email communication, the researcher determined the following:

According to the CAM municipal waste manager, the waste management practices in Struisbaai are as follows (Linnert, 2024):

- CAM is responsible for weekly waste collection in the town as well as some parts of the wooden boardwalk in the harbour area.
- General waste collection occurs once a week on Mondays, with waste transported to the Bredasdorp landfill site using wheelie bins designated for household general waste only; green waste, construction waste, and hazardous waste are not permitted.
- Recyclable items are collected in clear bags every Thursday, with new bags provided upon collection of full ones, and the recyclables are sent to a contracted recycler in Bredasdorp for sorting and baling before being sent to Cape Town for further processing.
- Street sweeping happens once every second month, while litter picking is conducted twice a month in residential areas and once a week along the beach.
- Litter bins are emptied every Monday, Wednesday, and Friday.
- The Expanded Public Works Programme (EPWP) and Working for the Coast projects focus on beach area clean-up.
- All collected waste is transported to the Struisbaai Drop Off and then to the Bredasdorp landfill site.
- Stormwater drains are cleaned regularly to prevent blockages, and complaints in the harbour area, due to high tourist activity, are handled within a day of reporting.

- Struisbaai has a municipal waste drop-off area where waste is collected and taken to the Bredasdorp landfill site, a small town approximately 27 km inland from Struisbaai.
- CAM is responsible for collecting waste and recyclable materials from the harbour at least once a week.
- The waste is collected in the harbour and placed in collection bins. These bins are emptied twice a week, normally on Mondays and Fridays.
- CAM and the DFFE do clean-ups along the coast on both sides of the harbour.
- The DFFE has a clean-up crew regularly collecting and picking up waste in the other areas of the wooden promenade and the harbour area.
- CAM also has a clean-up crew who occasionally stands in for the DFFE when the DFFE's clean-up crew is unable to collect waste.
- The DFFE is mostly responsible for the clean-ups in the harbour and promenade area.
- CAM and the DFFE collaborate through special clean-up operations.
- The restaurant is privately owned and responsible for its own waste management.

The researcher had further informal correspondence with the manager of the harbour to understand the waste management practices in the area and to gather information about the clean-up schedules and bin emptying routines within the research zone. The researcher ascertained the following:

- According to the manager and other workers, a clean-up crew begins their clean-up duties every morning between 06:00 and 07:00.
- The DFFE is responsible for picking up waste in a certain area in Struisbaai Harbour and the promenade.
- The clean-up crew removes waste from bins and relocates the collected waste to waste bins situated in front of the DFFE office building.
- The clean-up crew removes any visible waste found in and around Struisbaai Harbour and the promenade.
- CAM is responsible for emptying the waste bins in front of the DFFE office building weekly.
- The DFFE attempts to recycle recyclable materials and separates them into different bags to be taken to a recycling facility.

However, during the nine days of observation, the researcher confirmed that the clean-up crew was not present in the harbour at that time. Furthermore, a local resident reported having to visit the DFFE offices to request a clean-up due to the unsightly accumulation of waste over several days. Despite multiple requests, the clean-up crew only responded after several days. This incident occurred before the researcher began data collection, and the researcher can

verify the resident's account. The researcher had other informal conversations with local residents who voiced their concerns on the lack of waste management infrastructure, waste removal, and the accumulation of waste in the research area. The local residents reported instances where waste doesn't get removed or cleaned from the area for several days. Through observation, the researcher was able to determine that litter bins weren't emptied every Monday, Wednesday, and Friday, but were only emptied once a week.

This resulted in bins overflowing and waste being improperly discarded beside them, as people attempted to dispose of their waste despite the lack of adequate bin capacity. This not only exacerbated littering but also diminished the aesthetic value of the area (see Figure 4-6), attracting pests and seagulls to the beach and increasing pollution in the surrounding marine environment. This discrepancy between reported practices and observed behaviour highlights significant gaps in the waste management operations in the area.

Figure 4-6: Overflowing bins in Struisbaai Harbour and along the wooden promenade. (Source: Author's own photos).

4.5 Results related to RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour

The results from exploring public perceptions of plastic waste and waste management practices were obtained through the analysis of the survey questionnaire (see Annexure A). The following subsections provided a detailed discussion of the results.

A total of 211 survey questionnaires were completed. The results of the survey were discussed in three different sections: Section 1 required the participants to complete basic socio-demographic information, so that the researcher could evaluate the characteristics of the population (see Section 4.2); Section 2 of the survey questionnaire gathered information on the participants' views and opinions on plastic waste in the study area (see Section 4.5.1.); Section 3 of the survey questionnaire aimed to assess participants' perceptions of plastic waste in Struisbaai Harbour (see Section 4.5.2); and Section 4 of the survey questionnaire consisted of open-ended questions designed to evaluate the participants' perceptions on plastic waste and waste management practices in the study area (see Section 4.5.3).

4.5.1 Perceptions of plastic waste in the Struisbaai area

Section 2 of the questionnaire (Annex A) determined the participants' opinions and perceptions of the types of waste, source of waste, behavioural changes, awareness, and most effective approach to reducing plastic waste in marine environments. Respondents were required to select their top three choices for all questions posed in Section 2. The results are discussed in Sections 4.5.1.1 to 4.5.1.7 below.

4.5.1.1 Perceived primary type of waste found in and around the Struisbaai harbour area

Question 1 required respondents to reflect on *"In your opinion, what is the primary type of waste commonly found in and around the Struisbaai harbour area?"* Respondents were required to select their top three responses, with the option to add their own responses under the category "other". Participants perceived plastic waste as the predominant waste type (92% of respondents), followed by paper and cardboard (54% of respondents), glass (53% of respondents) and metal waste (34% of respondents) (Figure 4-7). Only 25% of respondents believed organic waste to be a primary waste type and approximately 4% indicated that hazardous waste is a primary waste type.

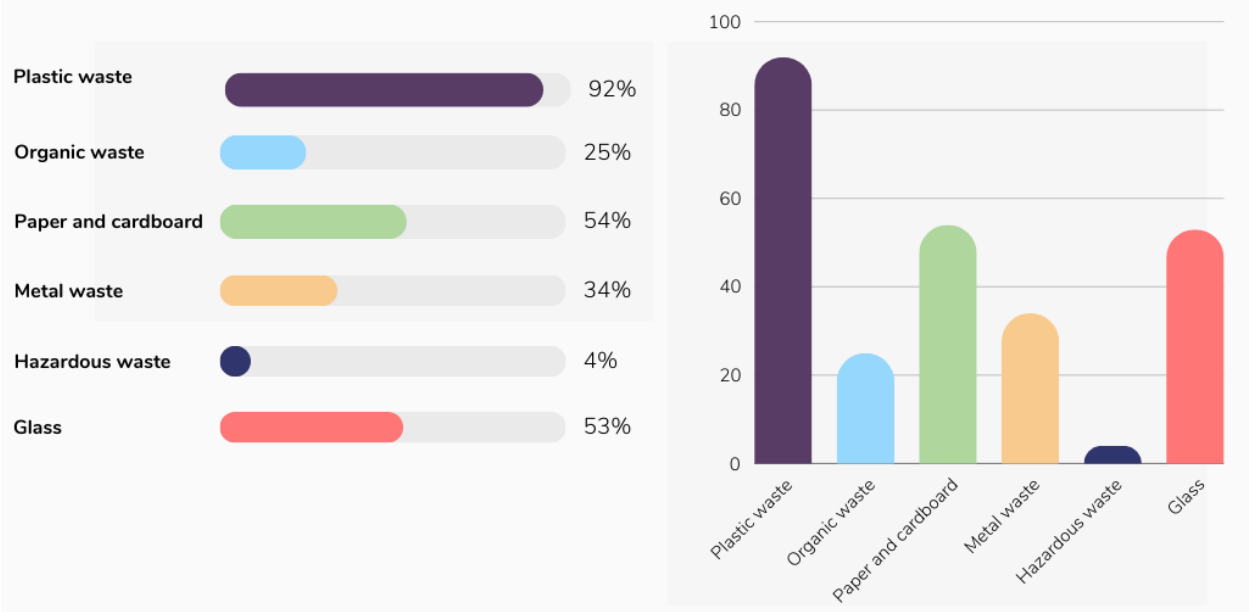


Figure 4-7: Primary type of waste in Struisbaai Harbour area as perceived by respondents.

Plastic, metal, and glass remained the three most prevalent waste types found within the harbour area, coinciding with the findings of Steyn (2022). Research has shown that 40 to 80% of macro-marine debris consists of plastic materials, mainly originating from food and beverage items such as bottles, caps, bags, straws, and polystyrene fragments (Andrady, 2011; Barnes *et al.,* 2009; and Bergmann *et al.,* 2015), corresponding to the findings of this research study. This also aligned with the results of a study by Chitaka and von Blottnitz (2019), who found that 94.5 to 98.9% of the waste collected was plastic. The perceived waste types (Figure 4-7) corresponded well with the actual waste types (as discussed in Section 4.3.1).

4.5.1.2 Perceived main sources of waste in the Struisbaai area

When asked about what respondents believed to be the main source of waste to the Struisbaai area (Question 2), the majority of respondents perceived beachgoers/tourists leaving waste behind (89% of respondents) as the main source, followed by littering from ships and boats (56% of respondents), insufficient waste management (46% of respondents), and windblown waste from other areas (47% of respondents) (Figure 4-8). Only 15% of the respondents believed household waste to be a major source of waste in the Struisbaai area (Figure 4-8).

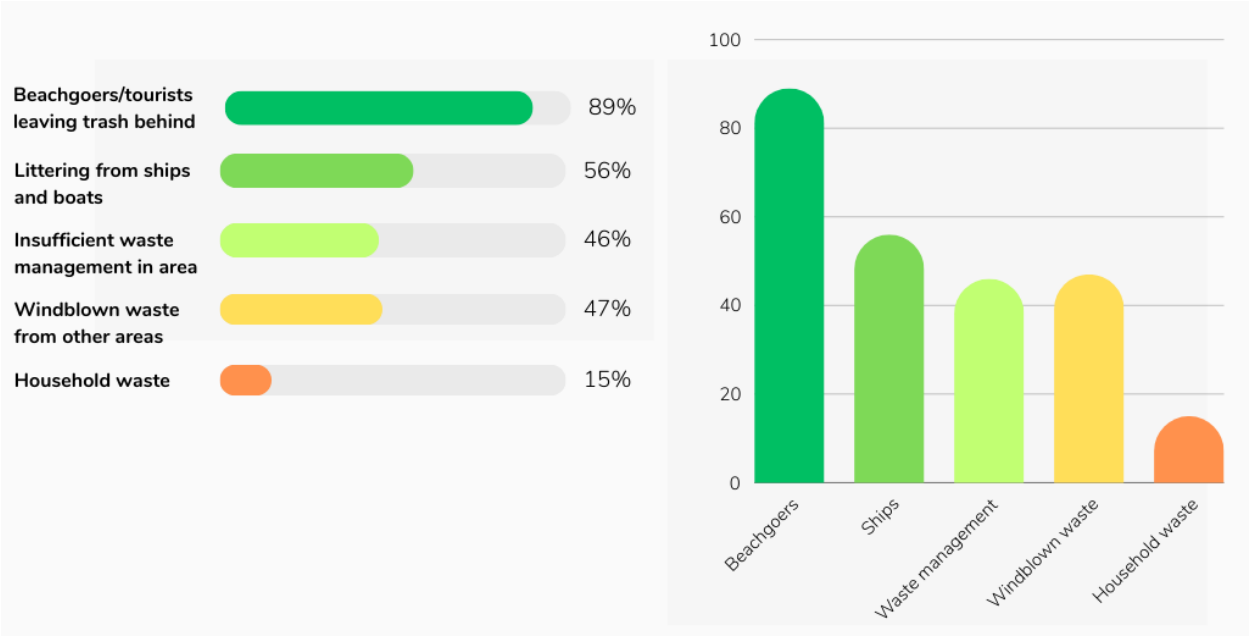


Figure 4-8: Main source of waste in Struisbaai Harbour as perceived by respondents.

In low-income countries, beach littering is particularly pronounced, with both tourists and local residents frequently leaving waste on the shores, as noted by Chitaka *et al.* (2023). This behaviour contributes to the accumulation of waste, including plastic, glass, and other non-biodegradable materials on beaches, as indicated by Tsagbey *et al.* (2010) and Lamprecht (2013). Following beachgoers, littering from ships and boats (56%) and windblown waste from other areas (47%) were also perceived as significant sources of waste in Struisbaai. This correlates with similar findings by Dąbrowska *et al.* (2021), who found that maritime transport is a direct source of waste and pollution entering the seas and oceans. Participants also pointed to insufficient waste management in the area (46%), which aligns with Verster and Bouwman (2020), who state that mismanagement of waste results in illegal dumping and littering into the environment.

Other sources of waste, each indicated by less than 1% of participants, included fishermen, water sports/angling, and plant-based waste, with UN Environment (2017b) and Ibabe *et al.* (2020) highlighting recreational fishing and boating as significant contributors to marine waste.

Less than 1% of participants reported not spending enough time in the area to observe waste (0.5%), not finding a lot of waste in the area (0.5%), or not specifying or answering (0.5%).

4.5.1.3 Perceived biggest challenges towards reducing plastic waste in the Struisbaai marine environment

Figure 4-9 provides an overview of the biggest challenges towards reducing plastic waste in the Struisbaai area, as perceived by respondents (Question 3). A lack of awareness and education was the most frequently selected challenge (75% of respondents), followed by convenience and availability of plastic products (67%), lack of governance and proper waste management (61%) and cost of alternatives to plastic (46%) (Figure 4-9).

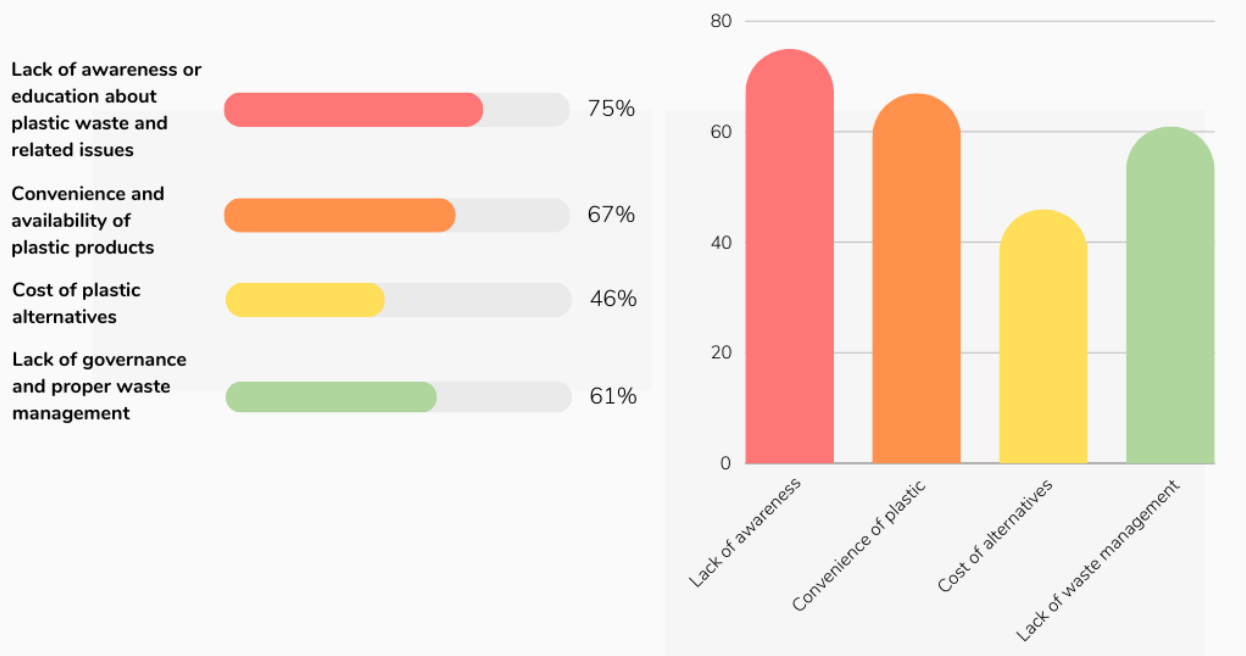


Figure 4-9: The biggest challenge towards reducing plastic waste in the Struisbaai marine environment as perceived by respondents.

The challenge of a lack of awareness and education perceived by 75% of participants correlates with the findings Kibria *et al.* (2023) and Debnath *et al.* (2023), who found that a lack of awareness and knowledge of waste disposal, rules, and regulations is one of the most influential barriers to reducing plastic waste. Convenience and availability of plastic products as a challenge is highlighted by Dilkes-Hoffman *et al.* (2019). Consumers typically link plastic with food packaging and convenience and, while many recognise plastic packaging waste as an environmental issue and wish to decrease their use of plastic, actual efforts to do so are uncommon. This is largely because avoiding and recycling plastic packaging clash with convenience, established consumer habits, and perceived responsibility, necessitating consumer knowledge and skills (Koutsimanis *et al.*, 2012). Furthermore, plastic is often favoured because it is more effective than alternative materials or less expensive to produce.

According to participant responses, 61% selected the lack of governance and proper waste management as a challenge to plastic pollution. Existing research supports this finding and highlights several key challenges in reducing plastic waste, including inadequate environmental policies, legislation, and regulations (Batista *et al.,* 2021), insufficient systematic waste collection (Pollans, 2017), and poor management practices (Kibria *et al.*, 2023).

Additionally, the following challenges were also indicated by less than 1% of the participants: Lack of rubbish bins with lids that keep rubbish from blowing out again and human behaviour (i.e. *South Africans have a culture of polluting; people don't care about the environment; people who litter don't have any self-respect or respect for their surroundings*). The lack of lids on rubbish bins was observed during the observation part of the study (See Section 4.4.1.1).

Another 1% of the participants did not answer the question or indicated that their visit was too short to answer.

4.5.1.4 Changes that respondents would be willing to make to reduce plastic waste

Question 4 required respondents to select their top three responses to *"What changes would you be willing to make to reduce plastic waste?"* Re-using or recycling plastic products were the most frequently selected response (75% of respondents), followed by safe disposal of plastic products (70%), supporting clean-up initiatives (58%) and avoiding the purchasing of single-use plastic products (57%) (Figure 4-10).

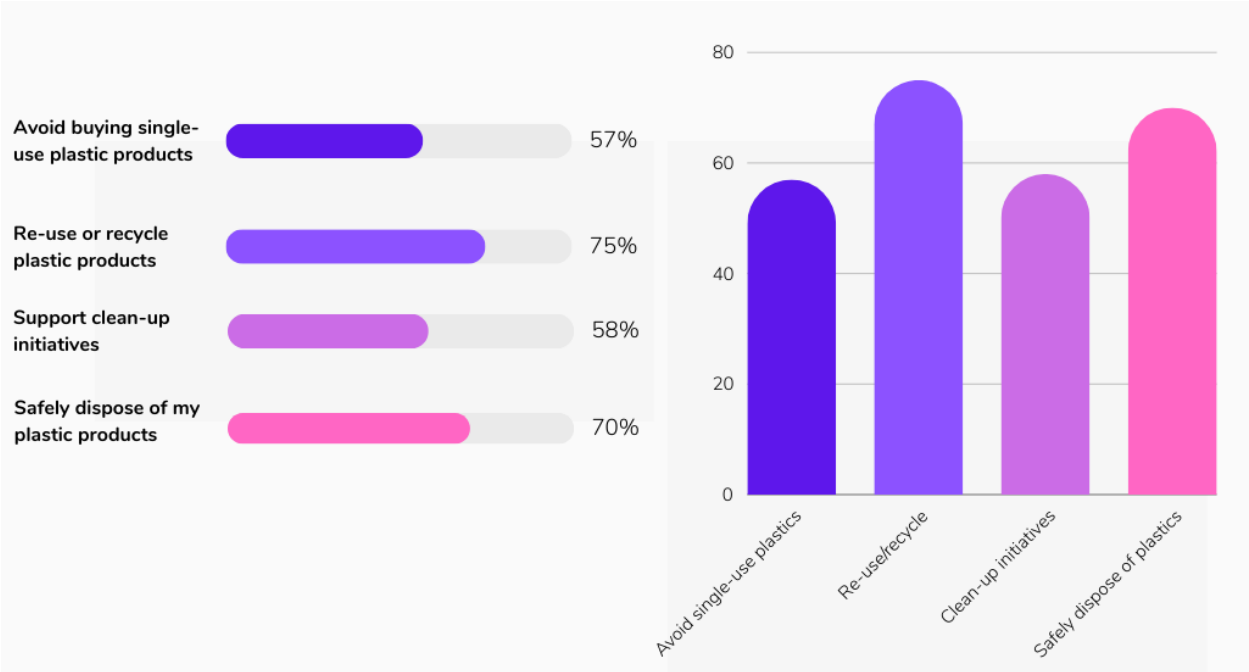


Figure 4-10: Changes participants would be willing to make to reduce plastic waste.

Research by Poole (2019) revealed that although 85% of individuals expressed a desire to purchase products in reusable packaging, only 16% used such packaging. This suggested that adopting reuse practices can be challenging and may present significant barriers for consumers. Additionally, data from Statistics South Africa showed that only about 10% of waste is recycled in the country, indicating a significant gap in the management and recycling of plastic waste (Stats SA, 2022).

While 70% of participants indicated they would safely dispose of plastic products, the findings of a study conducted in South Africa revealed significant challenges in the safe disposal of plastic products, especially in unserviced areas. Research by Haywood *et al.* (2021) highlighted that improper waste disposal practices are prevalent, with many families resorting to dumping waste in the streets or yards due to inadequate municipal waste management service.

Support for clean-up initiatives was shown by 58% of participants. This finding is supported by Funmilayo (2023) who reports on the positive impact of volunteer-driven efforts, such as the African Clean-up Initiative (ACI), to combat plastic pollution. This initiative, which operates in several African countries, including South Africa, organises regular clean-up events on beaches, rivers, and other areas. Removing larger plastic debris from beaches before it breaks down into microplastics significantly benefits marine ecosystems by reducing microplastic pollution (Andrady, 2011). Therefore, beach clean-ups are very important, not only for improving the aesthetic value of the area but also for reducing the generation of microplastics in marine environments.

Lastly, 57% of the participants would avoid buying single-use plastic products. These results align with a study conducted by King (2023), which found that 51% of their respondents claimed that they look for sustainability certifications on packaging. The global Tetra Pak Index study (2021) reported that 42% of the respondents made conscious efforts to reduce plastic consumption since the COVID-19 pandemic.

Less than 1% of participants indicated they would pick up plastics, throw away others' litter, or use biodegradable products to reduce plastic waste.

4.5.1.5 Factors encouraging respondents to reduce plastic waste in marine environments

When asked to choose their top three responses to *"What would encourage you to reduce your plastic waste in marine environments?"* (Question 5), respondents opted for government campaigns and regulations (72%), having access to a cleaner environment (72%), financial incentives or penalties (71%), doing it when others do it (24%) (Figure 4-11).

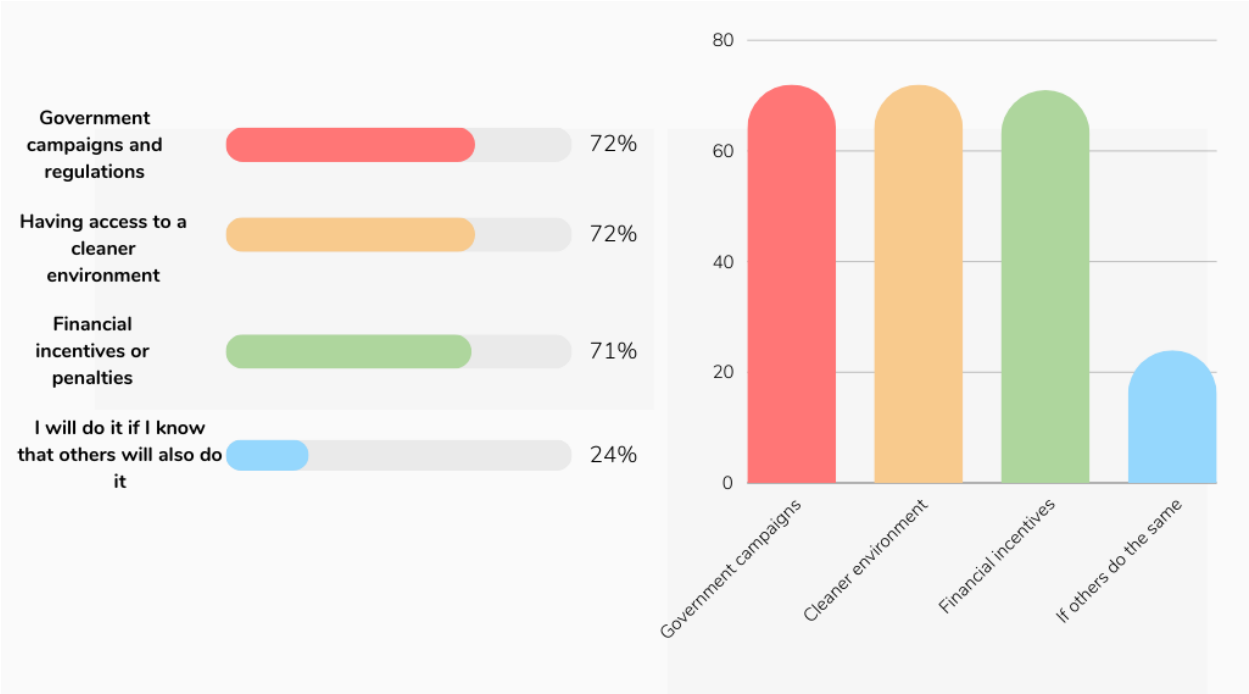


Figure 4-11: Factors encouraging reduction of plastic waste in marine environments.

Ensuring that people have access to clean and well-maintained environments can encourage them to keep these areas clean. Naragatti and Vadiraj (2023) have indicated that visible cleanliness in public areas can inspire individuals to maintain and protect these spaces, reducing littering, advancing the circular economy and contributing towards the preservation of natural resources and biodiversity.

As far as financial incentives and fines are concerned, Fung and Wodak (2020), whose research evaluated the effectiveness of fines in reducing and preventing littering behaviour have found that the public perception for the risk of receiving a littering fine is very low (31%) and not effectively impacted by fines. Another study found that financial incentives, along with non-monetary rewards like positive feedback and recognition, can also encourage pro-environmental behaviours (Kolodko *et al.*, 2016).

It was surprising that only 24% of participant opted for reducing their plastic waste if they knew others would do the same. Fang *et al.* (2017) found that, in Taiwan, social norms have a greater influence than attitudes on environmentally friendly behaviours. People are more likely to adopt sustainable practices, such as using reusable tableware, when they feel social pressure to conform. This effect is particularly pronounced in East Asian cultures, where Confucian values emphasise social belonging and collective responsibility. The study suggests that organised community actions and public awareness campaigns can effectively create a culture of

sustainability through normative social influence. In contrast, Schoeman and Rampedi (2022) discovered that social pressure is not the dominant driver of recycling participation in Johannesburg. Only 26% of respondents strongly agreed with the statement *"most people think I should recycle",* while 29% moderately agreed. However, 36% highly agreed that people would approve of an individual who recycles, indicating that social approval plays a significant role. This suggests that, while direct social pressure is limited, social norms and approval still influence recycling behaviour to some extent.

Less than 1% of participants indicated that the following would encourage them: their current efforts to reduce plastic waste, being shown the damage plastic waste does to the marine environment, more clearly marked bins and awareness signs, their existing habits of not littering, affordable alternatives to plastic, and education.

4.5.1.6 Perceived effective ways of raising awareness about plastic waste in marine areas

Question 6 required participants to reflect on the most effective ways to raise awareness on plastic waste in marine areas (with the instruction to select the top three options). As indicated in Figure 4-12, social media and online campaigns (77% of participants) and school and university education (76%) were selected by the majority of participants, followed by public awareness events and demonstrations (67%) and government campaigns and regulations (57%).

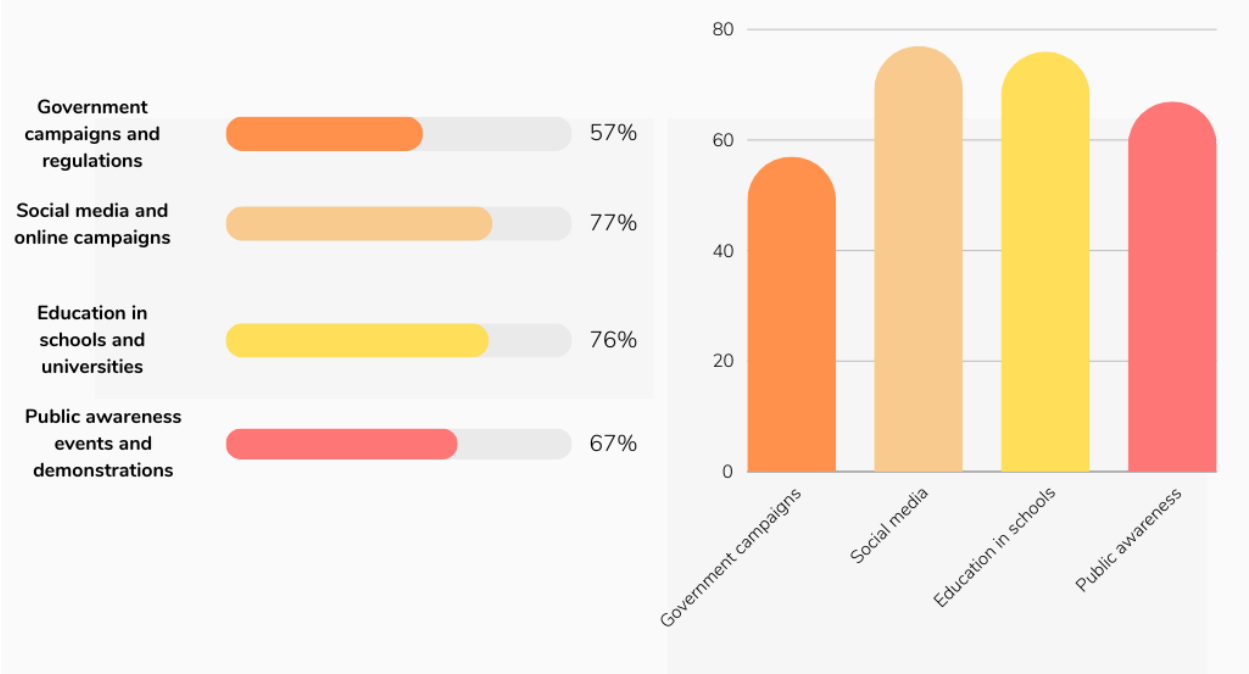


Figure 4-12: Most effective ways to raise awareness about plastic waste in marine areas as perceived by respondents.

Moss (2021) has also identified social media and online campaigns as one of the most effective methods to raise awareness on waste and plastic pollution. However, Moss highlighted the importance of approaching campaigns in the right way, while cautioning against common mistakes that would deter people from participating.

Participants also indicated that education in schools and universities is effective in raising awareness about plastic waste in the environment, with 76% supporting these measures. This finding is supported by the National Waste Management Strategy (NWMS) in South Africa, which emphasises the importance of education and awareness, particularly in schools, to improve waste management. According to the NWMS, *"schools and youth organisations are potential focus areas for community-based action on waste"* (NWMS, 2020: 60).

Having public awareness events and demonstrations was supported by 67% of the participants. The effectiveness of public awareness events and demonstrations are substantiated by the research findings of Willis *et al.* (2018), who concluded that public awareness can be raised through education programmes because they create a sense of environmental responsibility in participants. This substantiates the finding above and emphasises the importance of education programmes in schools and universities (as highlighted in the NWMS).

More than half of the participants (57%) indicated that government campaigns and regulations are effective in raising awareness. This once again coincides with the NWMS mentioned above, and emphasises the importance of collaboration among government entities, businesses, and individuals to successfully implement initiatives like community clean-ups and educational campaigns. In South Africa, there is little to no information available to evaluate the effectiveness of government regulations in place to raise awareness about plastic waste in marine environments.

Less than 1% of the participants felt that the following were effective ways to raise awareness: Enforcing bylaws and fining offenders; supplying visitors with paper bags; and discontinuing plastic use, amongst others.

4.5.1.7 Perceived most effective approaches to reduce plastic waste in marine environments

Lastly, Question 7 in Section 2 of the survey asked respondents: *"In your opinion, which of the following approaches do you think would be the most effective in reducing plastic waste in marine environments?"*

More than half of the participants (53%) indicated that bans on single-use plastic would be the most effective approach to reduce plastic waste, followed by 52% of the participants who, respectively, indicated that subsidies for companies that use recycled plastics and public education campaigns would be effective. Approximately 45% of the participants felt that properly functioning municipal services would be an effective tactic, while 39% indicated that mandatory producer responsibility for plastic waste would be positive, and 37% indicated that fees or taxes on single-use plastic could be implemented (Figure 4-13).

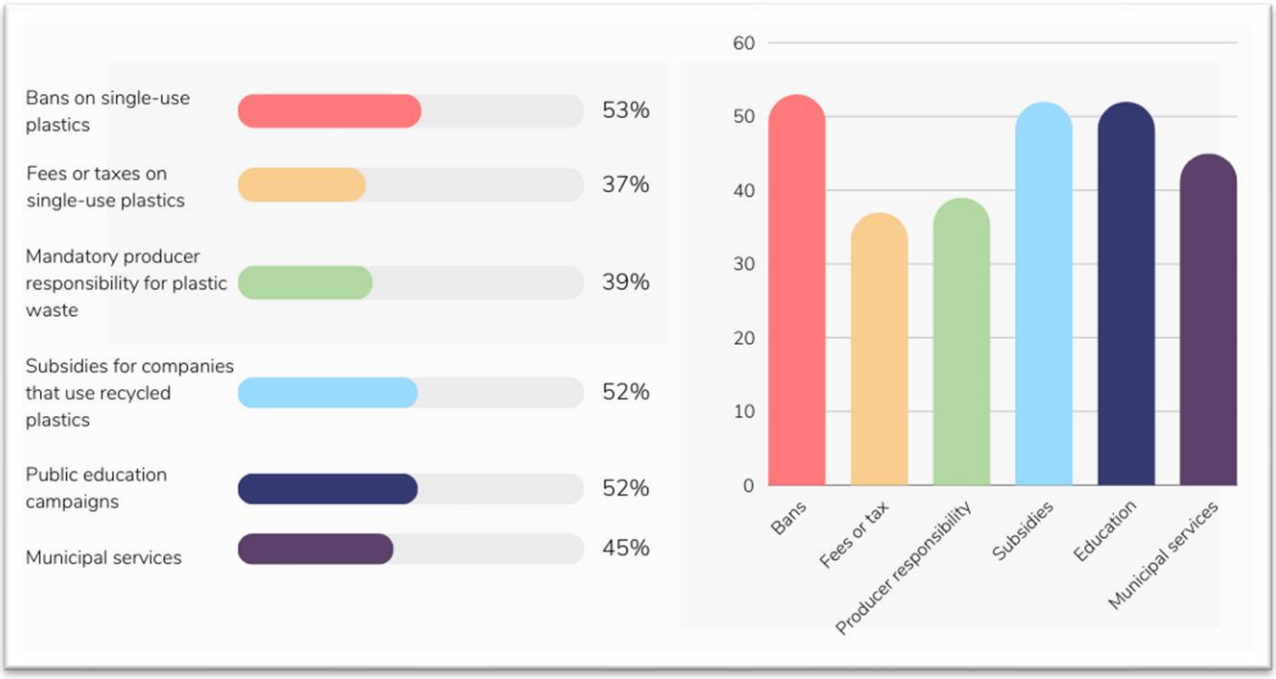


Figure 4-13: The most effective approaches in reducing plastic waste in marine environments.

According to the results of research by Prata *et al.* (2019), all the above are considered to be effective approaches to reducing plastic waste in marine environments.

Bans on single-use plastics was perceived by the participants as the most effective approach to reduce plastic waste in marine environments (53%). A study by Herberz *et al.* (2020) found that banning all types of single-use products, not just single-use plastics, can significantly reduce consumption and waste generation, thereby decreasing the amount of pollution entering the marine environment. However, implementing such bans may require legislative changes and interventions, which may take many years to implement.

The initiative of granting subsidies for companies that use recycled plastics was perceived as a good approach by 52% of the participants. These type of reward systems include programmes such as the Recycling Enterprise Support Programme which is funded by the Department of Environmental Affairs (DEA) where grants of up to R5 million can be tendered for by organisations (Khoro, 2019).

More than half of the participants (52%) indicated that public education campaigns could be an effective approach to reduce plastic waste in marine environments. This is backed by a study by WWF (2023) that found that these types of campaigns involving local communities and teaching them about waste can encourage locals to be more conscious about purchasing choices and to take action to protect the environment. The main goal of public campaigns is to increase awareness and impact the way locals perceive the threat of plastic pollution. It also promotes the different solutions to decrease plastic waste to encourage businesses and individuals to act.

Improved municipal services was supported by 45% of the participants. These findings align with a study by Willis *et al.* (2022), which indicated that while plastic pollution is a global issue, decisions made at local management level are vital for effectively reducing coastal plastic pollution on a global scale.

Fees and taxes in single-use plastics was supported by 37% of the participants. Levies and fees increase the cost of single-use plastics, encouraging consumers and businesses to seek alternatives or reduce usage (WWF, 2023). Funds generated from financial instruments can be used to support recycling infrastructure, public education campaigns, and environmental conservation efforts (Khoro, 2019). When properly implemented and enforced, financial incentives can drive significant behavioural change among consumers and businesses, leading to reduced plastic waste in marine environments. This is also suggested by the findings of a study conducted by Vorobeva *et al.* (2022), who found that incentives and systems such as the “pay-as-you-throw” (PAYT) and the “save-as-you-throw” (SAYT) initiatives hold significant value to encourage consumers to generate less waste. PAYT is a system where consumers are responsible for paying for the service of waste removal according to the quantity of waste that they throw away. SAYT is the rewarding of consumers based on their effectiveness to separate household waste (Vorobeva *et al.*, 2022).

Participants also indicated mandatory producer responsibility as the second least effective method, with only 38% of the participants supporting these measures. GNR.1187 provides the EPR regulations for paper and packaging in South Africa and outlines the responsibilities of producers, importers, brand owners, and retailers in managing the life cycle of their products, particularly regarding their end-of-life disposal. This Notice pertains to waste originating from the

use of plastic packaging, biodegradable and compostable plastic packaging, single-use plastic products, single-use biodegradable plastic, and single-use compostable plastic products by consumers or end-users (Department of Environment, Forestry, and Fisheries, 2020).

4.5.2 Likert-scale responses: Plastic waste perceptions

Section 3 of the survey focused on perception-based questions aimed at evaluating the perceptions of the participants of plastic waste in the Struisbaai Harbour area. This was achieved by using a five-point Likert scale, ranging through strong agreement (5), agreement (4), neutral (3), disagreement (2), to strong disagreement (1).

Table 4-3 provides a frequency table with percentage of responses relative to the Likert-scale and mean Likert-scale rating of each of the questions. Note: In Table 4-3, P = perceptions, B = behaviour, and W= waste management practices.

Section 4.5.22 provides a combined discussion of the findings (that are individually discussed in Sections 4.5.1 to 4.5.21) in the context of literature and observational findings of this research (as reported in Sections 4.3 and 4.4).

Table 4-3: Frequency table of Likert scale responses.

Statements	Frequency of Likert scale responses (% of responses)					
	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Mean
Perception statements						
1) **P1:** I regularly observe plastic waste on the beach or ocean in the Struisbaai harbour area.	5%	10%	19%	40%	26%	3.72
2) **P2:** The sight of plastic waste in and around the Struisbaai harbour bothers me.	4%	3%	10%	31%	52%	4.24
3) **P3:** I believe that the presence of plastic waste affects my enjoyment of the harbour and boardwalk's aesthetics.	2%	2%	7%	36%	53%	4.36
4) **P4:** I feel that the presence of plastic in the ocean and along the harbour and boardwalk in Struisbaai is a problem.	3%	6%	13%	35%	43%	4.09
5) **P5:** I think plastic waste is a major issue affecting the natural environment in and around Struisbaai harbour.	2%	6%	13%	31%	48%	4.17
6) **P6:** I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour has become worse over the past five years.	2%	9%	28%	30%	31%	3.79
7) **P7:** I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour could deter tourists from visiting the area.	2%	9%	25%	36%	28%	3.79
8) **P8**: I am aware of the long-term adverse impacts of plastic pollution on marine ecosystems.	1%	1%	2%	31%	65%	4.58
Behaviour statements						
9) **B1:** I think that individuals have a responsibility to reduce plastic waste in marine environments.	1%	1%	1%	27%	70%	4.64
10) **B2:** I am willing to avoid the use of single-use plastics such as plastic bags, water bottles, or straws when I am at the beach/in a marine environment.	1%	6%	11%	35%	47%	4.21
11) **B3:** I am willing to pay a reasonable price for products or services that are environmentally friendly and reduce plastic waste in marine environments.	1%	3%	23%	43%	30%	3.98

Statements	Frequency of Likert scale responses (% of responses)					
	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Mean
12) **B4:** I am willing to walk to where waste bins are located to dispose of my waste.	1%	0%	3%	23%	73%	4.67
13) **B5:** I am willing to keep my plastic waste with me and dispose of it at home.	1%	1%	4%	26%	68%	4.59
Waste management practices statements						
14) **W1:** I have noticed waste bins located in the Struisbaai harbour and the boardwalk area.	5%	10%	20%	47%	18%	3.63
15) **W2:** I have noticed a difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area.	2%	6%	13%	31%	48%	4.17
16) **W3:** I think that the current waste management infrastructure (bins/skips) in the Struisbaai harbour and boardwalk area is sufficient.	13%	37%	27%	18%	5%	2.65
17) **W4:** I am satisfied with the placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area.	13%	37%	27%	19%	4%	2.64
18) **W5:** I have encountered overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area.	4%	25%	28%	23%	21%	3.35
19) **W6:** I think the measures currently in place to manage plastic waste in the Struisbaai harbour area are effective.	12%	29%	33%	23%	3%	2.76
20) **W7:** I think that Struisbaai has the necessary waste management capacity to handle the increased number of tourists during the Holiday season.	13%	32%	26%	23%	6%	2.77
21) **W8:** I think that plastic waste management has improved over the past five years in the Struisbaai area.	9%	14%	50%	22%	5%	3.00

4.5.2.1 I regularly observe plastic waste on the beach or ocean in the Struisbaai harbour area.

More than 66% of the participants agreed (40%) or strongly agreed (26%) that they regularly observe plastic waste on the beach or in the ocean in the Struisbaai harbour area (Section 3, Question 1 of the survey). A total of 19% of the participants reacted neutrally to this statement, while 15% disagreed (10%) or strongly disagreed (5%) with this statement (Figure 4-14, Table 4-3). It can therefore be derived that plastic waste is a visible problem in the Struisbaai harbour area. This was also confirmed during the observational part of the research (see Section 4.3 and 4.4 above).

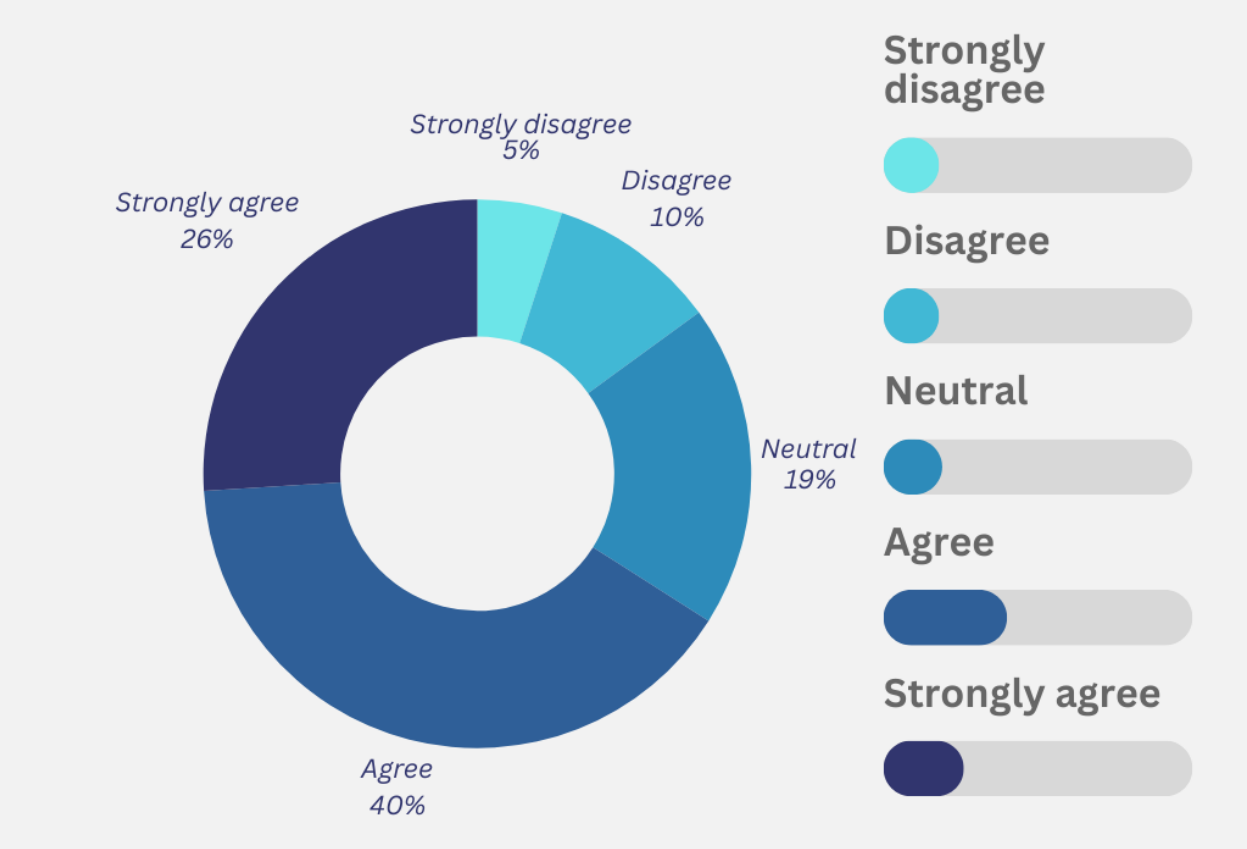


Figure 4-14: Participants perceptions of observations of plastic waste on the beach and in the ocean at the Struisbaai harbour area.

4.5.2.2 The sight of plastic waste in and around the Struisbaai harbour bothers me

The majority (83%) of participants agreed (31%) or strongly agreed (52%) that the sight of plastic waste in and around the Struisbaai harbour bothers them. Approximately 10% of the participants

remained neutral, while only 7% of respondents disagreed (3%) or strongly disagreed (4%) with the statement (Figure 4-15, Table 4-3).

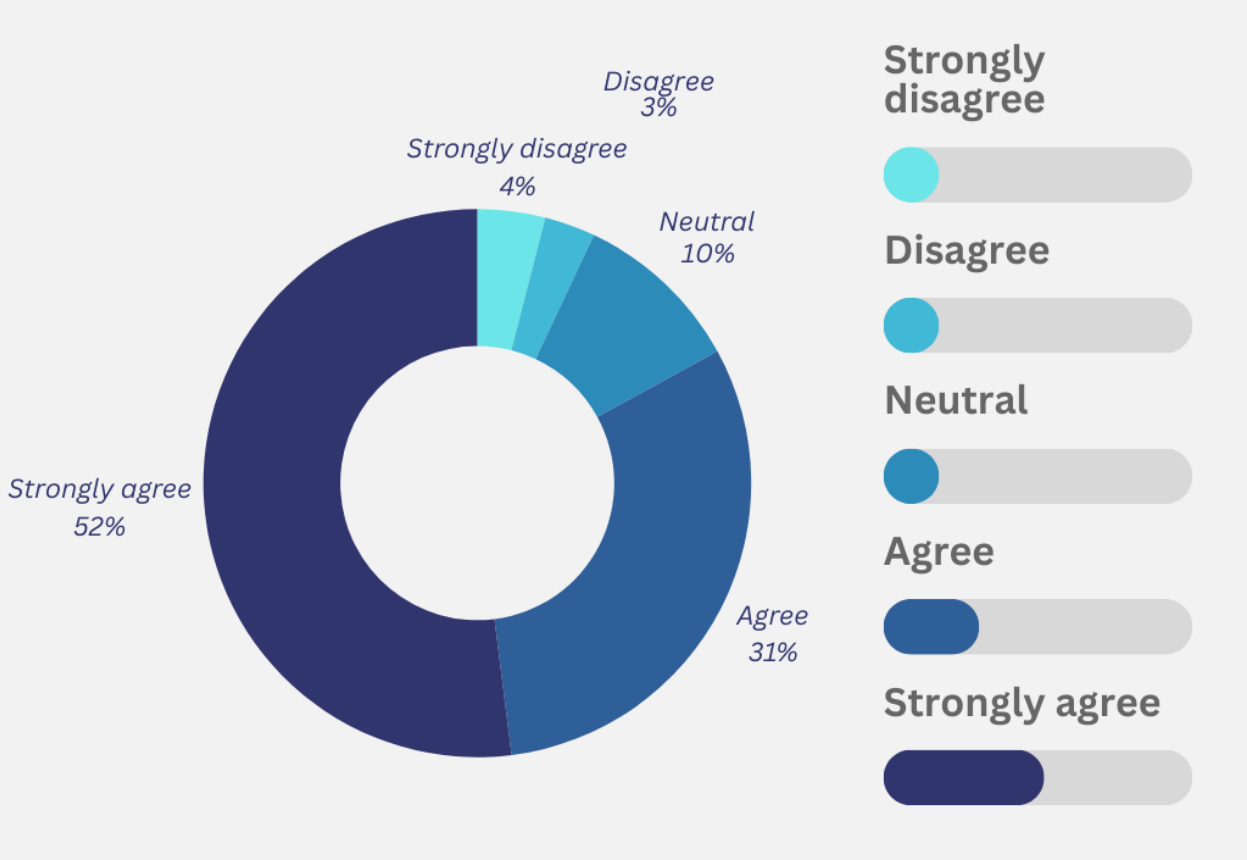


Figure 4-15: Participants perceptions of the sight of plastics bothering them.

Research by Ballance *et al.* (2000) has highlighted the importance of "clean beaches" and the adverse impacts that waste has on the experience of residents and tourists. Their research has highlighted that "cleanliness of beaches" was most frequently ranked as the most important beach attribute investigated, and that tourists will "avoid polluted beaches" and "are willing to travel 50 km or more to visit clean beaches (Ballance *et al.*, 2000: 211).

4.5.2.3 I believe that the presence of plastic waste affects my enjoyment of the harbour and boardwalks aesthetics

In total, 89% of the participants agreed (36%) or strongly agreed (53%) that the presence of plastic waste affects their enjoyment of the harbour and boardwalks' aesthetics. Only 7% of the participants remained neutral to this statement, while only 2% disagreed and another 2% strongly disagreed with the statement (Figure 4-16, Table 4-3).

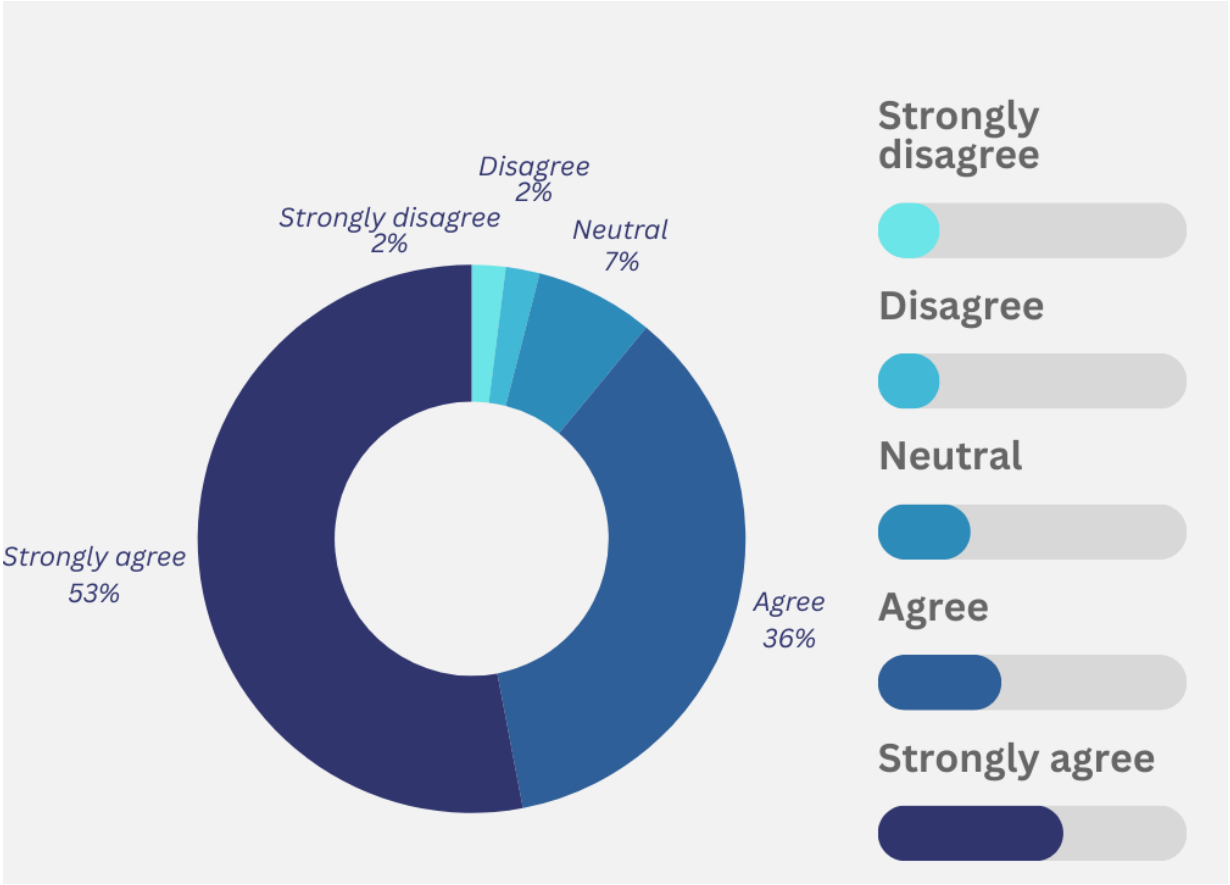


Figure 4-16: Participant perceptions on the presence of plastic waste affects their enjoyment of the harbour and boardwalks aesthetics.

The high percentage of participants who agreed with the statement showcases the impact that plastic waste can have on visitors' enjoyment of the area. Research by Tudor and Williams (2003) has found that plastic and other waste items are "often considered as being offensive" and that "the feeling of discomfort experienced due to pollution can lead to the loss of tourists and subsequent financial implications" (Tudor & Williams, 2003: 1114).

4.5.2.4 I feel that the presence of plastic in the ocean and along the harbour and boardwalk in Struisbaai is a problem

Approximately 78% of the participants agreed (35%) or strongly agreed (43%) that the presence of plastic in the ocean and along the harbour boardwalk in Struisbaai is a problem. Approximately 13% of the participants had a neutral response to the statement, neither agreeing nor disagreeing, and 9% of the participants disagreed (6%) or strongly disagreed (3%) to the statement (Figure 4-17, Table 4-3).

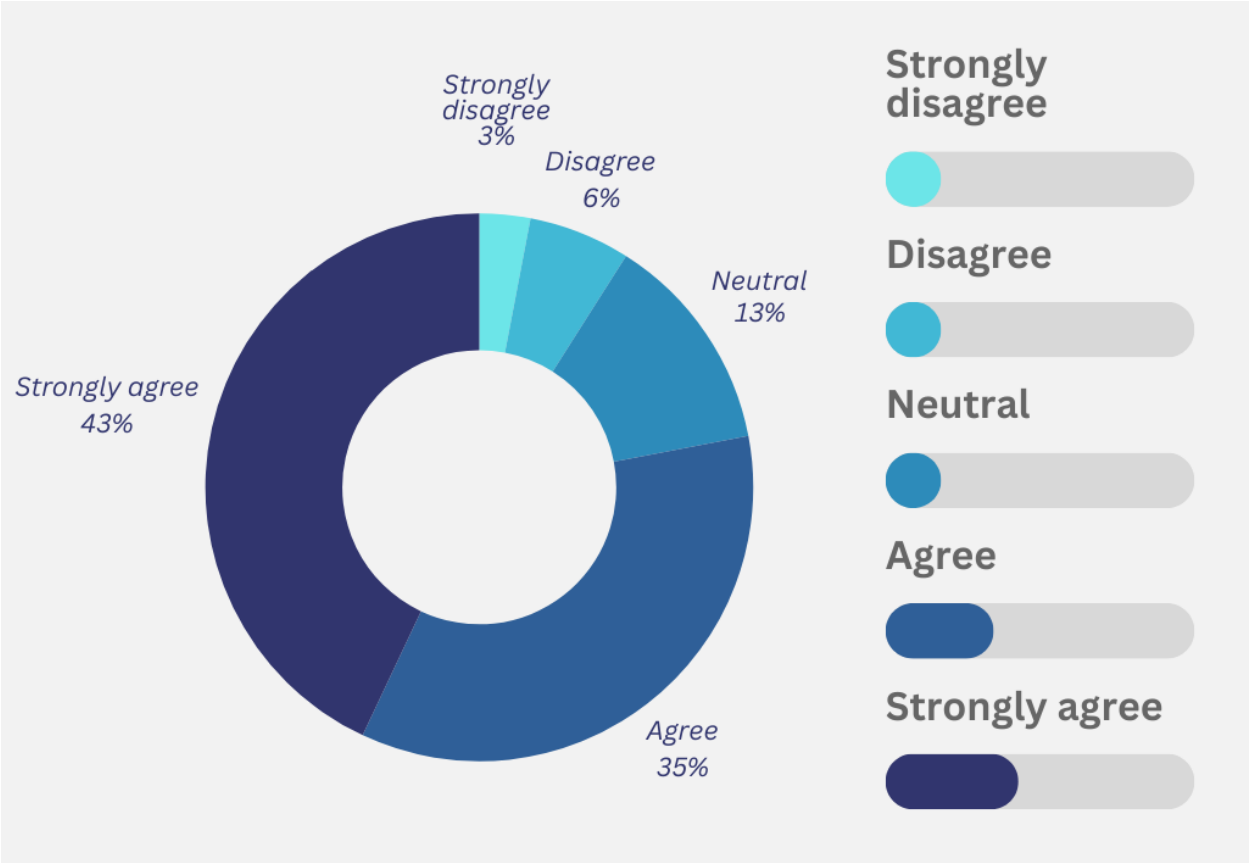


Figure 4-17: Participant perceptions on the presence of plastic in the ocean and along the harbour and boardwalk in Struisbaai being a problem.

Research by Chitaka and von Blottnitz (2019) on the accumulation and characteristics of plastic debris along five beaches in Cape Town have found that plastic accounted for 94.5% to 98.9% of debris found on beaches and that it was also perceived as a problem by residents and tourists in the areas investigated.

4.5.2.5 I think plastic waste is a major issue affecting the natural environment in and around Struisbaai harbour

A significant percentage of the participants (79%) either strongly agreed (47%) or agreed (31%) that plastic waste is a major issue affecting the natural environment in and around Struisbaai harbour (Figure 4-18, Table 4-3). The adverse effects of plastic waste on the natural environment are well documented (Arabi & Nahman, 2020; Fava, 2022; Chagas de Araújo *et al.,* 2021). This suggests a high level of awareness and concern among the respondents about the environmental impact of plastic waste in Struisbaai harbour. The responses indicate that most of the participants recognise the severity of the problem and likely perceive plastic waste as a threat to the natural environment in and around the harbour. Approximately 13% of the participants indicated a neutral response in answer to the statement, which could be because these participants are genuinely

unsure about the extent of the issue or might not have enough information to form a strong opinion. Lastly, 8% of the participants either strongly disagreed (3%) or disagreed (6%) with the statement (Figure 4-18, Table 4-3).

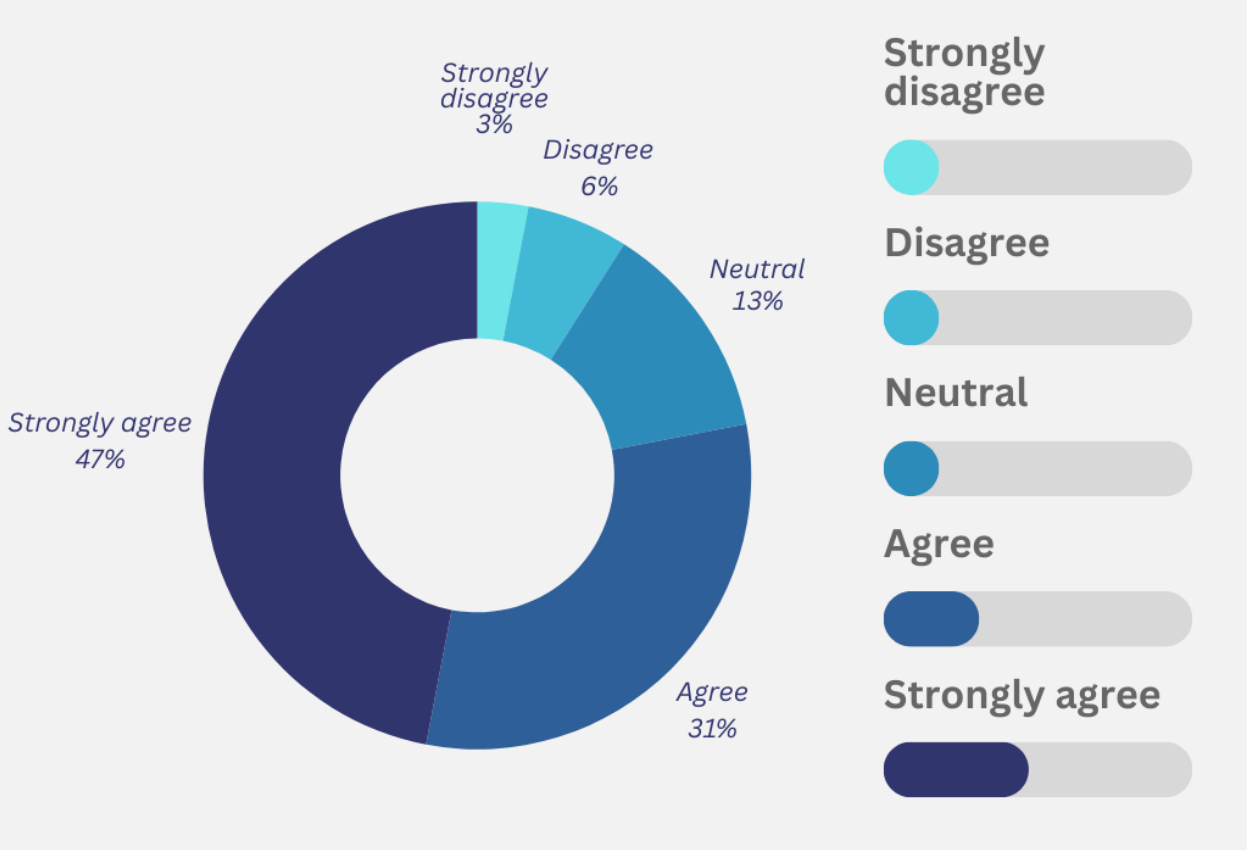


Figure 4-18: Participant perceptions on plastic waste being a major issue affecting the natural environment in and around Struisbaai harbour.

Research by van Oosterhout *et al.* (2022) on public perceptions of marine plastic litter, which includes a comparative study across European countries and seas provides interesting findings. Their research has indicated that, in response to questions on the adverse impacts of plastics, the majority of respondents agreed to plastics having adverse consequences on micro-organisms, followed by consequences on coastal appearance, and the fewest respondents were concerned over consequences for human health (van Oosterhout *et al.,* 2022).

4.5.2.6 I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour has become worse over the past five years

The majority of the participants (60%) either strongly agreed (30%) or agreed (30%) that the presence of plastic in the ocean and along the coastal area has worsened over the past five years (Figure 4-19, Tabe 4-3), which indicates that there is a predominant perception among

participants that plastic pollution has increased in the region during the specified time frame. A total of 28% of the participants gave a neutral response to the statement, perhaps indicating a lack of awareness about the situation over the past five years and whether it has worsened or not, or uncertainty due to not paying attention to the situation or being first time visitors to the area. A smaller portion of the participants (12%) strongly disagreed (3%) or disagreed (9%) with the statement (Figure 4-19, Table 4-3), that indicates differing viewpoints in the participant responses, albeit on a small scale.

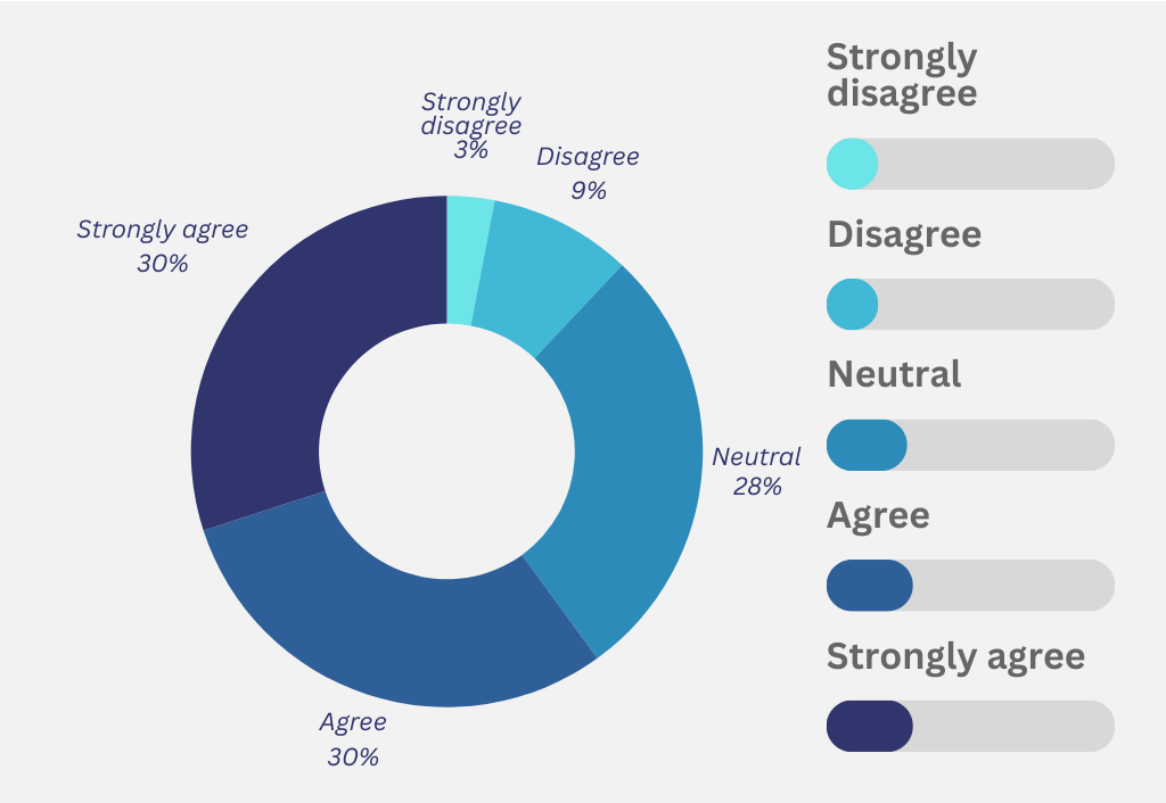


Figure 4-19: Participant perceptions on presence of plastic waste over a five-year period in the Struisbaai coastal area.

While actual data on the presence, amount and characteristics of plastic waste in the Struisbaai coastal area is not available, research by Yan *et al.* (2024) suggests that the amount of plastic on beaches has increased over the past ten years and is expected to increase towards 2050.

4.5.2.7 I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai harbour could deter tourists from visiting the area

A significant percentage of the participants (64%) either strongly agreed (28%) or agreed (36%) with the statement that the presence of plastic could deter tourists from visiting the area (Figure

4-20, Table 4-3). The high percentage suggests concern that pollution might negatively affect tourism in the Struisbaai harbour area, leading to economic repercussions for the region if not addressed. A quarter of the participants (25%) had a neutral view to the statement, while 11% of participants either strongly disagreed (2%) or disagreed (9%) with the statement (Figure 4-20, Table 4-3).

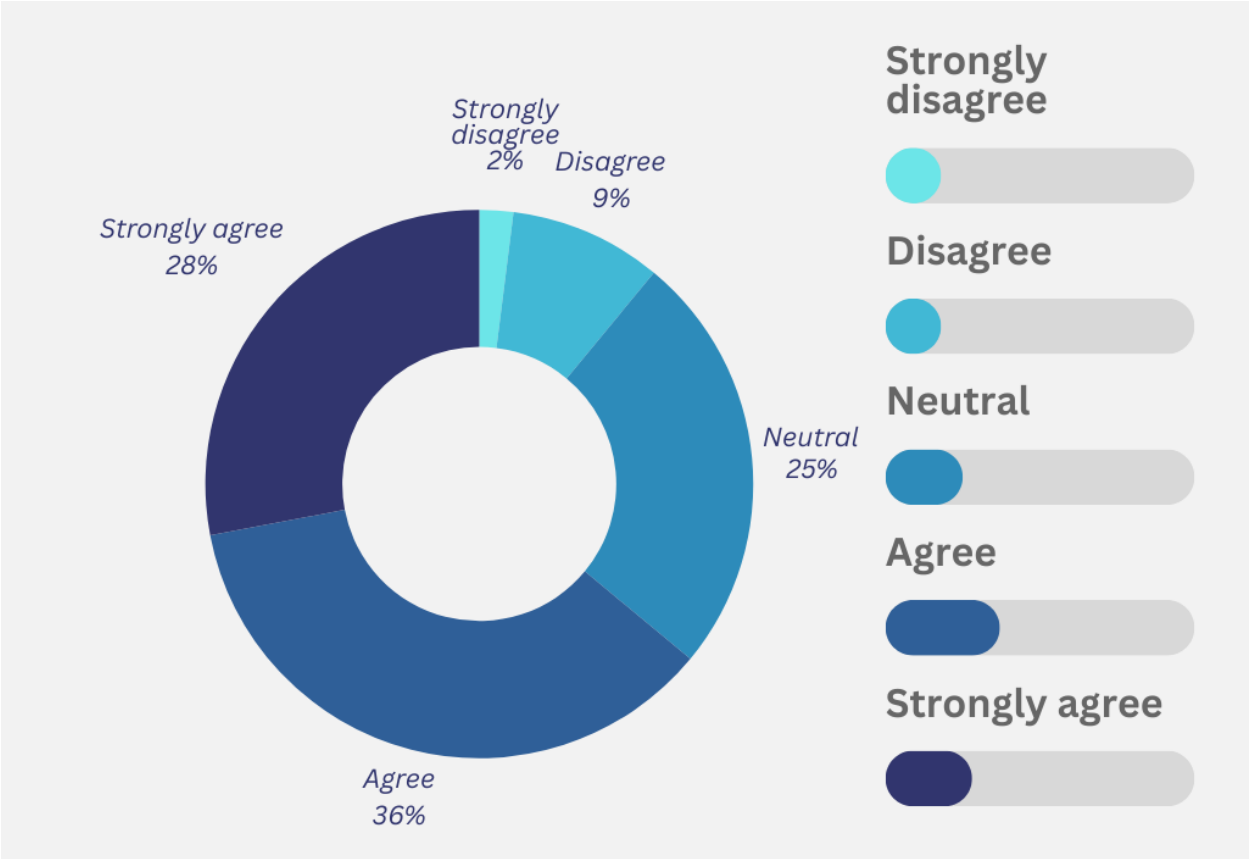


Figure 4-20: **Participant perceptions of the presence of plastic in the ocean and along the coastal area in Struisbaai harbour potentially deterring tourists from visiting the area.**

Research by Williams *et al.* (2016: 212) highlighted that tourists to beaches in the Caribbean Coast value “no litter and scenery” and that the presence of litter and plastic is regarded as a factor deterring tourists from “dirty” beaches. Similarly, Qiang *et al.* (2020) have found that impact of marine litter on tourism revenue is statistically significant, due to the deterrence of tourists from polluted areas.

4.5.2.8 I am aware of the long-term adverse impacts of plastic pollution on marine ecosystems

A combined 96% of the participants either strongly agreed (65%) or agreed (31%) that they were aware of the long-term impacts of plastic pollution on marine ecosystems (Figure 4-21, Table 4-3). Only 2% of the participants indicated a neutral opinion of the statement, while a very small minority (2% combined) of the participants indicated that they strongly disagreed (1%) or disagreed (1%) with the statement, which could be due to a lack of awareness, information, or education.

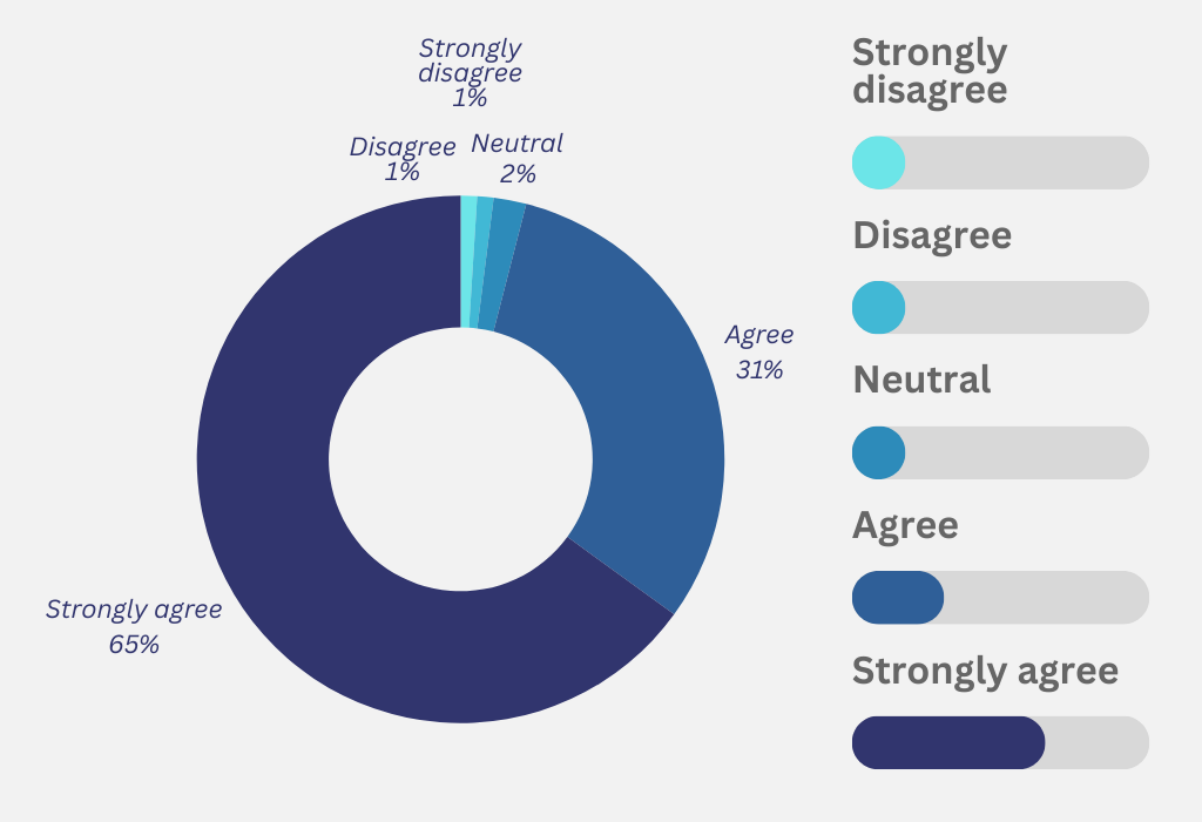


Figure 4-21: Participants' awareness of the long-term adverse impacts of plastic pollution on marine ecosystems.

A study by Soares *et al.* (2021) with the title *"Public views on plastic pollution: Knowledge, perceived impacts, and pro-environmental behaviours"* found that participants are well-informed about marine litter and plastic pollution, including its sources and environmental impacts. They possess high general knowledge, particularly regarding the environmental threat posed by plastics. Participants are aware that plastics take a long time to degrade and break down. Participants, however, indicated that they had less knowledge and awareness of microplastics.

4.5.2.9 I think that individuals have a responsibility to reduce plastic waste in marine environments

There was a strong consensus among the participants, as a combined 97% of the participants either strongly agreed (70%) or agreed (27%) that individuals have a responsibility to reduce plastic waste in marine environments (Figure 4-22, Table 4-3). This showcases acknowledgement on the participants' part that individuals play a key role in addressing plastic pollution. Only 1% of the participants indicated a neutral answer, and a combined 2% of the participants either strongly disagreed (1%) or agreed (1%) with the statement (Figure 4-22, Table 4-3).

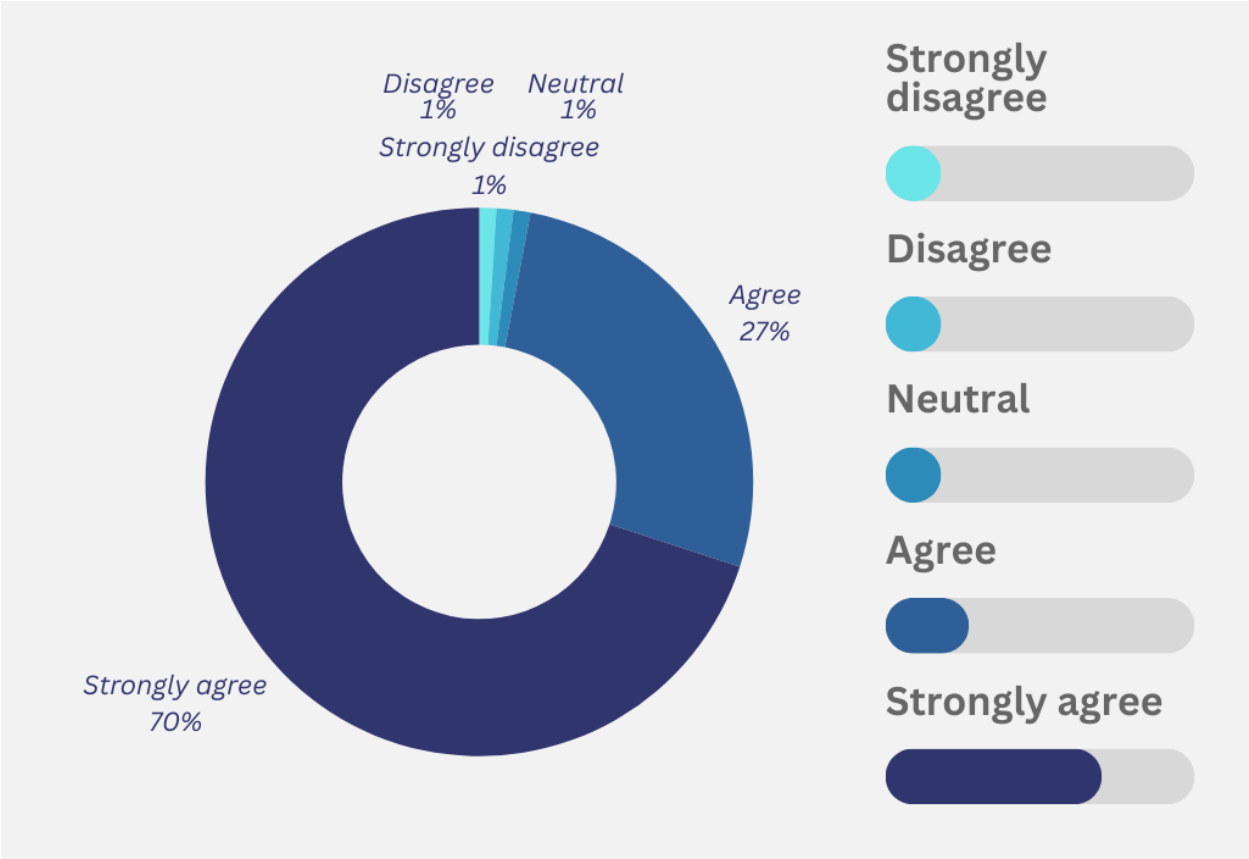


Figure 4-22: Participant perceptions of individuals' responsibility to reduce plastic waste in marine environments.

Sandu *et al.* (2020) highlights the important role of society and individuals in reducing plastic pollution. Furthermore, research by McNicholas and Cotton (2019: 163) indicate that "proponents are personally motivated to take individual action to reduce consumption, motivated, in part, by the negative impacts of plastic pollution". Their research participants also indicated that taking individual responsibility is key to addressing plastic pollution in the marine environment.

4.5.2.10 I am willing to avoid the use of single-use plastics such as plastic bags, water bottles, or straws when I am at the beach/in a marine environment

A combined 82% of the participants either strongly agreed (47%) or agreed (35%) that they were willing to avoid using single-use plastic in beach or marine environments (Figure 4-23, Table 4-3). Approximately 11% of the participants gave a neutral response to the statement and a combined 7% of the participants either strongly disagreed (1%) or disagreed (6%), which could be based on reasons such as convenience (Figure 4-23, Table 4-3).

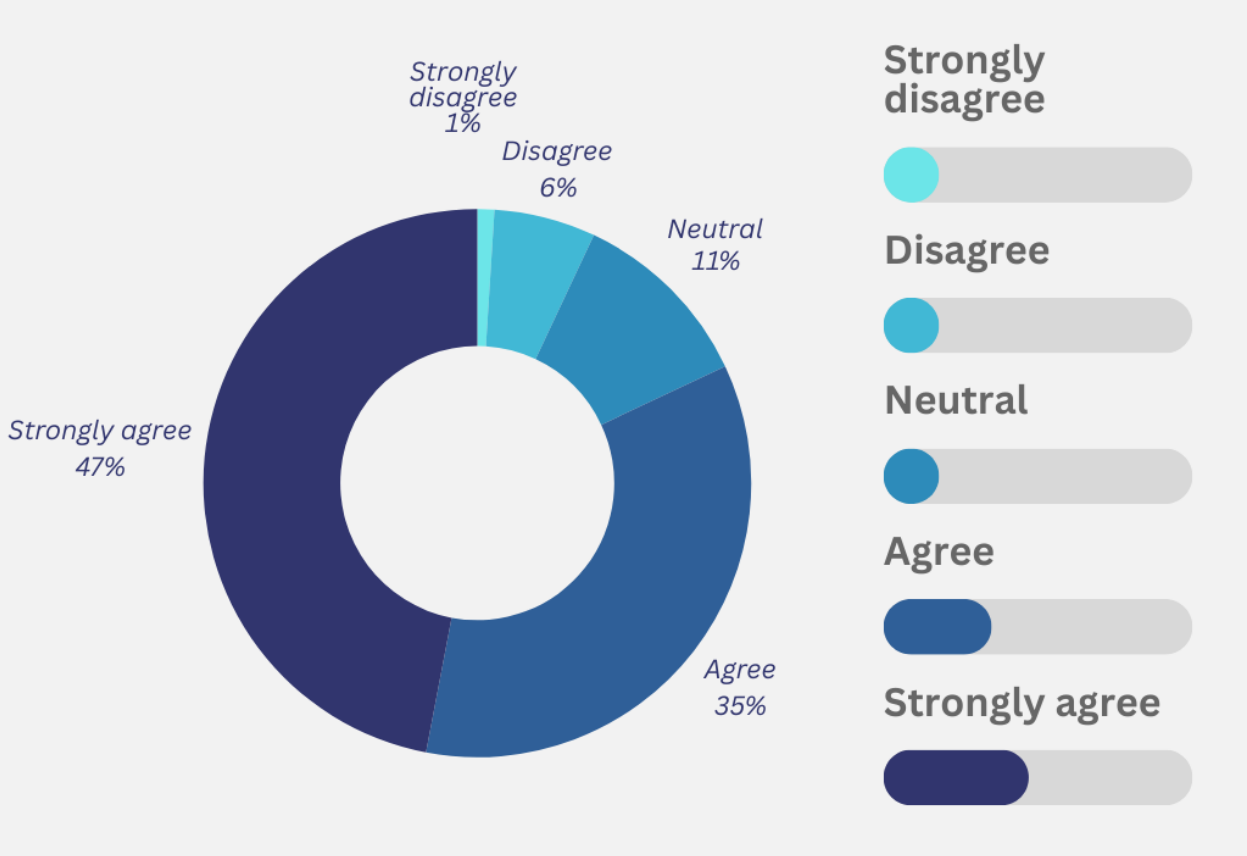


Figure 4-23: Participants' willingness to avoid the use of single-use plastics at the beach/in a marine environment.

Herweyers *et al.* (2023) in their paper titled *"Understanding who avoids single-use plastics and why: A cross-country mixed-method study"* conducted across the USA, Russia and Belgium have found that the majority of their research respondents indicated that they were willing to avoid single use plastics. Their research further revealed that "positive attitudes and subjective norms regarding plastic alternatives enhance consumers' intentions to avoid single use plastics" (Herweyers *et al.*, 2023: 137685).

4.5.2.11 I am willing to pay a reasonable price for products or services that are environmentally friendly and reduce plastic waste in marine environments

A combined 73% of the participants either strongly agreed (30%) or agreed (43%) that they would be willing to pay a reasonable price for products or services that are environmentally friendly and reduce plastic waste in marine environments (Figure 4-24, Table 4-3). These findings indicate that there is a demand for more sustainable options and that consumers are willing to take the environment into consideration when purchasing products or services. Approximately 23% of the participants provided a neutral response to the question, which could indicate that they might need more information about sustainable and environmentally friendly products as well as the related costs or might need some persuasion to buy these types of products. A combined 4% of the participants either strongly disagreed (1%) or disagreed (3%) with the statement which could indicate concerns about affordability or about the effectiveness of sustainable products (Figure 4-24, Table 4-3).

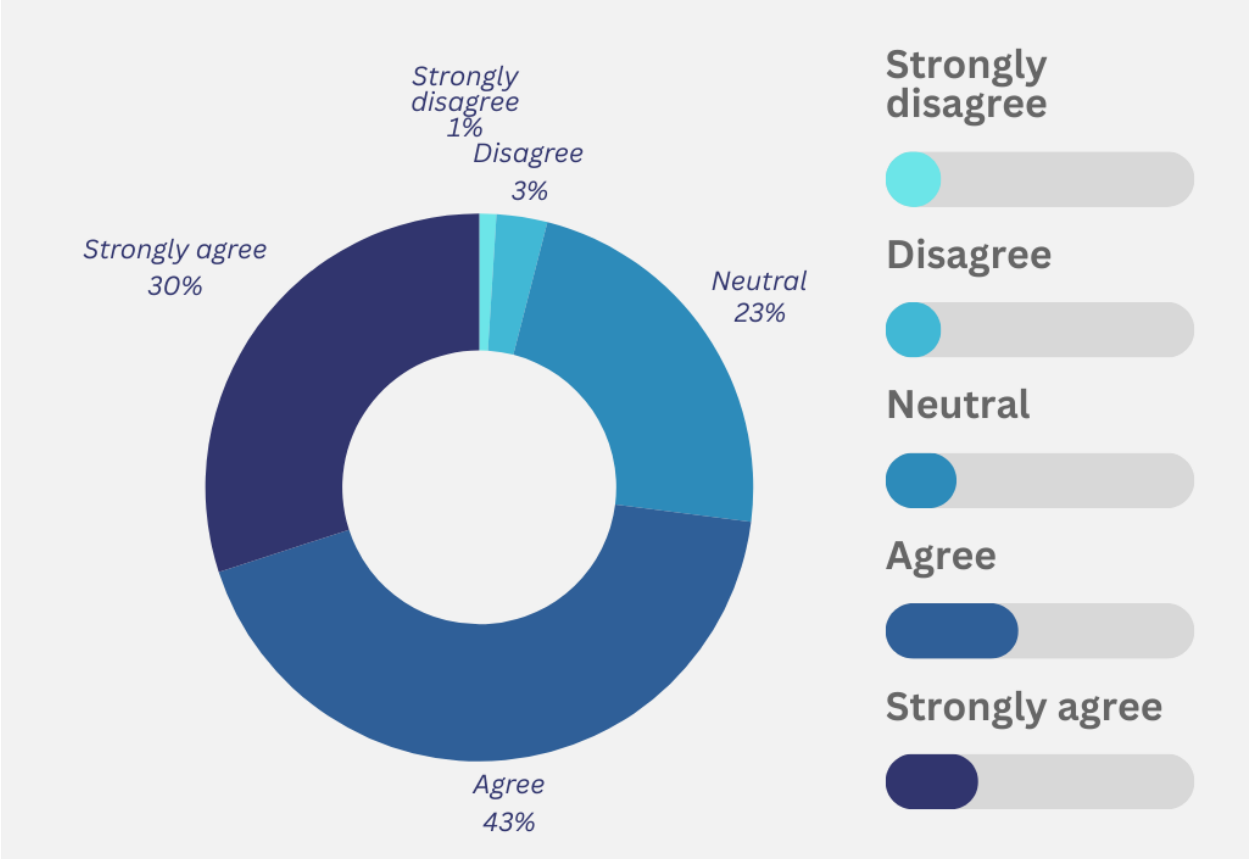


Figure 4-24: Participants' willingness to pay a reasonable price for environmentally friendly products and reduce plastic waste in marine environments.

A recent study by Dalhousie University in Halifax indicated that, while nearly 94% of Canadians polled wanted to reduce the use of disposable plastics in food, there is a significant reluctance to bear the associated costs. Only approximately 38% of their respondents expressed willingness to pay more for items with biodegradable packaging, and about 83% stated they would not be willing to pay more than a 2.5% premium for such alternatives (Versolatto, 2019).

4.5.2.12 I am willing to walk to where waste bins are located to dispose of my waste

The vast majority of the participants (96%) either strongly agreed (73%) or agreed (23%) that they would be willing to walk to waste bins to dispose of waste (Figure 4-25, Table 4-3). This suggests a high level of responsible behaviour and a high level of environmental awareness, as this portion of the participants recognise the importance of properly disposing of waste to maintain a clean and sustainable environment. A small percentage (3%) of the participants gave neutral responses which could indicate conditional willingness to walk to waste bins, most likely depending on factors such as the availability, accessibility and distance to the waste bins. Only 1% of the participants indicated an unwillingness to walk to the bins to dispose of waste (Figure 4-25, Table 4-3).

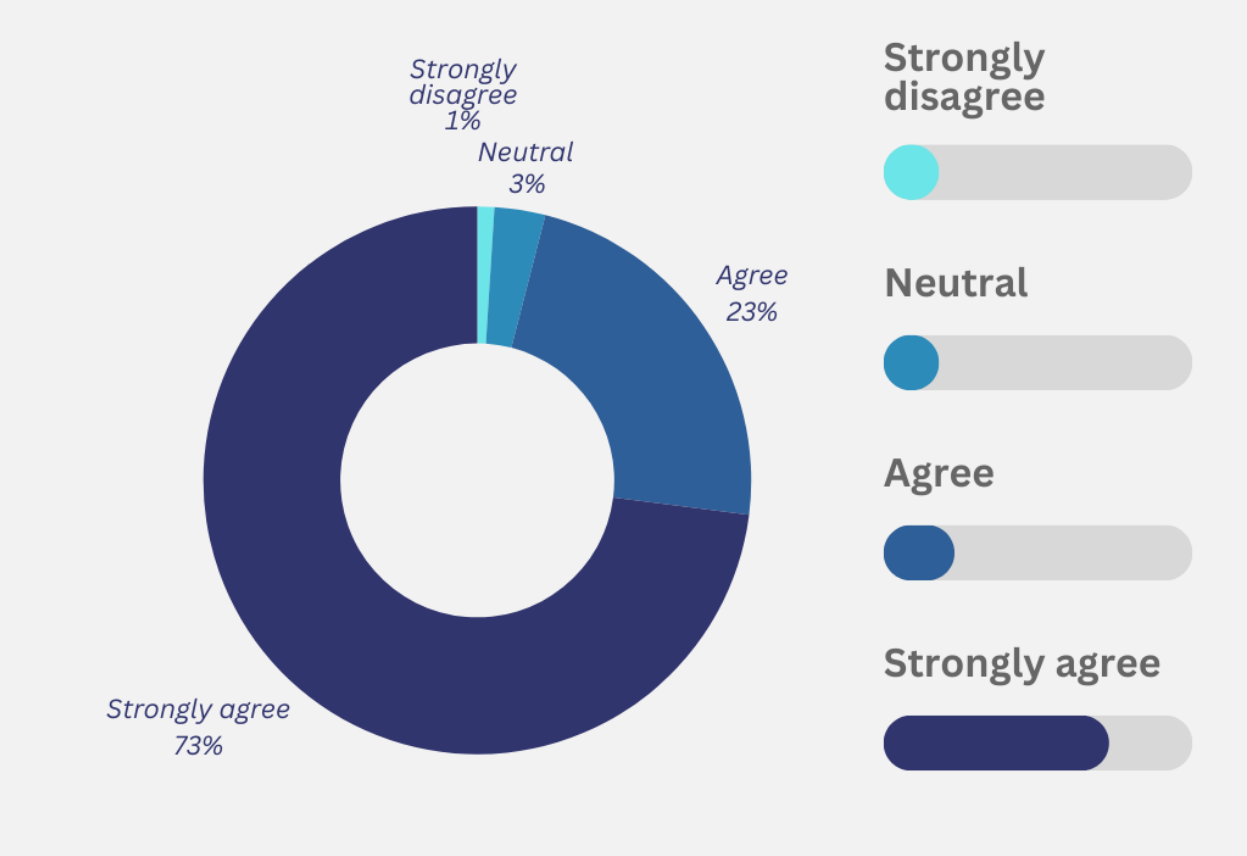


Figure 4-25: Participants' willingness to walk to waste bins to dispose of their waste.

Robinson (2023) in his research *"The effects of bin location and abundance on disposal behavior at beaches"* highlights that a decrease in disposal effort by increasing convenience and optimum placements of bins may change beachgoer behaviour, to ultimately reduce marine plastic pollution.

4.5.2.13 I am willing to keep my plastic waste with me and dispose of it at home

In response to Question *13 "I am willing to keep my plastic waste with me and dispose of it at home"*, 94% of the participants either strongly agreed (68%) or agreed (26%) that they were willing to keep their plastic waste with them until it could be discarded at home (Figure 4-26, Table 4-3). This could be attributed to a high level of awareness of the impact of plastic waste on the environment, which could encourage participants to dispose of their waste in a sustainable manner, even if it creates additional effort for them. Neutral responses were in the minority (4%) and only a combined 2% of the participants either strongly disagreed or disagreed with the statement, which could be due to the inconvenience of disposing of waste at home.

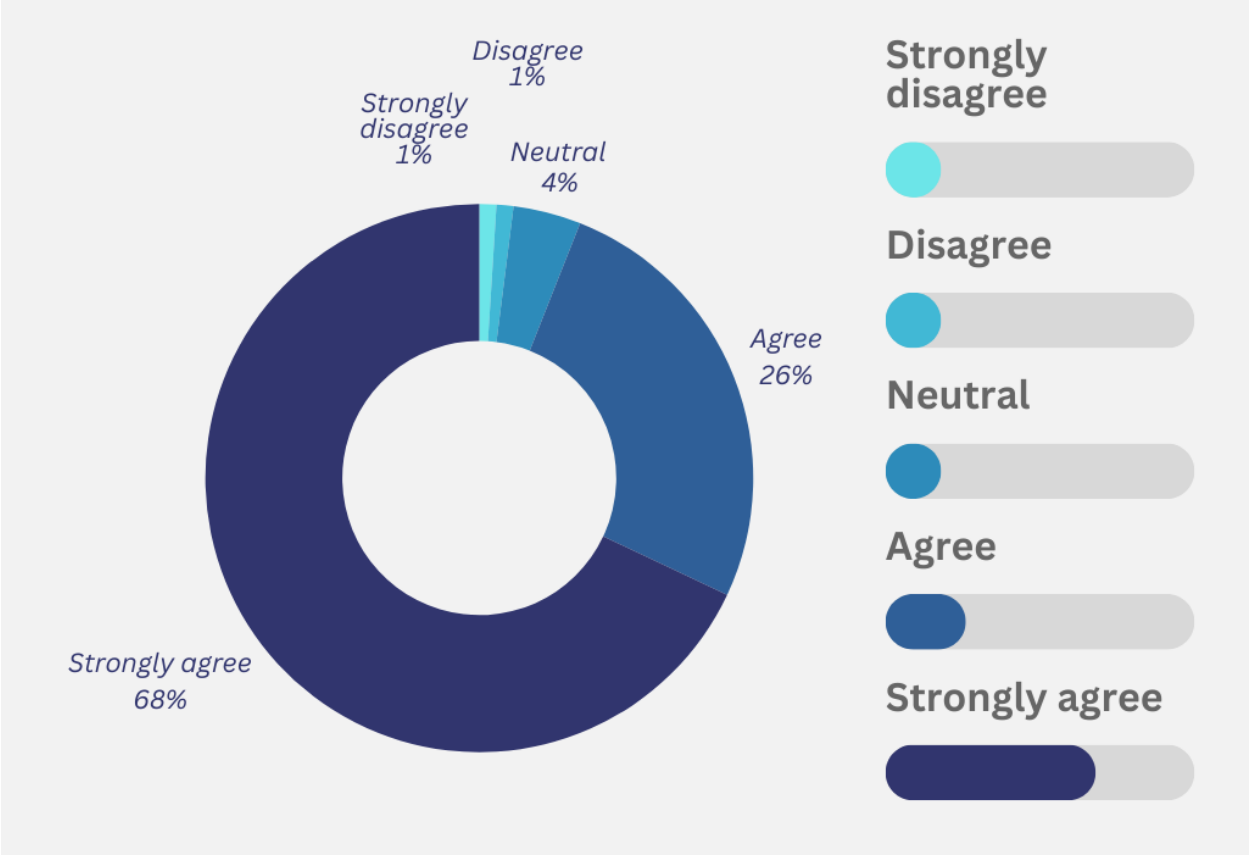


Figure 4-26: Participants' willingness to keep their plastic waste and dispose of it at home.

According to Eriksen *et al.* (2020), “leave no trace” or “take in, take out” measures, where no disposal of waste is allowed within a specific area, are effective mitigation measures to reduce the potential impacts of plastic waste on sensitive environments. However, implementing such measures would require a change in human behaviour around plastic waste management.

4.5.2.14 I have noticed waste bins located in the Struisbaai harbour and the boardwalk area

According to Robinson (2023), the placement and visibility of waste bins are important factors towards managing waste disposal behaviour on beaches. As mentioned in Section 4.4.1.1, there is a total of fourteen waste bins located in the promenade/boardwalk area. When asked whether they have noticed waste bins located in Struisbaai harbour and the boardwalk area, a total of 65% of the participants either strongly agreed (18%) or agreed (47%) that they had noticed waste bins located in the Struisbaai harbour and boardwalk area (Figure 4-27, Table 4-3). This majority indicates that the participants noticed the waste bins, even if they were not particularly paying attention to them. However, the majority only responded with agreement, and not strong agreement, which suggests that there is room for improvement to make waste bins more visible or accessible. The relatively high percentage (20%) of neutral responses (in comparison with previous questions), suggests that waste bins are not very noticeable, as participants were not able to recall seeing the bins. This is also emphasised by the combined 15% of participants that either strongly disagreed or disagreed with the statement (Figure 4-27, Table 4-3), which could be due to several reasons such as: poor visibility or placement of the bins, inadequate signage to indicate waste bins, or unfamiliarity with the area.

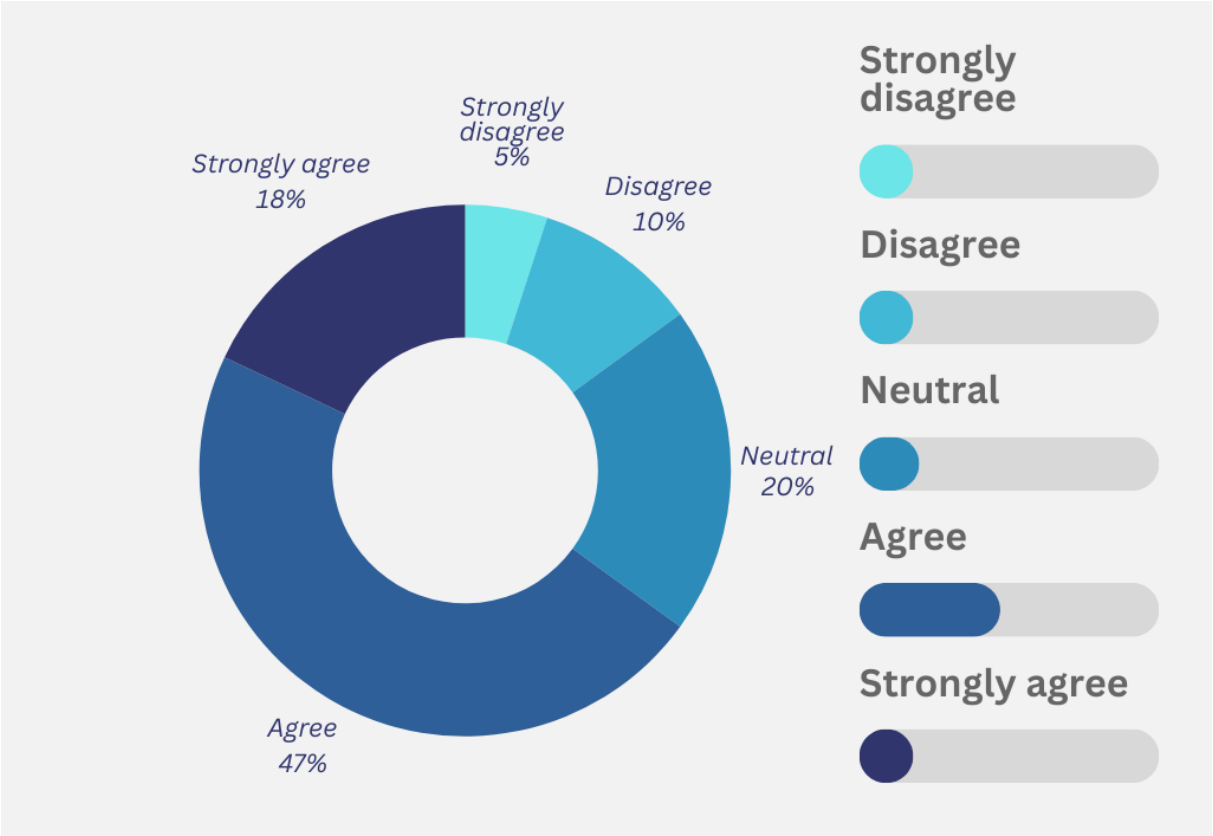


Figure 4-27: Participant perceptions of waste bins located in Struisbaai harbour and the boardwalk area.

4.5.2.15 I have noticed a difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area

A combined 79% of the participants agreed that they have noticed a difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area, with 48% strongly agreeing and 31% agreeing (Figure 4-28, Table 4-3). This is significant to note, as the two areas fall under two different jurisdictions and are, therefore, cleaned up by two different crews. The harbour area is under the jurisdiction of the DFFE, while the boardwalk area is under the jurisdiction of the local municipality, CAM. The majority of the participants indicated that they could see a difference in the amount of plastic waste between the two areas, which suggests that one of the areas could either be subject to more tourists and therefore more waste, or that the clean-up initiative of one of the areas is more effective than that of the other. Approximately 13% of the participants were neutral with regards to the statement, and a total of 8% of the participants either disagreed (6%), or strongly disagreed (2%) with the statement (Figure 4-28, Table 4-3), indicating that they could not see a difference between the two areas. This could be due to not paying

attention when walking through the area, or due to the clean-up crew already taking care of waste in the area before the participants arrived.

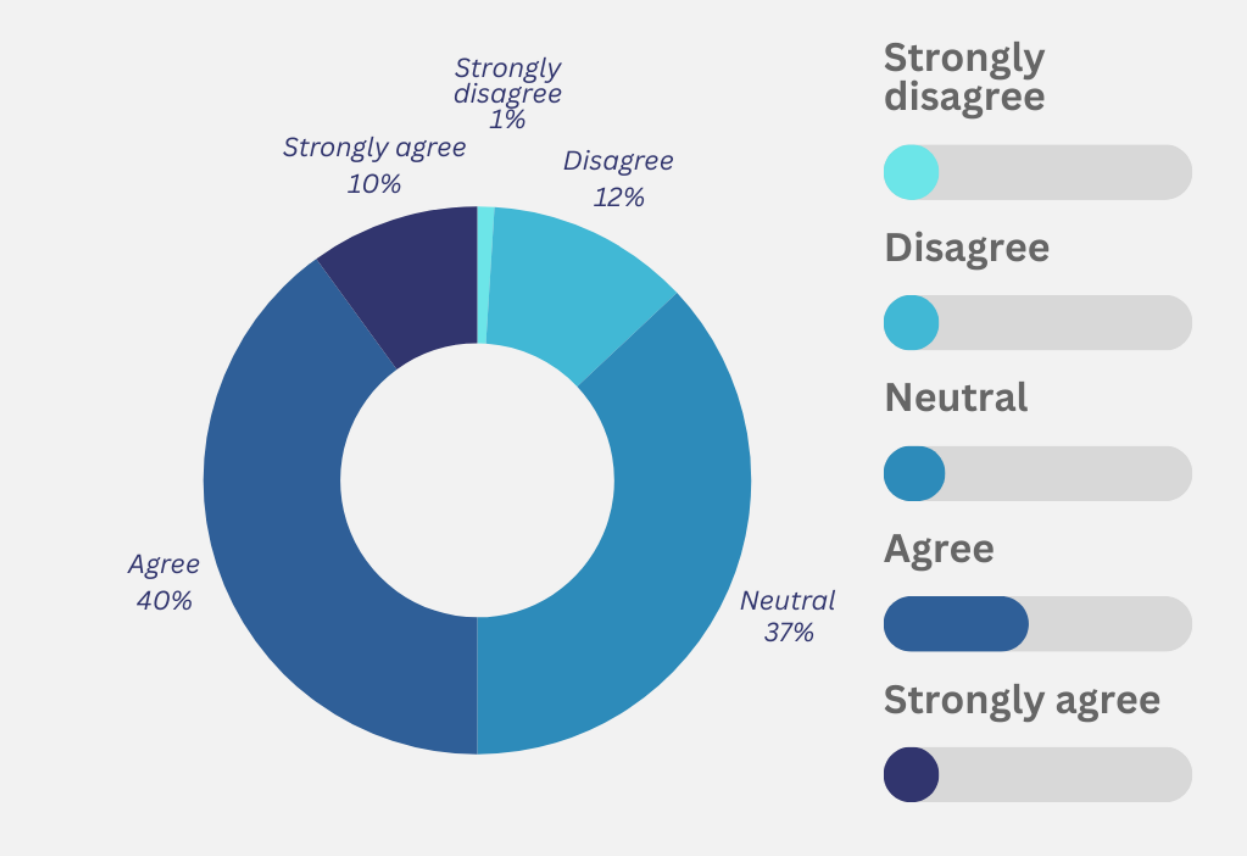


Figure 4-28: Participant perceptions of difference in the amount of plastic pollution between the Struisbaai harbour and the boardwalk area.

4.5.2.16 I think that the current waste management infrastructure (bins/skips) in the Struisbaai harbour and boardwalk area is sufficient

When asked whether they believed that current waste management infrastructure in the study area is sufficient, half of the participants (50%) either strongly disagreed (13%) or disagreed (37%) (Figure 4-29, Table 4-3) with the statement, which indicates the perceived inadequacy of the current waste management infrastructure. The 27% neutral responses suggests that participants may not be familiar with the area, did not pay attention to waste management infrastructure on their visits, or are unsure about the efficiency of the infrastructure. Only 23% of the participants either strongly agreed (5%) or agreed (18%) that the current waste management infrastructure is sufficient, which indicates that only a small percentage of the participants are satisfied with the current infrastructure and the number and placement of waste bins.

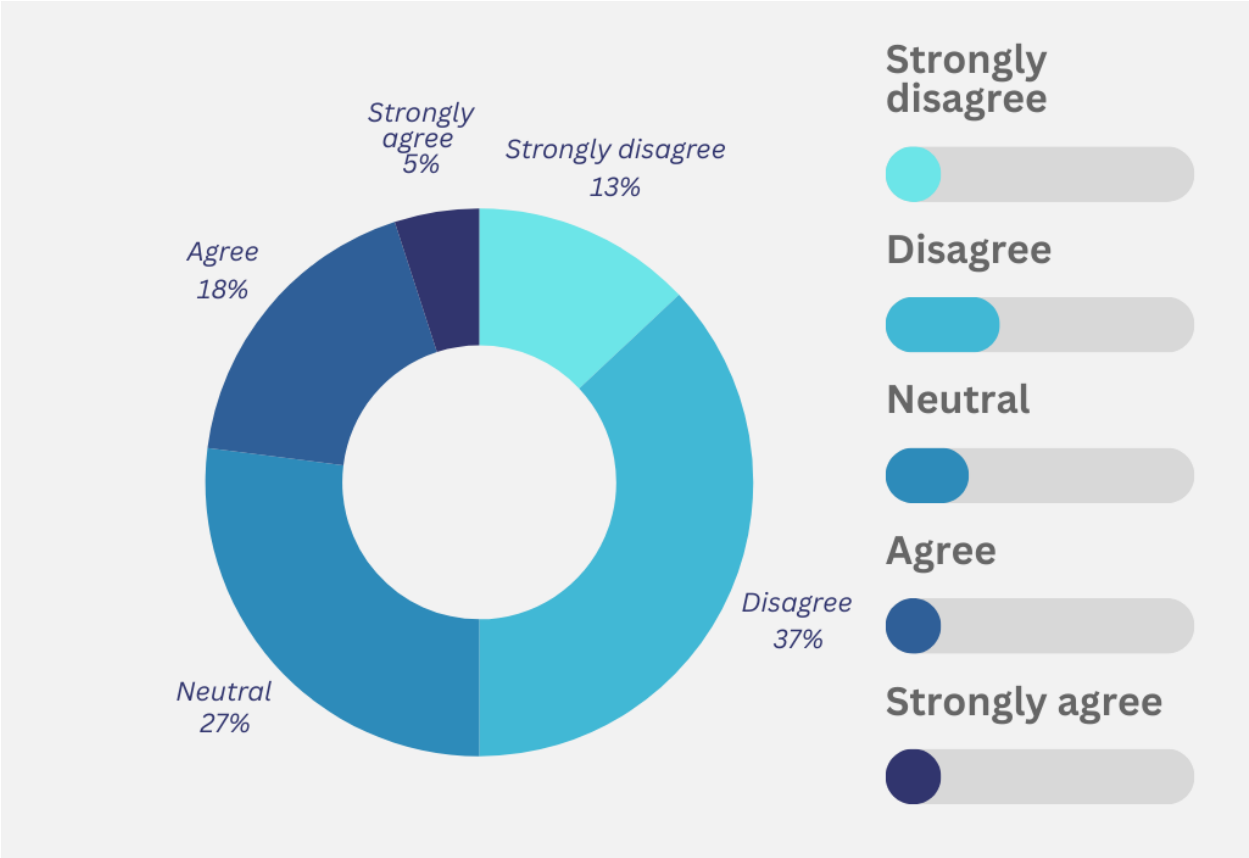


Figure 4-29: Participant perceptions of sufficiency of current waste management infrastructure.

As mentioned in Section 4.4.1.1, a total of 14 waste bins are located along the promenade area. However, many of these bins did not have lids, and some were broken or on their sides, rendering them unusable. The bins are also located far from one another. These may be reasons for the majority of the participants perceiving the infrastructure to be insufficient.

4.5.2.17 I am satisfied with the placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area

When asked to respond to their satisfaction with the placement and accessibility of waste bins, half of the participants (50%) were either in strong disagreement (13%) or disagreement (37%) with the statement (Figure 4-30, Table 4-3), indicating dissatisfaction with the placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area. A relatively large proportion of participants, 27%, responded neutrally which could be attributed to unfamiliarity with the area, or lack of attention to the waste management facilities. The minority of the participants (23%) either strongly agreed (4%) or agreed (19%) with the statement, indicating that a small

portion of the participants found the current placement and accessibility of the waste bins in the area to be sufficient (Figure 4-30, Table 4-3).

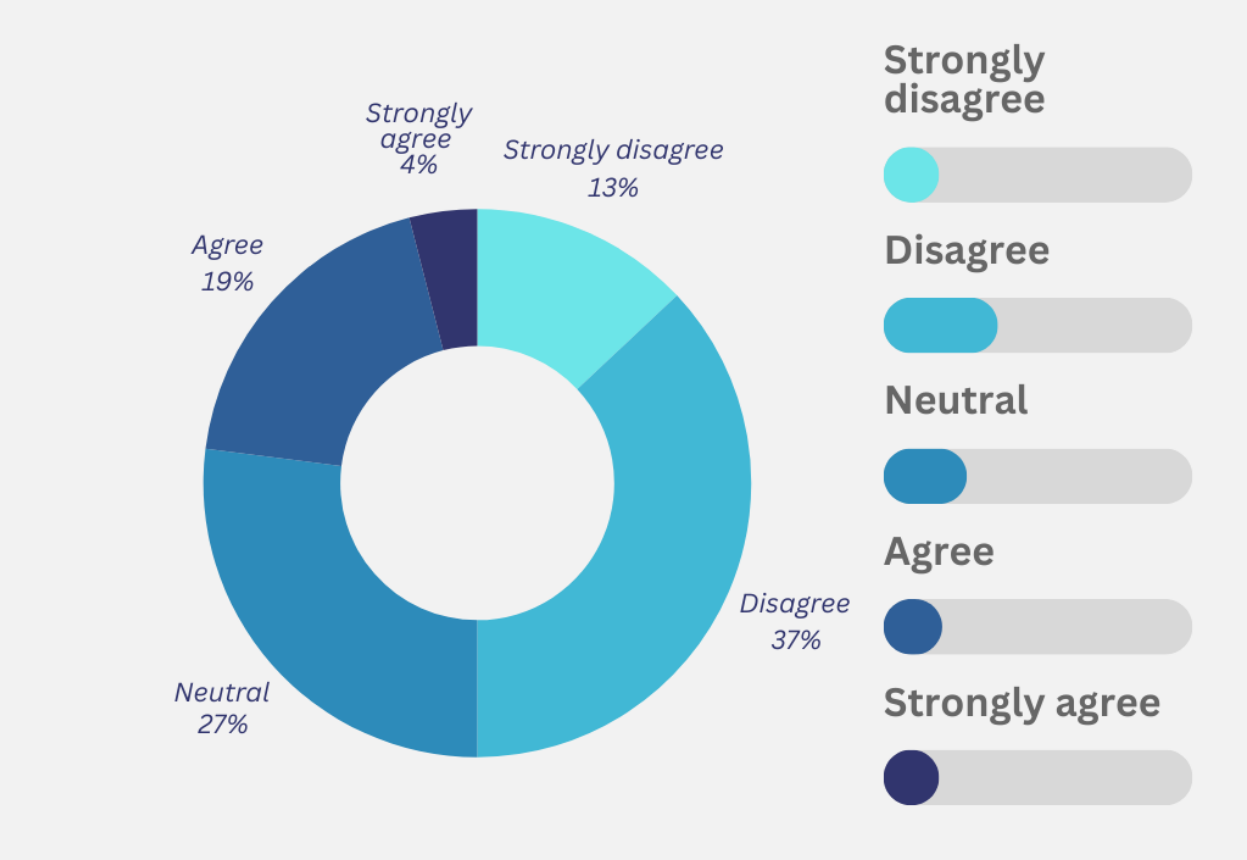


Figure 4-30: Participant satisfaction with placement and accessibility of waste bins in the Struisbaai harbour and boardwalk area.

This dissatisfaction with the placement of accessibility of waste bins could be because they are situated too far apart (See Section 4.1.1) or because the bins are located in areas that are not accessible to the public. According to Robinson (2023), research findings indicate that to increase the use of waste bins, they should be placed where people gather, which is uncommon due to aesthetic concerns. Typically, bins are located at the back of beaches near exits, which may not be optimal. Overall, Robinson's study supports the idea that behavioural change interventions, based on the optimal placement of bins could aid in marine pollution prevention.

4.5.2.18 I have encountered overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area

A combined 44% of the participants indicated that they had encountered overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area, while 28% remained neutral

regarding the issue (Figure 4-31, Table 4-3). A combined 29% did not agree with the statement, with 4% indicating strong disagreement, and 25% indicating disagreement. While these results are more evenly distributed than the previous results, the majority of the participants still indicated that they were dissatisfied with the current management of the waste bins in the area. Participant perceptions could also vary due to various factors, such as visiting the area before or after the clean-up crew had been there, the time of the year, and weather-related issues.

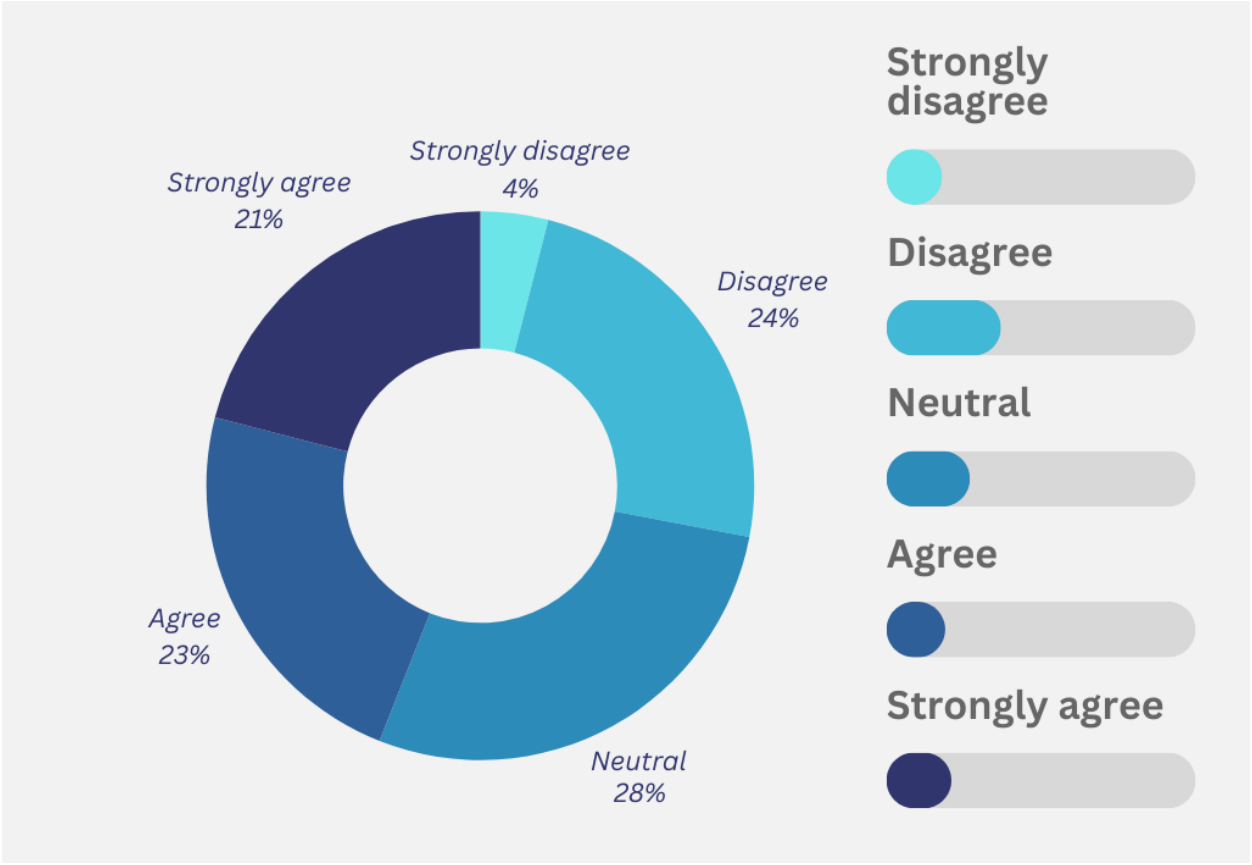


Figure 4-31: Participant perceptions of overflowing or improperly managed waste bins in the Struisbaai harbour and boardwalk area.

As discussed in Section 4.4.1.1, overflowing waste bins were observed on some of the data collection days, depending on the timing of beach clean-ups by clean-up crews.

4.5.2.19 I think the measures currently in place to manage plastic waste in the Struisbaai harbour area are effective

When responding to Question 19 “I think the measures currently in place to manage plastic waste in the Struisbaai harbour area are effective”, a combined 41% of the participants either strongly disagreed (12%) or disagreed (29%) (Figure 4-32, Table 4-3) with the statement, indicating that

the current measures to manage plastic waste in the Struisbaai harbour area are perceived as ineffective. This result suggests that more needs to be done to effectively manage plastic waste in the area. One third of the participants' (33%) responses were neutral. This could stem from a lack of attention to current waste management practices, or inconsistent experiences with the waste management in the area. Lastly, only a combined 26% of the participants agreed (23%) or strongly agreed (3%) that the current measures to manage plastic waste in the area are effective (Figure 4-32, Table 4-3).

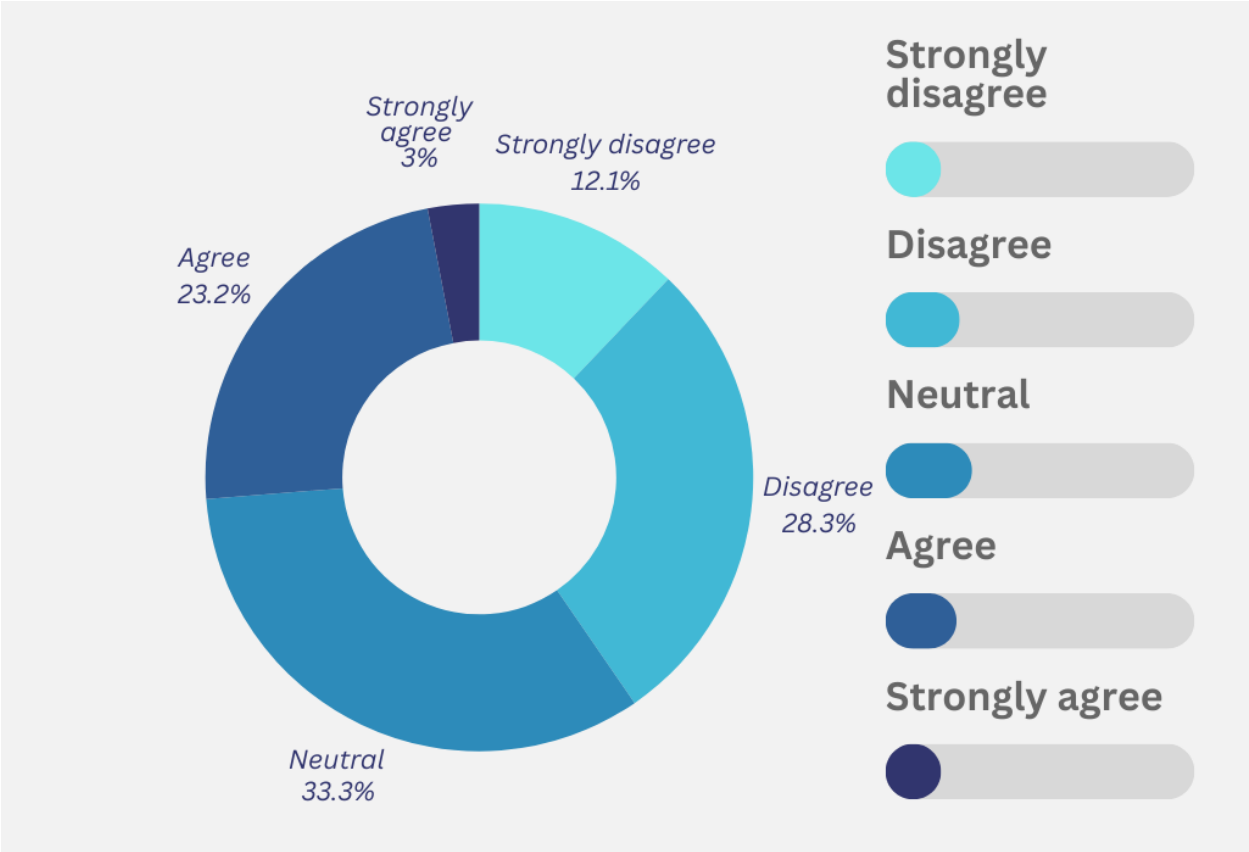


Figure 4-32: Participant perceptions of effectiveness of current measures to manage plastic waste in the Struisbaai harbour area.

According to Gifford and Nilsson (2014) the perceived effectiveness of an intervention of management measure has a strong influence on pro-environmental behaviour. This means that people may be more willing to engage in or support an intervention if they believe that it will have a positive outcome, and that the intervention is effective. To positively change human behaviour around plastic waste, it is, therefore, very important to demonstrate the effectiveness of waste management measures for this waste stream.

4.5.2.20 I think that Struisbaai has the necessary waste management capacity to handle the increased number of tourists during the Holiday season

Question 20 required participants to indicate their level of agreement with "I think that Struisbaai has the necessary waste management capacity to handle the increased number of tourists during the Holiday season". The combined 45% of participants who either strongly disagreed (13%) or disagreed (32%) (Figure 4-33, Table 4-3) with the statement indicated that there is a perceived challenge with the capacity of waste management services and/or infrastructure to handle to influx of tourists during the Holiday season. Only 29% of the participants either strongly agreed (6%) or agreed (23%) that Struisbaai has the waste management capacity to handle an increased population, while 26% of the participants responded neutrally (Figure 4-33, Table 4-3).

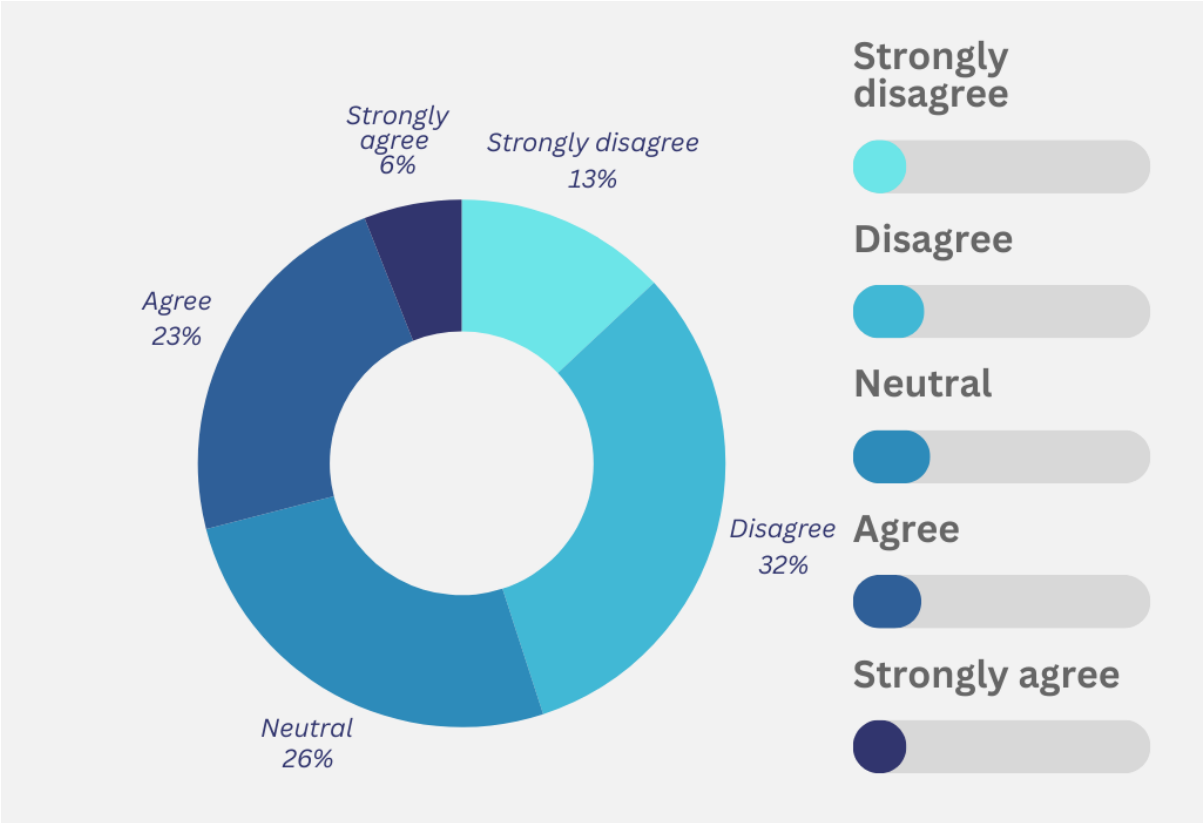


Figure 4-33: Participant perceptions of waste management capacity to handle peak tourist seasons.

Research by Tsagbey *et al*. (2009) in Ghana, and Lukoseviciute and Panagopoulus (2021) in Portugal indicate that popular holiday destinations, especially smaller towns or villages, often do not have sufficient waste management infrastructure and services to deal with the influx of people and increased waste generation during peak holiday periods. This may lead to increased pollution of beaches due to the exceedance of carrying capacities.

4.5.2.21 I think that plastic waste management has improved over the past five years in the Struisbaai area

When asked whether they believed that plastic waste management has improved over the past five-year period in the Struisbaai area, half (50%) of the participants provided neutral responses (Figure 4-34, Table 4-3), indicating that participants are uncertain about improvements, if any, over the past five years or that they do not have a strong opinion about the statement. A combined 27% of the participants either strongly agreed (5%) or agreed (22%) that there has been improvement over the past five years (Figure 4-34, Table 4-3). This relatively small percentage of participants who strongly agreed (5%) could indicate that, although participants agree that there has been some improvement, it has not necessarily a significant improvement. A total of 23% participants either strongly disagreed (9%) or disagreed (14%) (Figure 4-34, Table 4-3).

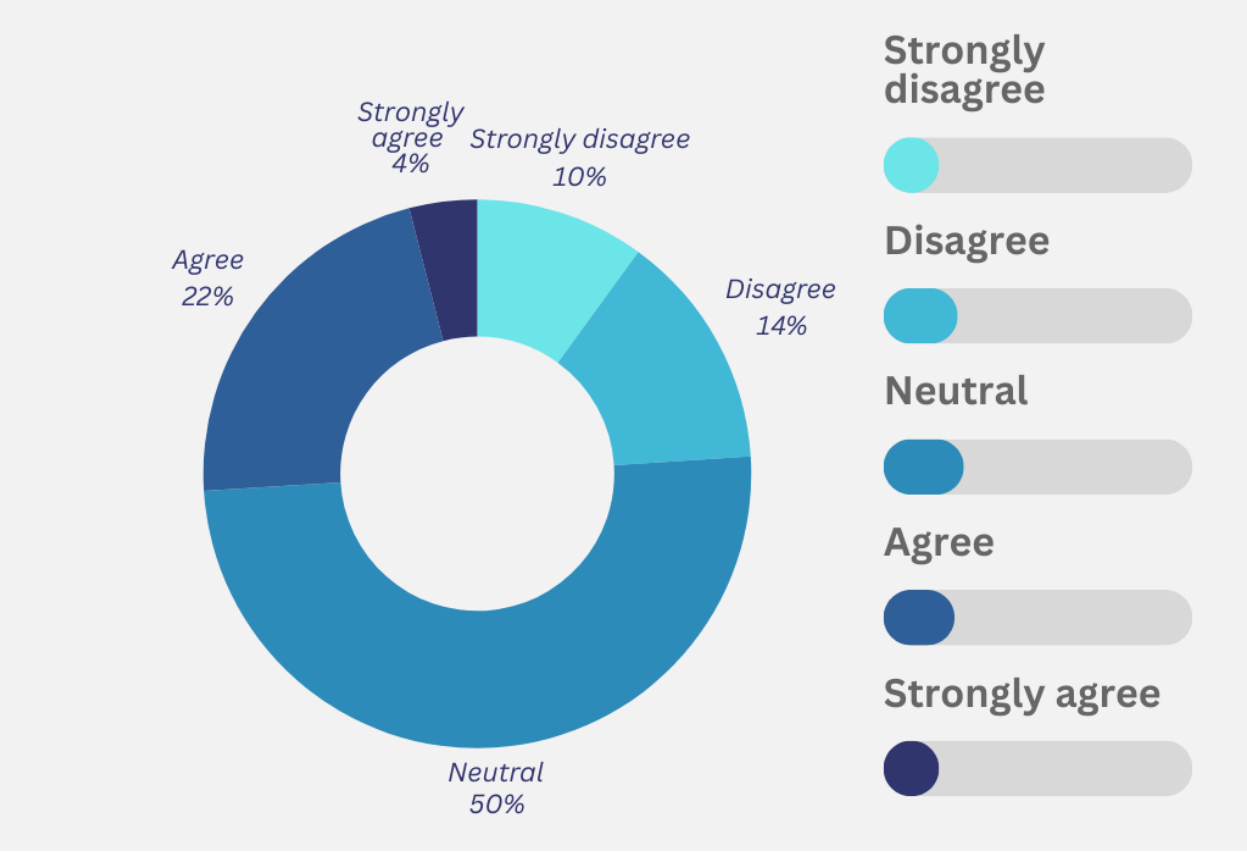


Figure 4-34: Participant perceptions of improvement of plastic waste management over a five-year period in the Struisbaai coastal area.

Since there is no baseline or other studies on plastic waste management in the study area, it is uncertain whether the situation has improved or deteriorated over the past five years.

4.5.2.22 Combined discussions on perceptions of plastic waste management in Struisbaai area (Likert scale questions)

The statements posed in P1 to P8 (Table 4-3) aimed to gauge participants' perceptions of the plastic management and plastic pollution situation in Struisbaai. The responses indicate that the majority of participants believe that plastic pollution is an issue of concern and that they are bothered by the impact and sight of plastics. The responses to P1 to P8 align with the findings from the waste observation data of RO2 (see Section 4.4.1.3), where it was determined that plastic waste was improperly discarded, making its visibility in and around the promenade and harbour area a significant issue. Studies by Randhawa (2024), Gladstone and Hesse (2006), and Hodge (2020) demonstrate that this is also a regular occurrence in other coastal areas. The fact that the presence of plastic made respondents feel uncomfortable and concerned corresponds with a study by Dilkes-Hoffman *et al.* (2019), which found that people view plastic waste as a major environmental issue. A polluted environment has been shown to bother the majority of people, as found by Pásková *et al.* (2023) and Randhawa (2024), and it also reflects deeper societal issues.

Thushari and Senevirathna (2020) and Gall and Thompson (2015) further substantiate this, agreeing that plastic waste poses various threats to marine ecosystems and coastal areas, damaging marine ecosystems and habitats. Additionally, Qiang *et al.* (2019) conducted a simulation to assess the impact of beach cleanliness on tourism revenue, finding that removing plastic and cans from beaches led to an increase in tourism revenue of up to 32.3% and 28.87%, respectively. Bhamra (2024) confirmed these findings, noting that decreased water quality due to pollution could harm local economies reliant on tourism, while Pásková *et al.* (2023) found that visitors prefer clean destinations. These studies collectively support the conclusion that visible plastic waste on beaches can deter tourists from visiting, highlighting the importance of effective plastic waste management in maintaining the attractiveness of coastal areas. It also concludes that the presence of plastic waste is seen as a major issue that affects tourists and residents alike.

The findings of this study showcased that participants are concerned about the issue of plastic waste, which was confirmed by a study conducted by Hodge (2020) (B1). Hodge's (2020) study found that consumers are not changing their habits despite concerns about plastic waste. This contrasts with the findings of this study which found that participants were willing to avoid the use of single-use plastics and were willing to pay a reasonable price for more environmentally friendly products (B2-B3). It is however important to note that willingness to act does not necessarily lead to actual change in behaviour or action. These findings correlate with a study conducted by King (2023), which found that 83% of citizens in a global study are worried about marine plastic waste and have made changes to their consumption habits by buying from companies that are more

environmentally friendly with regards to packaging. The same study found that half of the participants have altered their lifestyles to reduce the consumption of single use plastics.

Responses to B4 and B5 indicated that most participants are willing to walk to waste bins or take waste home with them to dispose of properly. According to Chetty and Ndlovu (2022), the consumers' level of environmental awareness directly corresponds with their willingness to correctly dispose of their waste. The higher the level of environmental awareness the more likely they are to correctly dispose of their waste products. In summary, human behavioural change is required to create a sustainable environment as most prevalent environmental issues can be traced back to human behaviour (Rosenthal & Linder, 2021).

Responses to statements W1, W3, and W5 showed that while participants were aware of waste bins in the harbour area, the number of bins was perceived as insufficient, and the bins were perceived as not being sufficiently accessible or visible. These findings are corroborated by a study conducted by Leeabai *et al.* (2021) who found that waste bins that were less noticeable and not properly indicated led to them being overlooked by consumers. They also indicated that the location and colour of the waste bins contributed significantly to visibility and proper waste disposal.

Responses to W4 found that participants were less willing to walk longer distances to reach less accessible waste bins. A study by Robinson (2023) found that the bins that were the most accessible were more frequently used to dispose of waste in comparison to less accessible bins that inconvenienced consumers.

Responses to W7 showed that participants were concerned that the current waste management capacity in Struisbaai harbour is insufficient to handle the influx of tourists during the holiday season. This corresponds to studies conducted by Kong *et al.* (2023) and the CSIR (2011) which found that waste drastically increased during the peak holiday season, especially in popular holiday destinations. The CSIR (2011) study relayed that some municipalities resorted to collecting waste twice a week instead of only once, which is mirrored in Struisbaai during the holiday season, although this proves insufficient for the number of tourists in the area, especially along the shore.

The next section, Section 4.5.3 builds on this section by providing participants' perceived opportunities and challenges regarding plastic waste management in the Struisbaai area in response to open-ended questions.

4.5.3 Perceived opportunities and challenges regarding plastic waste management in the Struisbaai area

This section presents the results and discussion of the intuitive thematic analysis of the open-ended questions in the survey questionnaire. Section 4 of the survey questionnaire provided four open-ended questions:

1. *In your opinion, what are the challenges regarding plastic waste management in the Struisbaai area?*
2. *In your opinion, what are the opportunities for plastic waste management in the Struisbaai area?*
3. *What are your suggestions/recommendations for improvement regarding plastic waste management in the Struisbaai area?*
4. *Are you aware of any ongoing initiatives or projects in and around Struisbaai that promote recycling or environmentally conscious campaigns and activities?*

Table 4-4 summarises the perceived challenges related to plastic waste management in the Struisbaai area, while Table 4-5 outlines the opportunities for improving plastic waste management, based on participant responses in this study. Themes were derived from phrases and statements made by respondents, with the frequency of mentions also noted.

4.5.3.1 Perceived challenges regarding plastic waste management in the Struisbaai area

This section presents the challenges related to plastic waste management in the Struisbaai area, as identified by participants in the study. Table 4-4 summarises these challenges and is categorised into themes based on participant responses. The frequency of mention for each theme is also noted. Key challenges include insufficient infrastructure, problematic tourist behaviour, infrequent emptying of bins, lack of education and awareness, lack of enforcement, and insufficient waste management.

Table 4-4: Perceived challenges regarding plastic waste management in the Struisbaai area (n = 211)

Theme	Phrases mentioned	Frequency
Tourist behaviour	*"too many tourists", "tourists don't care about the area", "too much waste generated by visitors", "messy and irresponsible tourists" "ignorance of holiday makers" "ill-disciplined*	68 (32%)

Theme	Phrases mentioned	Frequency
	people", "lack of care for environment", "vandalism of dustbins", "leave waste on beach"	
Insufficient infrastructure	*"not enough bins", "broken bins", "no lids", "uncovered waste bins", "bins too close to ocean", "waste blown away", "natural factors such as wind", "not enough bins close to the beach/harbour/boardwalk", "small bins", "ill placed", "overflowing bins", "not enough bins for all of the tourists", "too many tourists over peak season"*	57 (27%)
Lack of education and awareness	*"not enough education", "uneducated people", "unaware of the damage of plastic waste", "no signs to raise awareness"*	26 (12%)
Insufficient waste management	*"waste management is irregular", "no management", "insufficient action of municipal service", "don't have the necessary plastic waste management capacity", "non-existent local municipality", "local municipality doesn't have a solid plastic waste management system", "insufficient clean-up crew", "lack of government intervention", "lack of waste management schemes"*	23 (11%)
Infrequent emptying of bins	*"bins not emptied frequently enough", "waste not collected at frequent intervals", "insufficient waste removal from bins", "more cleaning people"*	10 (5%)
Lack of enforcement	*"not enough local police", "no patrolled regulation", "lack of monitoring"*	8 (4%)

4.5.3.1.1 Tourist behaviour

The most frequently mentioned challenge regarding plastic waste management in the Struisbaai area was tourist behaviour, which was mentioned by 68 of the 211 participants (32%). Participants mentioned challenges such as: “too many tourists”, “tourists don’t care about the area”, “messy and irresponsible tourists” “ignorance of holiday makers” “ill-disciplined people”, “vandalism of dustbins”, and “leave waste on beach”.

A first-time visitor mentioned that *“Guests and visitors leave plastic and waste in the beach area”*. Another visitor who has been to Struisbaai between six and ten times also mentioned that *“Some people have no respect for the environment and are too lazy to put their waste in a bin themselves.”*

The results indicated a direct correlation between the influx of tourists during peak seasons and the amount of waste accumulated on beaches. This aligns with Nachite *et al.* (2019), who identified beachgoers as major contributors to litter, with the volume of waste generated increasing together with increasing tourist numbers. The study also highlighted that the seasonality of beach use significantly impacts waste generation, with a noticeable rise in waste during the summer months. This is supported by other international studies in coastal areas by Silva *et al.* (2018), Gómez *et al.* (2020), Pervez *et al.* (2020), and Chen and Chen (2020).

Kombiok *et al.* (2021) attributed human behaviour as one of the main factors with regards to plastic waste. According to a study by Van Doesum *et al*. (2021), intentional littering often occurs because many people are unwilling to walk to waste bins, choosing instead to leave their waste on the beach. A study on South African consumers found that, despite the attempt by the local government to lower consumers’ plastic usage by implementing levies on plastic bags, consumers did not lower their consumption habits and were willing to pay the levies (Hira *et al.,* 2022). This is relevant to the study because nearly 80% of all marine pollution comes from land-based sources (Verster & Bouwman, 2020; Adam *et al.,* 2020), which is also the case in Struisbaai. The issue of plastic bags in oceans is also discussed by Chikodze *et al.* (2021).

4.5.3.1.2 Insufficient infrastructure

The second most frequently mentioned challenge regarding plastic waste management in the Struisbaai area was insufficient infrastructure, which was mentioned by 57 of the 211 participants (27%). Participants mentioned challenges such as “not enough bins”, “broken bins”, “no lids”, “uncovered waste bins”, “bins too close to ocean”, “waste blown away”, “influx of tourists over peak season”.

A visitor who has visited Struisbaai between six and ten times said, "*Walking along the boardwalk I only noticed that there were not enough bins and had kept my waste with me for a while before finding one*". One of the local residents also mentioned that *"Most of the bins are broken and not covered and waste gets blown into the ocean."* Another participant (second to fifth time visitor) said that "*Because this is a holiday town the amount of people moving in and out of town is not constant. The clean-up routine must be adapted according to the peak and off seasons*".

The research area had several waste bins, but most were not functional or properly maintained (refer to Section 4.1.1.1.). Despite a significant influx of tourists during peak seasons, waste collection efforts from the municipality did not scale up to handle the increased waste, even though it was requested multiple times from local residents. Additionally, the waste bins were not located close to each other, which significantly influenced whether people chose to litter. The availability and proximity of waste bins were found to have a major impact on littering behaviour, as supported by the findings of Schutz *et al.* (2013).

Insufficient waste management infrastructure is a common issue faced by South African municipalities. The National Waste Management Strategy aims to address this issue as part of Pillar 1, where it has the objective of reducing the impact of waste, particularly plastic packaging, in South Africa's coastal areas, rivers, wetlands, and communities. This involves implementing measures to redirect waste from landfills (Department of Forestry, Fisheries, and the Environment, 2020).

Garcés-Ordóñez *et al.* (2020b) found that rural coastal communities suffer from a lack of waste infrastructure due to being located far from large cities which complicates waste services. In recent years, Struisbaai is no longer classified as a rural area due to the development of infrastructure and a growing population, as well as becoming a very popular tourist holiday destination. However, the development of waste infrastructure has not kept up with other developments or the influx of permanent residents, which has led to a significant lack of waste infrastructure.

4.5.3.1.1 Lack of education and awareness

Lack of education and awareness was mentioned by 26 of the 211 participants (12%) as a challenge regarding plastic waste management in the Struisbaai Harbour area. The participants mentioned challenges such as "not enough education", "uneducated people", "unaware of the damage of plastic waste", "no signs to raise awareness".

A returning international visitor mentioned that *"People are not educated and unaware of the danger and negative impact plastic waste has on the environment"*. Another visitor who has visited

Struisbaai more than ten times also mentioned *"The lack of public education on how plastic can affect the area [is a challenge]."*

Kombiok *et al.* (2021) found that education was an underlying factor in the improper disposal of single-use plastics. To eradicate the lack of awareness, strategies such as big signage and information bulletins as well as other interpretation methods could be implemented to improve awareness about plastic waste (Chetty & Ndlovu, 2022). The apparent lack of these type of strategies could result in a lack of education and awareness about the negative impact of plastic waste.

Furthermore, it should be noted that consumers are more likely to have a more negative outlook towards plastic reduction efforts such as recycling if they are not confident in their knowledge about the topic or less aware about the negative impacts of plastic waste (Afroz *et al.,* 2017).

4.5.3.1.1 Insufficient waste management

Another challenge mentioned by 23 of the 211 participants (11%) was insufficient waste management in the Struisbaai area. Participants mentioned challenges such as: "Waste management is irregular", "there is no management of waste", "insufficient action of municipal waste service", and "Struisbaai does not have the necessary plastic waste management capacity".

A resident of Struisbaai said that there are "*not enough bins*" and that there is a *"lack of monitoring, and regular removal of waste".* Another local resident mentioned that there is a *"total lack of responsibility from DFFE and CAM and all responsible authorities."*

Another resident was of the opinion that *"Despite no longer being classified as a rural area, the infrastructure and waste management systems in Struisbaai are still on the same level as that of a rural area where infrastructure is unable to handle large influxes of tourists and cannot support the growing permanent population."*

The inadequacy of proper waste management in rural communities is supported by Mihai *et al.* (2022) who found that there is often no separation of recyclables during waste management in households or waste collection. Although, characteristically, rural areas have lower waste generation due to lower expendable income and being located far from major shopping malls, the increase in availability of pre-packaged goods and the surge in purchasing power, has led to an increase in plastic waste generation in these communities. This lack of waste management is only amplified in peak tourism seasons where tourists are not aware of the inadequate waste

management systems and do not realise the pressure that they add to an already struggling system.

This is supported by the findings of Chikodzi *et al.* (2021), who found that poor waste management in the Durban Harbour area resulted in heavy plastic pollution in the upper catchment area. According to a study by Lucrezi *et al.* (2015), the implementation of beach awards such as the Blue Flag Award aims to provide valuable tools for managers to control and limit the negative impacts of human activities on sandy beaches, such as marine pollution. In comparison to the findings of this study, waste management in Struisbaai (although it has Blue Flag status) complies very poorly with the criteria for Blue Flag beaches, including bins, litter picking, and recycling.

4.5.3.1.2 Infrequent emptying of bins

Another perceived challenge was infrequent emptying of bins, which was mentioned by ten of the 211 participants (5%). Participants mentioned challenges such as: “bins not emptied frequently enough”, “waste not collected at frequent intervals”, “insufficient waste removal from bins”, “more cleaning people”.

A first-time visitor mentioned that *“the bins are not cleaned out timeously”*, while one of the local residents also mentioned that *“bins should be emptied much more regularly during vacation times (capacity issue).”*

Kiessling *et al.* (2017) found that licensed Blue Flag beaches are commonly better equipped with litter bins and are regularly serviced in comparison to unlicensed beaches that have few litter bins and irregular litter removal services. This contrasts with the findings of this study as Struisbaai is a licensed Blue Flag Beach but has very few litter bins and irregular litter removal services as is characteristic of unlicensed beaches. Another factor that could play a role in the infrequent emptying of bins is the distance between waste collection points. Not only does this impact the use of the bins as consumers are unwilling to walk long distances to waste collection points, but it also increases the difficulty of regularly cleaning out the waste (Mihai *et al.,* 2022).

4.5.3.1.3 Lack of enforcement

Lack of enforcement was considered another challenge for plastic waste management in the Struisbaai area by eight (4%) of the 211 participants. The participants noted challenges such as: “not enough local enforcement”, “no patrolled regulation”, and “lack of monitoring.

A sixth to tenth time visitor said that *“there are not enough local police to maintain a clean environment around the harbour”*. A visitor coming to Struisbaai for more than ten times mentioned that *“there is no control of littering at all.”*

Inadequate law enforcement leads individuals to believe they will not be caught for non-compliance (Willis, 2021; Mihai *et al.,* 2022). Additionally, gaps in law enforcement and legislation can encourage consumers to illegally dump or burn their waste, more so if there are no consequences involved with these actions (Niyobuhungiro & Schenck, 2020). The municipality and stakeholders must intensify their efforts in enforcing environmental laws to protect the oceans and support the blue economy (Chikodzi *et al.,* 2021).

4.5.3.2 Perceived opportunities regarding plastic waste management in the Struisbaai area

This section highlights the perceived opportunities for improving plastic waste management in the Struisbaai area, as identified by participants in the study. Table 4-5 summarises these opportunities, categorised into themes based on participant responses, with the frequency of mentions also noted. Key opportunities include improving waste infrastructure, enhancing waste management practices, increasing the frequency of waste bin emptying, banning plastic products, implementing awareness and education programmes, providing incentives, encouraging behavioural changes, creating job opportunities, establishing a fining system, and improving enforcement measures. In many instances, a direct link can be seen between the perceived challenges and the opportunities proposed.

Table 4-5: Perceived opportunities regarding plastic waste management in the Struisbaai area

Theme	Phrases mentioned	Frequency
Improvement of waste infrastructure	*"more bins", "bins that cannot tip over", "covered bins", "recycling bins", "more waste collection points", "bigger bins", "visibility of bins", "colour code recycle bins", "enough bins with lids", "more accessible waste bins", "replace damaged bins", "properly anchor waste bins"*	123 (58%)
Waste awareness, education, and clean-up programmes	*"local community involvement", "awareness and education", "clean-up programmes", "polls/voting", "education of dangers of plastic", "anti-plastic waste campaigns/activities", "promote green*	87 (41%)

Theme	Phrases mentioned	Frequency
	environments", "recycling programmes", "educate visitors in waste management", "reuse, reduce, recycle", "banners", "public participation", "educate the people", "get schools involved", "clean-up crew and awareness campaigns especially during peak season", "summer jobs for school children", "education in schools", "training programmes", "unemployed youth projects", "use social media for awareness", "recycling plant"	
Fining system	*"issue fines when necessary", "implement fine for littering"*	35 (17%)
Improvement of waste management	*"privatise waste management", "better management", "more municipal action", "more municipal responsibility", "improve management of landfills", "there is room for improvement"*	32 (15%)
Work opportunities and job creation	*"hire unemployed people in peak season", "job creation", "economic benefit", "allocate government work to locals"*	32 (15%)
More frequent emptying of waste bins	*"frequently empty waste bins", "empty bins on a daily basis during peak season", "municipality must collect waste more frequently", "increase waste collection"*	23 (11%)
Better enforcement	*"littering will not be tolerated", "policing", "use authority figures to watch over harbour", "monitor by local patrols", "municipal workers supervised", "stricter regulations", "law enforcement on a regular basis"*	18 (9%)

Theme	Phrases mentioned	Frequency
Behavioural changes	*"people need to take responsibility to keep the environment clean", "reduce and avoid the use of single-use plastics", "refuse to buy plastic products", "recycle"*	17 (8%)
Banning of plastic products/implement alternatives to plastic products	*"plastic free area", "restaurants must ban single use plastics", "substitute alternative materials", "make restaurants environmentally friendly", "adopt sustainable alternatives"*	14 (7%)
Incentives	*"reward system for schools and businesses", "for every bag of waste picked an incentive should be given", "incentives for dis-use of plastic products", "incentives for reuse and recycling"*	13 (6%)

4.5.3.2.1 Improvement of waste infrastructure

The most frequently mentioned opportunities regarding plastic waste management in the Struisbaai area was improvement of waste infrastructure, which was mentioned by 123 of the 211 participants (58%). Participants mentioned opportunities such as: "more bins", "bins that cannot tip over", "covered bins", "recycling bins", "more waste collection points", "bigger bins", and "visibility of bins".

One of the visitors who visited Struisbaai more than ten times mentioned "*the bins could have lids"* and another said, "*recycling dustbins should be used for different wastes*". One of the local residents suggested *"implement more waste bins around the harbour, promenade, and the docks."*

Proper waste infrastructure in coastal areas is vital to prevent waste from entering marine environments. Implementing effective waste systems in these areas is an essential solution for managing waste properly. This statement is supported by research done by Herdiansyah *et al.* (2021), who stipulated that the high amounts of waste generated in coastal areas is directly related to insufficient infrastructure. Implementing adequate waste infrastructure can contribute

to a healthy ecosystem and a good social and economic environment for the community (Herdiansyah *et al.,* 2021).

4.5.3.2.1 Waste awareness, education, and clean-up programmes

The second most frequently mentioned opportunity regarding plastic waste management in the Struisbaai area was the improvement of waste awareness, education, and clean-up programmes which was mentioned by 87 of the 211 participants (41%). The participants mentioned phrases such as “local community involvement”, “awareness and education”, “clean-up programmes”, “education of dangers of plastic”, “anti-plastic waste campaigns/activities”, and “recycling programs”.

A local resident suggested: *“implement anti-plastic waste campaigns and activities”*. Another tourist who has visited Struisbaai more than ten times who was in the area for work highlighted the following opportunity: “*involve local community in waste management and have programmes that will teach/educate them about the importance or benefits of healthy marine environments”.*

These suggestions align with a study by Kombiok *et al.* (2021), which supports the idea that public education is a key part of the solution to minimising plastic waste. Similarly, a study by Iroegbu *et al.* (2020) supports this finding as the authors also called for proper public education campaigns across the nation of South Africa to encourage behavioural changes with regard to plastic waste.

A study by Willis *et al.* (2022) confirms the impact of educational programmes with regards to plastic waste as the results of the study indicated that there was a decrease in pollution and plastic consumption in communities where taxes and levies on single-use plastics and education programmes were used.

4.5.3.2.1 Fining system

Participants indicated the implementation of a fining system as an opportunity for plastic waste management in the Struisbaai area. This suggestion was made by 35 of the 211 participants (17%). Participants mentioned phrases such as: “issue fines when necessary”, “implement fines for littering”.

A person who has visited Struisbaai more than ten times mentioned *“if people don’t adhere to rules of the harbour area maybe a small fine would encourage them to do the right thing”*. One of the local residents also suggested "*better law enforcement with regular patrols that issue fines*."

An example of using fines as a method to discourage the use of single use plastics is Kenya, where fines have been imposed on both individuals and companies for the use of plastic bags.

This proved to be effective as nearly 80% of the population stopped buying plastic bags (Hira *et al.,* 2022). Kiessling *et al.* (2017) confirms this finding as participants in that study also recommended implementing various degrees of fines for coastal littering.

4.5.3.2.2 Improvement of waste management

Participants suggested the improvement of waste management (infrastructure and services) as another opportunity regarding plastic waste management in the Struisbaai area, which was mentioned by 32 of the 211 participants (15%). Participants mentioned opportunities such as: “privatise waste management”, “better management”, “more municipal action”, “more municipal responsibility”.

An international visitor recommended: *“more and better cleaning efforts from the municipality and they should start doing clean-ups twice a day”*. A local tourist who has visited Struisbaai six to ten times suggested: *“improving the measures and waste management currently in place to manage plastic waste in the Struisbaai Harbour are.”*

A study in Ponta Do Ouro revealed that, due to the ineffective waste management by the government, business owners in the private sector started a clean-up initiative where local community members cleaned the beaches and the residential areas (Botha, 2023). Other cases of this were observed by Kerber and Kramm (2021) and Botero *et al.* (2017), who observed a significant contrast between tourist beaches where the government is responsible for clean-ups and more remote private beaches. This suggests that privatising waste management could be more effective than depending on the government.

4.5.3.2.1 Work opportunities and job creation

Another opportunity regarding plastic waste management in the Struisbaai area was work opportunities and job creation, which was mentioned by 32 of the 211 participants (15%). Participants mentioned opportunities such as: “hire unemployed people in peak season”, “job creation”, “economic benefit” and “allocate government work to locals”.

A frequent visitor to Struisbaai (visiting the area more than ten times) *“students can be employed and paid to collect plastic waste”*. One of the local residents also mentioned that *“the municipality can hire unemployed people especially during peak season to clean up at least twice a week.”*

The local government is failing to address marine plastic pollution (Dijkstra *et al*., 2022). This gap in the market created a platform for informal job opportunities such as waste reclaiming, which is slowly becoming an organisation on its own (Roberts, 2022). The waste reclaiming association has even created its own recycling facility, although it is still struggling to receive government

recognition and integration into the system (Mafata, 2024). Initiatives like these would be greatly beneficial in Struisbaai as they would not only provide job opportunities, for which there is a dire need, but also positively contribute to a cleaner environment and environmental awareness.

4.5.3.2.2 More frequent emptying of waste bins

Of the 211 participants, 23 (11%) mentioned that more frequent emptying of waste bins is an opportunity regarding plastic waste management in the Struisbaai area. “Frequently empty waste bins”, “empty bins on a daily basis during peak season”, “municipality must collect waste more frequently”, “increase waste collection”, were opportunities mentioned by the participants.

A tourist who has visited Struisbaai between six and ten times said that *“bins should be emptied much more regularly during vacation times (capacity issue)”,* and another tourist visiting Struisbaai for the second to fifth time said, “*the dustbins are overflowing and refuse removal needs to happen more frequently*”.

Regular waste collection will ensure that bins do not overflow and will make waste collecting more pleasant and effective for waste collectors. This is substantiated by Sciortino and Ravikumar (1999) who found that overflowing waste bins discouraged people from using and emptying bins. If coastal waste bins are frequently emptied, bins will not be overflowing with garbage and windblown waste would be reduced (TOMRA, 2022a). As mentioned earlier, Struisbaai is often subject to strong wind conditions and frequent emptying of bins could prevent windblown waste blowing into the surrounding marine environment.

4.5.3.2.1 Better enforcement

An opportunity mentioned by 18 of the 211 participants (9%) was better enforcement of regulations for plastic waste in the Struisbaai area. “Littering should not be tolerated”, “policing”, “monitor by local patrols”, “stricter regulations”, and “law enforcement on a regular basis” were opportunities mentioned by participants.

A visitor who has visited Struisbaai more than ten times mentioned *“stricter regulations and rules regarding plastic waste management in the Struisbaai Harbour and surrounding areas”*. One of the local residents stated, “*hire personnel to patrol the area to ensure that no one litters and to keep the harbour completely free of waste.”*

According to a study by Kombiok *et al.* (2021), regulatory enforcement is seen as part of the solution to combat plastic waste. Enhancing law enforcement through the establishment of policies and regulations is essential for protecting the environment from plastic pollution and is crucial for environmental preservation (Puluhulawa & Puluhulawa, 2021).

4.5.3.2.1 Behaviour changes

Of the 211 participants, 17 (8%) mentioned that people's behaviour needs to change towards plastic waste management in the Struisbaai area. "People need to take responsibility to keep the environment clean", "reduce and avoid the use of single-use plastics", "refuse to buy plastic products", "recycle" were phrases mentioned by the participants.

A first-time visitor from South Africa said, *"Every person must take own responsibility to dispose of their plastic waste. We need to change our behaviour"*. One of the local residents mentioned that *"people should avoid and discontinue the use of single-use plastics such as straws and plastic bags. It should become part of the way in which we do things (a habit)."*

Consumer decision making and behaviours is the ultimate reason for plastic ending up in oceans (Pahl *et al.,* 2020). Portman *et al.* (2019) highlight that it is important to dissuade consumers from litter, particularly beachgoers in areas where a lot of waste is accumulated over holiday seasons. The same study reiterated the important role that beach infrastructure design plays in consumer behaviour relating to littering, such as bin design, colours, etc. Through intentionally studying consumer behaviour towards littering as well as behavioural determinants, governments and organisations can devise more effective strategic plans to encourage the reduction of waste (Badawi *et al.,* 2024).

If behavioural traits of both local residents and tourists can be analysed at Struisbaai, the authorities in charge of waste management would be able to determine the most effective ways of encouraging a behavioural change to littering.

4.5.3.2.2 Banning of plastic products/implement alternatives to plastic products

Another opportunity raised regarding plastic waste management in the Struisbaai area was the banning of plastic products, which was mentioned by 14 of the 211 participants (7%). Participants mentioned opportunities such as: "plastic free area", "restaurants must ban single use plastics", "substitute alternative materials".

A first-time visitor suggested: *"attempt to make Struisbaai a zone free of single use plastics. This can be used as a marketing campaign to sell the tourism in the area"*. An international tourist and a first-time visitor also mentioned that *"an effective way is the ban of some plastic products especially where other non-plastic products are feasible (plastic bags, straws, cups, cutlery). While this might be harder to implement locally, a joint effort of shops and restaurants in this regard might help a lot."*

Kombiok *et al.* (2021) suggests that substitutes for plastic products are an integral part of the solution to plastic waste issues. Bans on single-use plastics are also an effective way to reduce plastic consumption as is evident from a study conducted by Fanini and Guittard (2021), who concluded that a ban on single-use plastics seems to be the most effective approach to avoid these products. Banned items were determined by the frequency of their presence on beaches (Fanini & Guittard, 2021), which could also be used as a guideline in Struisbaai to determine which products should be banned.

4.5.3.2.3 Incentives

Participants indicated incentives as an opportunity for plastic waste management in the Struisbaai area, which was mentioned by 13 of the 211 participants (6%). Participants mentioned opportunities such as: “reward system for schools and businesses”, “incentives for dis-use of plastic products”, “incentives for reuse and recycling”.

An international tourist mentioned that *“a small recycling facility can be established where people can take plastic/glass/metal for a small incentive”*. One of the local residents mentioned “*arrange challenges with companies or schools to keep sections of beaches clean with a ‘reward’ system for cleanest sections.”*

In a study conducted on Australian and United States coastlines it was found that incentives played a major role in removing plastic waste (specifically bottles) from coastal areas (Schuyler *et al.,* 2018). Incentives are proven to be more effective than disincentives such as levies and taxes as the latter encourages illegal dumping to avoid taxation while incentives encourage picking up litter (Schuyler *et al.,* 2018). Furthermore, the study results indicated that the area offering the highest reward for litter deposits also had the highest number of deposits. Norway has the most successful deposit refund system in the world, with a 92.8% return rate, attesting to its success and effectiveness (TOMRA, 2022b). This could be an effective strategy in Struisbaai as it will encourage people, especially low-income groups, to deposit waste safely. Struisbaai could use Norway’s deposit refund system as a foundation from which to build its own system tapered to the local needs.

4.6 Results related to RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai

The final research objective aimed to evaluate the governance and legislative frameworks/structures for plastic waste management in Struisbaai. This was done through literature review, document review and informal correspondence, as discussed in Chapter 3.

Sections 2.7, 2.8 and 2.9 in Chapter 2 provide a comprehensive account of the legal framework related to plastic waste management. Section 2.10 of Chapter 2 more specifically reflects on the governance frameworks and structures for waste management in the case study area. For the sake of brevity, these sections will not be repeated here. The sections below attempt to summarise the findings related to RO4.

On 8 April 2022 the Western Cape Government published the Provincial Gazette Extraordinary 8580, entailing the Integrated Waste Management By-law, 2021 for the Cape Agulhas Municipality (CAM). The document is a by-law detailing waste management practices and regulations in Struisbaai, Western Cape, South Africa. It outlines the responsibilities of the Municipality and waste generators, the types of waste management services provided, approved receptacles, separation of waste streams, submission of waste management plans for certain activities, and the requirements for handling different waste types (Cape Agulhas Municipality, 2022). The document outlines the following key points:

- Ownership and responsibility of waste;
- Requirements for developing an Integrated Waste Management Plan (IWMP);
- Provision of waste management services;
- Receptacles and waste storage;
- Waste separation and recycling;
- Specific waste types;
- Enforcement and compliance.

Although the document does not explicitly mention plastic or plastic waste, it focuses on general categories of waste such as organic, bulky, building, hazardous, event, and tyre waste, without specific references to plastic. However, the document does mention the prohibition of unauthorised disposal of waste and the prohibition of littering in Chapter 5 of the by-law. Chapter 4, Section 16 stipulates the storage, separation, and collection of recyclable waste and Section 17 outlines waste separation in a geographical area.

The governance framework for waste management in Struisbaai is structured around the Municipality's responsibility to develop and implement an Integrated Waste Management Plan (IWMP). The IWMP should include strategies for waste minimisation, recycling, and pollution prevention. As at the date of writing, the Municipality has yet to develop an Integrated Waste Management Plan (IWMP) for Struisbaai and the Struisbaai Harbour. The Municipality oversees the collection and disposal of waste (see Section 4.4.2) and the provision of waste management services. Aside from the Integrated Waste Management By-law, 2021 for CAM, there are no

known legislative or governance framework documents specifically addressing plastic waste management in Struisbaai.

One other document that mentions waste management in this region is the Agulhas National Park Management Plan (as outlined in Section 2.10), although this document is specific to the Agulhas National Park. The Agulhas National Park Management Plans outline various management strategies for tourism, development, biodiversity and ecosystem protection, cultural heritage management, and infrastructure, but the plan does not specifically address waste or waste management. The Agulhas National Park Management Plan provides for broad actions related to "waste recycling and minimisation where possible" (SANParks, 2020:92) and "increased recycling of waste" (SANParks, 2020:122) in relation to mitigating carbon footprint over time. The management plan also states that, throughout SANParks, other programmes are being implemented, including waste management programmes (SANParks, 2020).

4.7 Chapter summary

This chapter presented a comprehensive analysis of the results and discussions emerging from the study. It provided the key findings of each of the research objectives through the integration of existing literature, offering insights into the effectiveness of current waste management practices in Struisbaai Harbour and identifying gaps in legislative and governance structures. For each research objective, the following findings were observed:

RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour

- Plastic waste increased notably during the peak season, rising from 38% of total waste on 19 December 2023, to 60% on 1 January 2024.
- The increase in plastic waste correlated with the holiday season, peaking around New Year's Day.
- The total waste collected during the data collection period was 1 346 items, with 796 being plastic (59%).
- The influx of tourists during the peak season led to a 34% increase in waste, similar to trends observed in other tourist destinations.
- The most common plastic waste items collected were sweet wrappers (225 items) and plastic drinking bottles (149 items).
- New Year's celebrations and increased local tourism led to higher waste generation and improper disposal.

- Struisbaai has a limited waste management infrastructure and struggled to handle the increased waste volumes.

RO2: Determining plastic waste management practices in Struisbaai Harbour

- Poor waste infrastructure was correlated with higher waste accumulation and environmental impact.
- Insufficient waste bins led to increased littering.
- Overflowing bins were not emptied frequently, causing improper waste disposal and diminished aesthetics of the area.

RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour

- A total of 211 survey questionnaires were completed.
- The results showed that the public predominantly perceived plastic waste as the main waste stream, primarily sourced from beachgoers and tourists.
- The public perceived the presence of plastic waste littering to beachgoers and tourists leaving waste behind on the beach.
- Respondents expressed concerns over the adequacy of waste management practices in Struisbaai Harbour and highlighted the insufficiency of waste bins, infrequent emptying of bins, and the overflow of waste bins leading to increased littering.

RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai.

- The only known legislative framework for waste management in Cape Agulhas Municipality is the Integrated Waste Management By-law.
- There are no known legislative or governance framework documents specifically addressing plastic waste management in Struisbaai.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The aim of this research was to explore plastic waste and related management practices within a South African coastal area, the Agulhas National Park, focusing on Struisbaai Harbour as a case study area, with a view to making recommendations for improvement. To achieve the aim, the following research objectives were set in Chapter 1:

1. Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour.
2. Determining plastic waste management practices in Struisbaai Harbour.
3. Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour.
4. Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai.

The sub-sections below draw conclusions on each of the four research objectives (Section 5.2), while recommendations are provided in Section 5.3.

5.2 Conclusions

The sub-sections to Section 5.2 draw conclusions related to each of the four research objectives.

5.2.1 Conclusions related to RO1: Determining the extent (quantities and nature) of plastic waste pollution in Struisbaai Harbour

Notably, the amount of plastic waste surged during the peak tourist season, rising from 38% of total waste on 19 December 2023, to 60% on 1 January 2024. This increase was closely linked to the holiday season, particularly around New Year's Day. Throughout the data collection period, 1 346 waste items were collected, of which 796 were plastic, accounting for 59% of the total waste. This highlights the predominance of plastic in the waste stream.

The influx of tourists during the peak season resulted in a 34% increase in overall waste, aligning with patterns observed in other tourist destinations and indicating that tourism significantly contributes to waste generation. The most frequently collected plastic items were sweet wrappers (225 items) and plastic drinking bottles (149 items), indicating specific sources of plastic pollution. New Year's celebrations and increased local tourism led to higher waste generation and improper disposal, exacerbating the waste management challenges (Mihai *et al.,* 2022).

5.2.2 Conclusions related to RO2: Determining plastic waste management practices in Struisbaai Harbour

Struisbaai's limited waste management infrastructure struggled to cope with the increased waste volumes during the peak season. Poor waste infrastructure was correlated with higher waste accumulation and greater environmental impact. The study found a shortage of waste bins, leading to increased littering. Additionally, existing bins were often overflowing and not emptied frequently, resulting in improper waste disposal and a decline in the area's aesthetics.

The correlation between poor waste management infrastructure and higher waste accumulation was evident. Insufficient waste management resources directly impacted the environment of Struisbaai Harbour. Enhancing waste management infrastructure, including increasing the number of waste bins and ensuring regular maintenance and emptying, is crucial. Implementing public awareness campaigns to educate both tourists and locals on proper waste disposal practices can mitigate the impact of plastic waste. Developing and enforcing stricter waste management policies during peak tourist seasons can help manage the surge in waste more effectively. These findings highlighted the need for comprehensive and adaptive waste management strategies in Struisbaai Harbour, particularly during peak tourist seasons, to protect the environment and maintain the area's natural beauty. This is supported by Botha (2023); Kerber and Kram (2021); Botero *et al.* (2017); and Herdiansyah *et al.* (2021).

5.2.3 Conclusions related to RO3: Exploring public perceptions of plastic waste and waste management practices in Struisbaai Harbour

A total of 211 participants completed the survey. The majority of the participants were female (50%), with an age range of 46 to 55 years, originating mostly from South Africa (93.8%). On average, participants had been on holiday visiting Struisbaai (66.8%), and many of the participants had visited Struisbaai more than ten times (38.9%). Additionally, 33.6% of the participants reported going to the harbour and walking along the promenade daily.

Participants identified plastic waste as the primary type of waste found in and around Struisbaai Harbour, with 92% of respondents citing it as the predominant waste stream. Other types of waste perceived included paper and cardboard (54%), glass (53%), and metal waste (34%), while organic and hazardous wastes were less commonly noted (25% and 4%, respectively).

The public predominantly attributed the presence of plastic waste to beachgoers and tourists, aligning with the influx of visitors during peak holiday seasons. This perception highlights the significant impact of tourism on local waste generation and supports the notion that land-based

sources are the main source of pollution from coastal areas into marine environments. This is supported by Nachite *et al.* (2019).

Respondents expressed concerns over the adequacy of waste management practices in Struisbaai Harbour. Key issues highlighted included the insufficiency of waste bins, availability of waste bins, infrequent emptying of bins, and the overflow of waste bins leading to increased littering (Schultz *et al.,* 2013; Kiessling *et al.,* 2017). These concerns were supported by observational data, which revealed that waste bins were often not emptied according to the schedule, exacerbating the problem of improper waste disposal.

The perceived inadequacy of waste management infrastructure and practices was correlated with higher waste accumulation and a negative environmental impact. Overflowing bins and waste not only had a negative impact on the aesthetic appeal of the area, but also had negative environmental impacts, especially to marine life.

The thematic analysis of open-ended responses reveals a clear consensus on the prominence of plastic waste as the main environmental issue in Struisbaai Harbour, primarily attributed to tourist activities. The public's dissatisfaction with current waste management practices highlights the need for significant improvements in infrastructure and operational efficiency. Addressing these issues is crucial to mitigate the environmental impact of plastic waste and enhance the overall waste management system in Struisbaai Harbour.

Research participants suggested several improvements to address the waste management challenges in Struisbaai Harbour. These included increasing the number of waste bins, ensuring more frequent emptying of bins, and improving public awareness campaigns to promote responsible waste disposal among tourists and locals alike.

These insights are important for informing policy decisions and developing targeted interventions aimed at reducing plastic waste and improving waste management practices in seasonal tourist regions such as Struisbaai Harbour. The findings reveal the importance of engaging the public in these efforts, as their perceptions and recommendations provide valuable guidance for effective waste management strategies.

5.2.4 Conclusions related to RO4: Evaluating the governance and legislative frameworks/structures for plastic waste management in Struisbaai

Plastic waste in marine protected areas is regulated through various legislation – focusing on waste management and the management of marine protected areas. Legislation exists on an international, regional (African), national and local (municipal) level.

The Cape Agulhas Municipality (CAM) plays a critical role in managing waste within the community, while subject to broader national legislation such as the National Environmental Management Act (NEMA) of 1998 and the National Environment Management: Waste Act (NEM:WA) of 2008. These acts set the foundation for environmental protection and waste management practices across South Africa.

Waste management practices within Agulhas National Park are primarily handled by SANParks (South African National Parks) and are outside the scope of the research area. The governance structures for waste management within Struisbaai Harbour are divided into three different spheres (CAM, the DFFE, and a private sector). CAM is responsible for the collection of waste in Struisbaai and certain areas within the harbour and discards the waste at the local landfill site or at the Bredasdorp landfill site. The DFFE is responsible for waste management in a different sector within the same harbour, with a private sector company situated within the harbour responsible for its own waste management. The overlapping jurisdiction within the same area complicates current waste management practices.

On April 8, 2022, the Western Cape Government published the Provincial Gazette Extraordinary 8580, which included the Integrated Waste Management By-law 2021 for the Cape Agulhas Municipality. This by-law outlines comprehensive waste management practices and regulations within the municipality, detailing responsibilities for both the municipality and waste generators. Key aspects include the provision of waste management services, approved receptacles, waste separation and recycling, submission of waste management plans, and requirements for handling different waste types. Notably, while the by-law covers various waste categories, it does not explicitly address plastic waste. Instead, it focuses on general categories like organic, bulky, building, hazardous, event, and tyre waste. However, it prohibits unauthorised disposal of waste and littering, and stipulates the storage, separation, and collection of recyclable waste

Despite the existence of this by-law, there are no known legislative or governance framework documents specifically addressing plastic waste management in Struisbaai. The governance framework for waste management in Struisbaai is structured around the municipality's responsibility to develop and implement an Integrated Waste Management Plan (IWMP), which should include strategies for waste minimisation, recycling, and pollution prevention. As at the date of writing, the municipality has yet to develop an IWMP specifically for Struisbaai and the Struisbaai Harbour. Additionally, the Cape Agulhas Municipality is compliant with NEMA and NEM:WA, but the only known legislative framework for waste management in the municipality is the Integrated Waste Management By-Law. This highlights a significant gap in the legislative

framework specifically addressing plastic waste management in Struisbaai, emphasising the need for more targeted policies and regulations to manage plastic waste in this area effectively.

5.3 Recommendations for improvement and areas of future research

The results of this study can inform improvements to the current plastic waste and related waste management practices in Struisbaai and in other similar areas. Additionally, recommendations for future research were discussed.

5.3.1 Recommendations for improvement of plastic waste management practices

Recommendations for improvement are based on gaps or areas of deficiency noted during observations, as well as recommendations made by research participants as part of open-ended responses.

5.3.1.1 Improving waste services and infrastructure

The research findings indicated that waste infrastructure (i.e. availability, access and condition) was inadequate and that the level of waste services rendered is insufficient for the amount of waste generated during peak holiday periods in Struisbaai. Roos *et al*. (2023) in their research, highlight the importance of the provision of effective waste services and infrastructure (Principle 4).

As far as recommendations for improvement are concerned, the following measures should be considered for plastic waste management in the Struisbaai area:

- Improving the condition of waste bins, and installation of more waste bins that are in closer proximity to one another, as proposed by Schultz *et al.* (2013) and Herdiansyah *et al.* 2021;
- Increasing the waste collection frequency and emptying of bins, especially during peak holiday periods. It may be necessary to increase the collection to once or twice per day during peak periods, as overflowing waste bins discourages people from emptying bins (Sciortino & Ravikumar, 1999);
- Installation of separate bins for plastic, organic, glass, metal, and other types of waste throughout the harbour area, including the promenade and beaches, to promote recycling. Brightly coloured and colour coded bins would be more visible and help consumers to recycle;
- Establishing a frequent and reliable waste collection schedule to prevent bin overflow and ensure the timely removal of waste. The waste collection schedule should be adapted during peak seasons to cater for the influx of tourists and therefore the increased waste volumes;

- Investing in local recycling facilities to handle the segregated waste efficiently, reducing the need for transport to distant recycling facilities;

- Installing waste bins at every entry and exit point on the promenade at 20-25 m intervals. Install waste bins in the harbour and beach areas at regular intervals as well;

- Ensuring that all bins are equipped with working lids to prevent windblown waste and distribution of waste via animals such as seagulls. Provide big enough bins to accommodate the influx of tourists during peak seasons to ensure sufficient waste infrastructure for increased waste generation and disposal;

- Fostering partnerships between local government, businesses, and NGOs to fund and support waste management initiatives;

- Engaging the tourism sector to promote eco-friendly practices and contribute to waste management efforts;

- A ballot bin is an innovative and interactive public waste disposal system designed to encourage people to dispose of their litter, particularly cigarette butts, properly. However, this can be adapted to plastic products such as bottle caps to help address the plastic problem in Struisbaai by making it engaging and fun. The bin typically features two transparent compartments, each labelled with a different option for a question displayed on the bin. Users cast their litter "vote" by placing it in the compartment corresponding to their preferred answer;

- An integrated waste management programme (**Annexure C**) has been developed as an indirect outcome of this research. It is suggested that this programme is implemented for the Struisbaai area to improve plastic waste management.

5.3.1.2 Increasing education and awareness to change behaviour

The research findings indicated that education and awareness (i.e. signage, campaigning and awareness activities) was inadequate and that the level of education and awareness rendered are insufficient. Willis *et al*. (2022) highlights the importance of the provision of educational programmes.

As far as recommendations for improvement are concerned, the following measures should be considered for plastic waste management in the Struisbaai area:

- Launching educational programmes and campaigns to raise awareness about the impact of plastic waste on the environment and the importance of proper waste disposal;

- Integrating waste management education into local school curriculums to educate learners about the impacts of plastic pollution from a young age;

- Organising regular beach and harbour clean-up events involving local residents, businesses, and tourists (Botha, 2023);

5.3.1.3 Enhancing regulation and enforcement

The research findings indicated that regulation and enforcement (i.e. fines, monitoring) was inadequate and that the level of regulation and enforcement rendered are insufficient for limiting littering in Struisbaai. Chikodzi *et al.* (2021) highlights the importance for municipalities and stakeholders to intensify efforts in enforcing laws to protect the oceans from plastic waste.

As far as recommendations for improvement are concerned, the following measures should be considered for plastic waste management in the Struisbaai area:

- Enforcing existing regulations on illegal dumping and littering with fines and more frequent monitoring. Locals can be employed to patrol the coastline which can encourage the local community to become more aware and to be held accountable for their actions (Puluhulawa & Puluhulawa, 2021);
- Implementing policies to reduce the use of single-use plastics within the harbour area, encouraging alternatives such as biodegradable or reusable items. Restaurants in the area, especially close to the harbour, should be required to avoid single-use plastics such as cutlery, take-away containers, straws, etc. as proposed by Kombiok *et al.* (2021);
- Requiring businesses operating in the harbour to have waste management plans that include plastic reduction and recycling measures. These plans should be reviewed and accepted by the authorities and regular audits should be carried out to ensure compliance;
- Implementing EPR programmes to make manufacturers and consumers responsible for the entire lifecycle of their products;
- Monitoring and evaluating the effectiveness of clean-up crews and make recommendations for improvement;
- Implementing a fining system for both individuals and companies as suggested by Hira *et al.* (2022);
- Implementing a system to regulate data collection on waste types, volumes, and sources to monitor and evaluate the effectiveness of waste management practices;
- Conducting periodic assessments to evaluate the environmental and social impacts of waste and adjust the waste management practices as necessary.

5.3.1.4 Incentivising good practice

The research findings indicated that incentives (i.e. rewards, grants/subsidies) can be an adequate measure in reducing plastic waste in Struisbaai.

As far as recommendations for improvement are concerned, the following measures should be considered for plastic waste management in the Struisbaai area:

- Introducing reward schemes for residents and businesses that actively participate in waste reduction and recycling programmes. The deposit reward system followed in Norway is a

great example of successful incentive systems that could also be incorporated in Struisbaai (TOMRA, 2022b);

- Providing financial incentives, such as grants or subsidies, for initiatives that aim to reduce plastic waste and improve waste management infrastructure (Schuyler *et al.,* 2018);

5.3.2 Recommendations for further research

Based on the limitations and conclusions of this study, the key recommendations for further research include:

- Repeating this research during low tourism seasons (June to August) to be able to draw a comparison between the peak season and the off season for a better understanding of the extent of waste generation.

- Focusing on the impact of tourism on plastic waste management is recommended for future research, since tourism and tourism-related activities were found to play a significant role in this research.

- Human behaviour and perceptions were a key factor derived from the results and further studies could be done to determine the impact of human behaviour on plastic waste management from a psychological perspective.

- This research could be replicated in other marine protected areas or coastal areas in South Africa and beyond.

- While this study focused on plastic waste management practices within Struisbaai Harbour, future research could benefit from exploring the geographical and environmental factors that may influence the accumulation of plastic waste in the area. This includes examining tidal patterns, ocean currents, and wind direction, which could affect the movement of waste into and out of the study area. Investigating these factors would provide valuable insights into the extent to which waste may originate from outside Struisbaai, such as windblown waste or waste transported by ocean currents. Such an analysis would contribute to a more comprehensive understanding of the sources and pathways of plastic pollution in the region.

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ANNEXURE A

Participant consent form and survey questionnaire

Survey questionnaire: Exploring plastic waste management practices surrounding the Agulhas National Park: The case of Struisbaai Harbour.

Background to the project

You are invited to participate in a research study conducted by Bianca Botha, a registered MSc. student at the North-West University, Potchefstroom, under the supervision of Prof. Claudine Roos. This study is entitled "**Exploring plastic waste management practices surrounding the Agulhas National Park: The case of Struisbaai Harbour"** and aims to explore the plastic waste and waste management practices within Struisbaai Harbour. The research will form part of a thesis that will be submitted for the degree MSc. in Geography and Environmental Management at the North-West University, South Africa.

This project has been approved by the Faculty of Natural and Agricultural Sciences (FNAS) Ethics Committee (Ethics Number: NWU-01260-23-A9).

The survey will take you approximately 10 to 15 minutes to complete. Your participation is completely voluntary and anonymous. You may choose to withdraw your consent at any time.

The records from this study will be kept as confidential as possible. No individual identities will be used in any reports or publications resulting from the study. All transcripts will be given codes (e.g. Participant 1) and stored separately from any names or other direct identification of participants. The information obtained through the survey will be used exclusively for this study and no other purpose.

Thank you for your participation in this study. For any queries, please feel free to contact botha6689@gmail.com or claudine.roos@nwu.ac.za.

PARTICIPANT CONSENT

☐ By completing this questionnaire and ticking the box, you declare that you are fully informed of the purpose of this study and give permission for the data to be used for research purposes without identifying you as an individual.

Section 1: Socio-demographic profile

1. Age

18 - 25	
26 - 35	
36 - 45	
46 - 55	
56 – 65	
Older than 65	

2. Gender

Male	
Female	
Other	

3. Country of origin:

South Africa	
Other (please specify):	

4. What is the reason for your current visit to Struisbaai?

Resident	
Work	
Holiday	
Education	
Other	

5. How often have you visited Struisbaai?

Resident	
First-time visitor	
It’s my 2nd to 5th time	

It’s my 6th to 10th time	
I have visited Struisbaai more than 10 times	

6. When you are in Struisbaai, how often do you go to the harbour and walk along the wooden boardwalk?

First-time visitor (once)	
Daily	
Weekly	
Monthly	
Rarely	

Section 2: Plastic waste in Struisbaai area

1. In your opinion, what is the **primary type of waste** commonly found in and around the Struisbaai harbour area?

   (Please indicate your top three choices).

Plastic waste	
Organic waste (food waste, plant material)	
Paper and cardboard	
Metal waste (cans/scrap metals)	
Hazardous waste (chemicals, oils, electronic waste)	
Glass	
Other (please specify):	

2. In your opinion, what is the main **source of plastic waste** in the Struisbaai area?

   (Please indicate your top three choices).

Beachgoers/tourists leaving trash behind	
Littering from ships and boats	
Insufficient waste management in the Struisbaai area	
Windblown waste from other areas	
Other (please specify)	

3. In your opinion, what is the biggest **challenge** towards reducing plastic waste in the Struisbaai marine environment?

   (Please indicate your top three choices).

Lack of awareness or education about plastic waste and related issues	

Convenience and availability of plastic products	
High cost of plastic-alternatives	
Lack of governance and proper waste management	
Other (please specify)	

4. What **changes** would you be willing to make to reduce plastic waste?

   (Please indicate your top three choices).

Avoid buying single-use plastic products	
Reuse or recycle plastic products	
Support clean-up initiatives	
Safely dispose of my plastic products	
Other (please specify)	

5. What would **encourage you to reduce** your plastic waste in marine environments?

   (Please indicate your top three choices).

Government campaigns and regulations	
Having access to a cleaner environment	
Financial incentives or penalties	
I will do it if I know that others will also do it	
Other (please specify)	

6. In your opinion, what are the most effective ways to **raise awareness** about plastic waste in marine areas?

   (Please indicate your top three choices).

Government campaigns and regulations	
Social media and online campaigns	
Education in schools and universities	
Public awareness events and demonstrations	
Other (please specify)	

7. In your opinion, which of the following approaches do you think would be most effective in **reducing plastic waste** in marine environments?

   (Please indicate your top three choices).

Bans on single-use plastics (e.g. straws, bags, cutlery)	
Fees or taxes on single-use plastics	
Mandatory producer responsibility for plastic waste	
Subsidies for companies that use recycled plastics	
Public education campaigns on plastic waste reduction	
Municipal services	
Other (please specify)	

Section 3: Perspectives of plastic waste in the Struisbaai area

Please indicate the extent to which you agree to the following statements using the five-point scale provided below (where 1 = strongly disagree and 5 = strongly agree).

1. I regularly observe plastic waste on the beach or in the ocean in the Struisbaai area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

2. The sight of plastic waste in and around the Struisbaai harbour bothers me.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

3. I believe that the presence of plastic waste affects my enjoyment of the harbour and boardwalk's aesthetics.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

4. I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai is a problem.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

5. I think plastic waste is a major issue affecting the natural environment in and around Struisbaai.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

6. I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai has become worse over the past five years.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

7. I feel that the presence of plastic in the ocean and along the coastal area in Struisbaai could deter tourists from visiting the area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

8. I am aware of the long-term adverse impacts of plastic pollution on marine ecosystems.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

9. I think that individuals have a responsibility to reduce plastic waste in marine environments.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

10. I am willing to avoid the use of single-use plastics such as plastic bags, water bottles, or straws when I am at the beach/in a marine environment.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

11. I am willing to pay more for products or services that are environmentally friendly and reduce plastic waste in marine environments for a reasonable price.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

12. I am willing to walk to where waste bins are located to dispose of my waste.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

13. I am willing to keep my plastic waste with me and dispose of it at home.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

Waste management in Struisbaai area:

14. I have noticed waste bins located in the Struisbaai Harbour and the boardwalk area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

15. I have noticed a difference in the amount of plastic pollution between the Harbour and the boardwalk area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

16. I think that the current waste management infrastructure (bins/skips) in the Struisbaai Harbour area is sufficient.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

17. I am satisfied with the placement and accessibility of waste bins in the harbour and boardwalk area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*

1	2	3	4	5

18. I have encountered overflowing or improperly managed waste bins in the harbour and boardwalk area.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

19. I think the measures currently in place to manage plastic waste in the harbour and boardwalk area are effective.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

20. I think that Struisbaai has the necessary waste management capacity to handle the increased number of tourists during the holiday season.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

21. I think that plastic waste management in the Struisbaai area has improved over the past five years.

Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
1	2	3	4	5

Section 4: Challenges, opportunities, and recommendations for improvement

5. In your opinion, what are the challenges regarding plastic waste management in the Struisbaai area?

6. In your opinion, what are the opportunities for plastic waste management in the Struisbaai area?

7. What are your suggestions/recommendations for improvement regarding plastic waste management in the Struisbaai area?

8. Are you aware of any ongoing initiatives or projects in and around Struisbaai that promote recycling or environmentally conscious campaigns and activities?

End of questionnaire – Thank you for your participation!

ANNEXURE B

Waste type	19/12/2023	20/12/2023	21/12/2023	22/12/2023	27/12/2023	28/12/2023	29/12/2023	01/01/2024	01/02/2024
Glass bottles	9	7	4	13	11	10	6	92	29
Plastic drinking bottles	5	5		10	11	11	25	46	36
Metal cans	3	9	6	8	6	8	13	30	12
Plastic lid			4	1	1		2	1	1
Plastic cup	1	2	3	1	1	4	7	71	2
Plastic ice cream spoons		4	2	3		10		13	4
Polystyrene ice cream cups	4	3		3	10	10	16	7	24

Cigarette packet	6	1	6	3	3	2	5		11
Yogurt container	2				1	2			1
Sweet wrapper			2	8	3	8	39	122	43
Foil	1	1		1	1	1			2
Sheet of paper									1
Chip packets	10	6	1	20	21	7	24	20	82
Plastic straws	2	1	2	3	3		4	8	1
KFC takeaway box and bag									1

Polystyrene takeaway boxes		3	1	22	3			1	10
Single-use plastic bags		5	2	9	3	2		7	9
Fireworks								20	4
Flares								6	1
Textiles	1		1			4	4	4	4
Bread bag		1	1						2
Bottle caps	9	3	3	2			5	2	6
Paper plate				1				1	2
Fruit net	1		1	1					1
Single use plastic packaging				2	11	10	31	34	29

Beer plastic packaging				1					5
Streepsak									1
Ice lolly packaging					7	2	5		2
25 litre can							1		1
Carton takeaway boxes	3	3	1		1	1	1		8
Highlighter									1
Cork								17	3
Plastic takeaway container	1	1	2		1				
Wine foil canteen	1							1	

Plastic utensils	1	1					7		
Rope	1		1						
Takeaway coffee cup and lid			1	1					
Advertising board		1							
Paper			2				2		
Paper cups					4	4	2	3	
Beer caps		3							
Plastic toys				1		3	2	1	
Vape				1				3	
Sunscreen bottle			1						

Drinking yogurt			1						
Milk bottle			1	1					
Milk container							2	1	
Margarine tub						2			
PVC Pipe						1			
Steel pipe							2		
Cooler box and lid						1		1	
Lighter						1		2	
Juice carton				1					
Cartons				1				2	

Wooden spoons								3	
Fishing gear	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multiple ice cream cone holders	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multiple tissues	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multiple serviettes	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multiple wet wipes	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multiple cigarette buds	✓	✓	✓	✓	✓	✓	✓	✓	✓

Small pieces of plastic	✓	✓	✓	✓	✓	✓	✓	✓	✓

ANNEXURE C

Integrated waste management plan for plastic waste and related waste management practices in Struisbaai

An Integrated Waste Management Plan (IWMP) includes several different elements that collaborate to create a combined approach aimed at improving waste management and sustainability. The following section describes a sample integrated waste management plan that could be implemented in Struisbaai Harbour to contribute to the successful implementation of new waste management practices.

Executive Summary

This waste management plan outlines strategies and recommendations for effective waste management in Struisbaai Harbour and surrounding areas.

The report aims to address the current waste management practices, identify areas for improvement, and provide actionable steps to minimise waste generation and promote sustainability within the region.

Introduction

Struisbaai is a small fisherman’s village located in the Overberg region of the Western Cape, is about 5 km from L’Agulhas, where the Indian and Atlantic Ocean meets at the southernmost point of Africa. The village has the Southern Hemisphere's longest natural beach, stretching 14 km towards Waenhuiskrans, and is awarded Blue Flag status. Due to its location and various activities, Struisbaai has become a popular destination for local as well as international tourists. With the increase in tourist numbers, the amount of waste being generated is also increasing rapidly. Proper waste management is essential to preserve the natural beauty and integrity of the area while minimising its environmental impact.

The purpose of the IWMP is to: 1) provide a comprehensive strategy for managing all types of waste in Struisbaai, with a particular focus on plastic waste and 2) ensure environmental protection, compliance with regulations, and enhancement of community well-being.

The scope covers waste management practices for residential, commercial, and industrial waste, with a specific emphasis on plastic waste, and is applicable to Struisbaai Harbour and surrounding areas.

The objectives of the IWMP include:

- Reducing waste generation and increasing recycling rates
- Implementing effective waste management practices for all waste streams
- Enhancing public awareness and community participation in waste management
- Enforcing existing policies and regulations on waste management.

Legal and policy framework

National and local legislation

- Relevant national waste management legislation.
- Local regulations and by-laws.

Policy context

- Alignment with national and local strategies.
- Existing waste management policies.

Waste management overview

Current waste management practices

- Description of existing waste collection, disposal, and recycling practices in Struisbaai.
- Identification of key stakeholders, including municipal authorities and waste management companies.

Waste generation and composition

- Overview of waste generation rates in Struisbaai
- Breakdown of waste types, with a focus on plastic waste composition (e.g., single-use plastics, packaging, fishing gear).

Waste management strategies

Waste prevention and minimisation

- Initiatives to reduce waste generation at source (e.g., promoting reusable items, reducing packaging).
- Community outreach programs to encourage waste minimisation.

Waste collection and transportation

- Description of current collection methods and schedules.
- Proposed improvements to enhance efficiency and coverage.
- Consideration of alternative transportation methods to reduce carbon footprint.

Waste separation and sorting

- Implementation of waste separation at source (e.g., separate bins for recyclables, organics, and general waste).
- Development of sorting facilities to improve recycling rates and reduce contamination.

Recycling and reuse

- Overview of current recycling facilities and programmes.
- Expansion plans for plastic waste recycling, including potential partnerships with recycling centres.
- Promotion of products made from recycled materials.

Waste treatment and disposal

- Description of waste treatment methods, including composting and waste-to-energy options.
- Guidelines for proper disposal of non-recyclable and hazardous waste.

Plastic waste management

Current plastic waste challenges

- Analysis of the impact of plastic waste on the local environment and marine life.
- Identification of major sources of plastic waste in Struisbaai (e.g., fishing activities, tourism).

Plastic waste reduction initiatives

- Strategies to reduce single-use plastics (e.g., bans on plastic bags, straws).
- Encouragement of alternative materials and eco-friendly products.

Plastic waste collection and recycling

- Enhanced collection programmes for plastic waste.

- Development of specialised recycling processes for different types of plastics.

Public awareness and education

- Campaigns to raise awareness about the impact of plastic waste and proper disposal practices.
- Educational programs for schools and local businesses.

Waste management goals and targets

Short-term goals

- Immediate improvements in waste collection efficiency.
- Launch of public awareness campaigns on waste reduction and recycling.

Medium-term goals

- Significant reduction in single-use plastics.
- Increased recycling rates through enhanced facilities and community programmes.

Long-term goals

- Establishment of a sustainable waste management system.
- Zero waste to landfill by a specified target year.

Specific targets

- Reduction of plastic waste**:** Achieve a 30% reduction in plastic waste within 5 years.
- Increase in recycling rates: Increase recycling rates by 50% within 5 years.

Strategic Actions and Initiatives

Waste Reduction and Prevention

- Public awareness campaigns: Regular educational campaigns to inform the public about waste reduction and recycling.
- Incentives for reducing waste generation: Implement incentive programs for households and businesses to minimise waste.

Collection and Transportation Improvement

- Optimisation of waste collection routes: Improve efficiency through better route planning and scheduling.
- Introduction of separate collection for recyclables: Establish a system for a separate collection of recyclable materials.

Recycling and Recovery

- Expansion of recycling facilities: Increase the capacity and number of recycling centres.
- Promotion of community-based recycling programmes: Encourage local recycling initiatives and programmes.

Disposal and Treatment

- Improvement of landfill management: Implement best practices for landfill operations to minimise environmental impact.
- Exploration of alternative waste treatment technologies: Investigate and pilot innovative waste treatment solutions.

Management of Specific Waste Streams

- Plastic waste: Develop specialised programmes and facilities for plastic waste management.
- Hazardous waste: Ensure safe and compliant disposal of hazardous waste.

Stakeholder engagement

Key stakeholders

- Identification of key stakeholders, including local government, businesses, and community groups.
- Roles and responsibilities of each stakeholder in the waste management process.

Communication and collaboration

- Strategies for effective communication and collaboration among stakeholders.
- Platforms for stakeholder input and feedback.

Monitoring and evaluation

Performance metrics

- Key performance indicators (KPIs) to measure the effectiveness of waste management practices.
- Metrics for tracking reductions in waste generation and increases in recycling rates.

Data collection and reporting

- Methods for collecting and analysing waste management data.
- Regular reporting procedures and frequency of updates.

Review and improvement

- Periodic review of the IWMP to assess progress and identify areas for improvement.
- Strategies for incorporating feedback and making necessary adjustments.

Implementation Plan

Action Plan

- Detailed action plan with specific tasks, timelines, and responsible parties.
- Budget and resource allocation for implementing waste management strategies.

Risk management

- Identification of potential risks and challenges in implementing the IWMP.
- Contingency plans and mitigation strategies.

Conclusion

- Restate the main objectives and strategies outlined in the IWMP.
- Emphasis on the importance of collective effort and community involvement.