Henderson Island Cleanup Report

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”For the betterment of the planet, the wildlife and humanity. It is time we stopped ignoring the repercussions of our luxurious life-styles and begin to take action before it is too late and we can never undo what we have already done.”

—- Team S-3 B-3

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Chapter 1

Executive Summary

1.1 Summary of Complete Proposal

We are generating an increasing amount of waste and the effective management of it has become one of the most pressing issues of our time. Marine litter is one of the biggest environmental problems created by the mismanagement of waste with devastating effects on both aquatic and terrestrial life. Despite the efforts of non-profit organisations, it is a fact that around six million tonnes of debris enter the world's oceans every year. On average there are 18,000 pieces of plastic litter floating on every square kilometre of ocean, and a big part of it ends up on remote beaches. Even larger countries, such as Japan and India, are feeling the consequences of the plastic waste, reporting up to approximately 150.000 tonnes and 300 tonnes a day of marine plastic debris washing up onto their shores, respectively [1]. In April 2017, research showed that the highest density of plastic rubbish collected anywhere in the world was found in and on the beaches of a small island in the Pacific, namely Henderson Island, which happens to be part of UK's overseas territory. It currently has a 17.6 tonnes of plastic waste on its beaches [2]. The purpose of this project is to clean the three main beaches of Henderson Island from the plastic waste. The plastic will be later sold to the Plastic Bottle Village for recycling and reuse. The project will take place on April 2019. Staff crew from the UK will be transported to Chile and depart from the port of Anofagasta by RRS Sir David Attenborough. Staff members will first remove the larger pieces of plastic manually. Then Special machinery will be operated by engineers to remove most of the plastic. All the resources and organisation for the project will be done in the UK by our office staff.

1.2 Primary Benefits of Proposal

The following proposal will be focusing on removing as much plastic from the three main beaches of the Henderson Island as possible whilst causing the minimum amount of destruction to the wild life present. A limited amount of machinery will be used, whilst a large amount of people will manually clean the beaches. This will reduce noise pollution and carbon emissions. Great considerations has been taken for the safety of our staff, who will extensively get informed on health and safety for the trip before April 2019, to ensure that everyone is aware of the regulations. In addition, there will be a highly trained doctor on the boat and a helicopter to transport injured persons to the nearest medical facility in case of emergency. The date that the project will be performed was carefully chosen in order to reduce the risk of danger due to extreme weather conditions. This project also aims to campaign for the proper disposal of plastic and educating people about the detrimental effects of plastic pollution. This will be done through the BBC reporter that will cover our project and the volunteering organisations that are going to help us operate the project. A key benefit of this project is that the plastic collected will

be transformed to something new and innovating by the Bottle Village Company in Panama. Through the project this company, as well as the two volunteering organisations that we will be working with: the 'Beachwatch Beach Clean (Marine Conservation Society) and the 'BRISTOL SU RAG, VOLUNTEERING AND SUSTAINABILITY NETWORK', will be given the opportunity to advertise their cause, become more recognizable to big organisations and do more good for the planet by getting more funds.

1.3 Primary Risks and Issues

There is a vast number of unexpected things that should be considered as the could occur during the project's progression. These could range from unexpected weather conditions to injuries. There are some issues and risks that are more likely to occur than others.
The major issue that will be faced by the following proposal will be that our staff will have to travel from the UK to Chile, therefore spending 10 days on the open ocean. The unpredictable weather whilst travelling to and from the island, as well as the time during which the ship will be moored just off the coast of the island is a big concern. The closest hospital will be miles away, which is something that has been taken into consideration in the following pages.
Another key issue is making sure that we do not cause any harm to the environment whilst trying to better it. The noise and air pollution due to the ship and the machinery are both a big concern, especially since the island has been untouched by human activity so far, apart from the plastic that have drifted onto it's beaches. Protecting the unique animal and plant species of Henderson island is essential for our project to be successful.
To avoid primary risks and issues like these, we have allowed for reasonable 'cushions', so that if something were to go wrong, we will still be able to get everyone back to safety.

Chapter 2

Background

2.1 Summary of Challenge

Henderson Island is a remote island located in the south pacific ocean, whose uninhabited land is a territory of the United Kingdom. Recent research into the rapid increase in anthropogenic debris has discovered that Henderson island has the highest density of debris ever reported in the world [2].This is largely due to the fact that it sits near the centre of the South Pacific Gyre, a vast rotating current that collects plastics from all across the globe [3].

It has been estimated that Henderson Island currently has around 38 million pieces of debris on its beaches, 99.8% of which is plastic. It has also been estimated that the majority of the debris is buried around 10 cm below the beaches surface [2]. Henderson island is a UNESCO world heritage listed site and home to a rare ecology, largely due it having never been succumbed to by human presence until recently by indirect means. The welfare of this ecology, consisting of rare endemic birds, plants and other animals, whose wellbeing also impacts the wider marine ecosystem, is now being threatened by the large quantity of unnecessary plastic debris [4].

The challenge is thus to try and remove the debris off the island, as efficiently and effectively as possible, due to the remoteness of the island and the limited number of operational days available.

2.2 Essential Information about Henderson Island Relevant to the Project

Henderson Island has three beaches located on the northern half of the island, where vast amounts of plastic have washed up. The remaining coast line consists of rocky cliff faces that are not easily accessible by foot nor by boat. To remove the plastics and debris that have washed up and clung to the rock faces would be a very difficult task in itself, so we will only be considering clearing the debris from the beaches. These three beaches are shown in the figures below, including their estimated lengths and widths:

Figure 2.1: Henderson Island's north-eastern beach. Using Google maps, the length of this beach is estimated to be around 2.2 km long and around 100m wide.

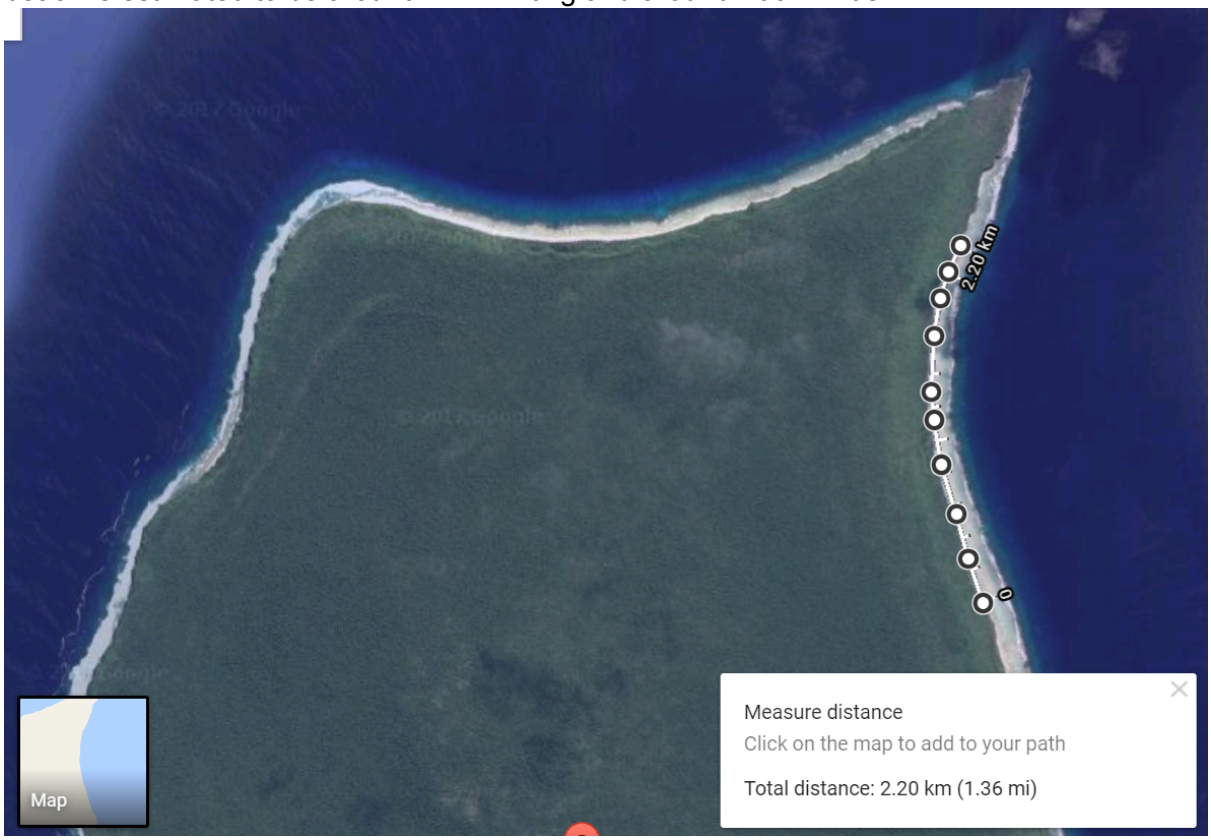


Figure 2.2: Henderson Island's northern beach. Using Google maps, the length of this beach is estimated to be around 2.9 km long and around 100m wide.

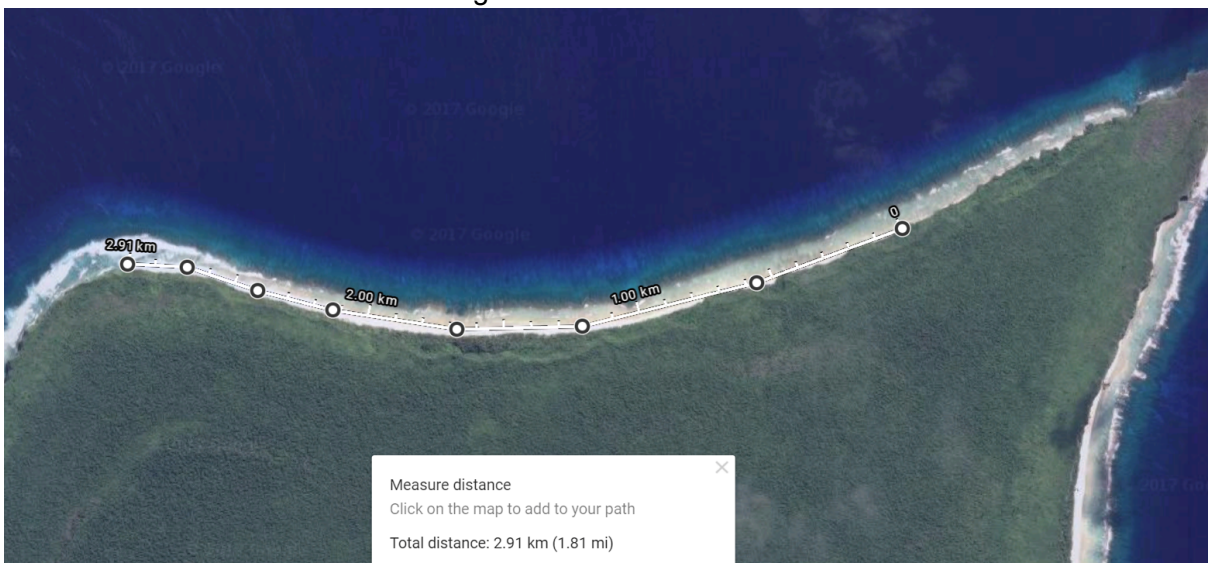


Figure 2.3: Henderson Island's north-western beach. Using Google maps, the length of this beach is estimated to be around 350m long and around 70m wide.

Chapter 3

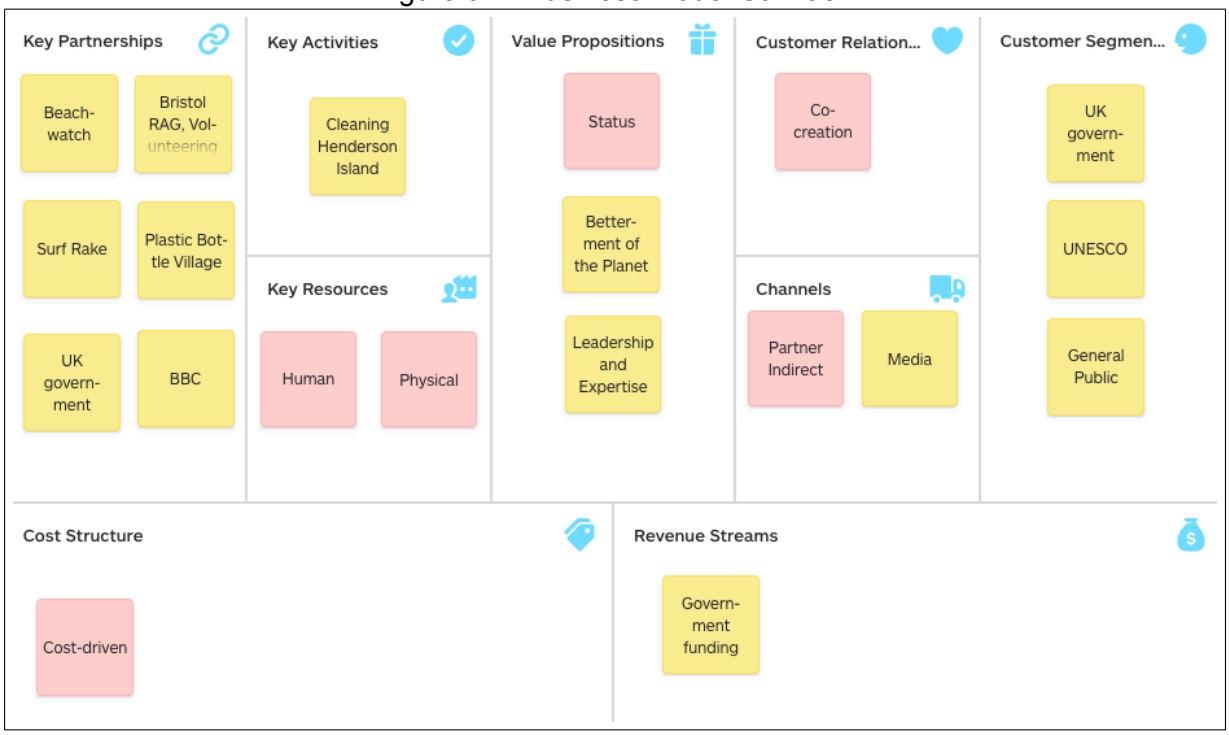
Business Model

It is not sufficient to only consider the technical solution for such a project. We must also account for the business aspect of the project, which will take care of all the necessities needed to get the project up and running and bring the project to completion. The business model will provide answers to questions such as: Where will the workforce come from? Which assets will be available in order to complete the project? What will happen to the plastic once it has been collected and brought back to the main land?

In order to get the ball rolling a team of 4 office staff will work from home. We decided that an physical office space is not needed as only a small number of staff will be visiting regularly. This cuts down cost and potential car pollution from removing the daily commute. This will act as the main contact point for the operation and will cover all legal, social, economic, technical, environmental and political aspects needed to ensure the project runs smoothly. Staff will be provided with the necessary technical equipment (telephone, laptop etc.) in order to complete their work appropriately.

The following figure shows an example of the business model we expect the head office to launch and bring to completion to the best of their abilities. It is necessary to mention that there exists no *ideal* business model that will encompass the task perfectly, and we understand that the model will need to be adjusted in order to best fit the political, economic, social, technological and environmental requirements during the time when the project will be put into action. Nevertheless, we believe that the following model, which is based on extensive research into non-profit businesses, should act as a well functioning model for most scenarios in the near future and should thus be followed as accurately as possible.

Figure 3.1: Business Model Canvas



Customer Segments

Who has similar needs for this project? We believe that the main customers of this undertaking are the UK government and UNESCO, both of whom will be reaping the benefits of this enterprise. The UK government through its investment in projects and initiatives such as this, as well as any policy and law changes they make regarding the issue, will place themselves as leaders in world negotiations about the plastic crisis. This problem is only going to become ever more pressing as the years go by. Since Henderson Island is a UNESCO world heritage site, this organisation will be very glad to ensure that Henderson Island is decontaminated from the plastic waste and restored to its untouched, unpolluted, wild-life haven.
The general public, although the majority is probably oblivious of the damage the plastic is causing in the oceans, are in desperate need that projects such as the one proposed here are brought into action. The situation will become increasingly worse and more and more of our food sources will become contaminated with plastic.

Customer Relationships

It is our job to keep our afore-mentioned customers aware of the progress we are making and to maintain a good relationship with them. We would like the relationship to be one of 'co-creation', whereby we feed off the recommendations from the Government, UNESCO and the general public and they, through their involvement, become more enticed to support and fund the project.

Channels

Using a 'Partner Indirect' approach we hope to expand our reach and gain popularity for this project using a variety of different partnerships (see below under key partnerships). Having a partnership with the BBC, for example, will allow us to use the media to reach our customer segments efficiently and effectively.

Value Proposition

What value does this project entail? To many, Henderson Island might be considered as an irrelevant little island in the southern pacific ocean, but we believe that it has the potential of being a stepping stone to larger and more pressing issues of the same kind. The value lies in the gained knowledge of undertaking such an enterprise and of understanding how badly our oceans are being polluted. It is inevitable that this increase in plastic pollution will lead to a thriving business sector dedicated to recycling plastic and making alternative, more environmentally friendly materials. We believe that being a part of this project will be of great benefit to our partners and customers. They can use their involvement as a tactical move in public relations and as well as a stepping stone into this up and coming business sector.

Key Activities

The key activity of this project is, of course, to eradicate the plastic on Henderson Island. However, we would also like to take this project as an opportunity to campaign against plastic waste. By actively documenting the trip (through staff taken progress photos and blogs) we intend to publicise all aspects of the trip. We hope this will inspire and encourage people across the globe to start similar projects, or to just change their lifestyle to include less one-use plastic.

Key Resources

The key resources needed for this project are human labour, the RRS David Attenborough, the John Deere (tractor) 4520 and the *surf rake* (beach cleaning machine). To find more information on these key resources please see the Technical Proposal section of the report. Other resources, such as food, drinkable water, vaccinations, medicine, petroleum etc. will also been taken into account and preparations have already been made as to these how will be best optimised.

Key Partnerships

In order for this project to run smoothly we will need the help and cooperation of other like-minded businesses and organisations. We have been in touch with the following organisations to receive guaranteed cooperation before confirmation that project has been approved and funding has been established from the client. Please note that the following organisations have been arranged in such a way that they reflect the stages with which the project will be undertaken.

STAGE 1. GETTING VOLUNTEERS

Beachwatch Beach Clean (Marine Conservation Society)

- Beach Clean is a non-profit organisation that helps clean beaches around the UK. They have willingly offered to send out information on the project and encourage their volunteers to participate in the the project. They believe that our cause, with the correct documentation, will help encourage more people in the UK to look after their local beaches and think more about recycling their plastics and are thus happy to have their company name associated with this project.

BRISTOL SU RAG, VOLUNTEERING AND SUSTAINABILITY NETWORK

- We have the great fortune to be linked, through the University of Bristol, with a society that is desperately looking for projects such as this. The Bristol RAG, volunteering and sustainability network has already undertaken many projects, some of which have been similar in nature to that of ours and are renown for having a large number of members. They too have offered to send emails around to all their members and encourage them to participate in this project. Furthermore, they said they are willing to provide insurance for those members that *do* decide to go on the trip and organise all legal documents and vaccinations needed for the trip.

STAGE 2. GETTING EQUIPMENT

Surf Rake

- *Surf rake* will provide us with the necessary equipment for removing the plastic from Henderson Island's beaches. For more information please see go to the Technical Proposal section.

UK Government

- The key element for this operation is the research vessel RRS Sir David Attenborough, which will allow the crew and volunteers to get to Henderson Island and back again with the plastic. For more information please see go to our Technical Proposal.

STAGE 3. RECYCLING THE COLLECTED PLASTIC

Once the plastic has been collected from Henderson Island and been stored on the RRS Sir David Attenborough we need to ensure that the plastic is passed on in both an efficient and sustainable manner - it would be an absolute disaster if the collected plastic were to end up back in the ocean again! After researching nearby sustainable-plastic entrepreneurs, we have found the following crowd-funded organisation. We think the plastic bottle village, Colón Island, Panama have come up with a brilliant solution for recycling plastic. On a island, the village is easily accessible from the sea. The RRS Sir David Attenborough can cruise up their nearest peer, drop the plastic off in their capable hands, then voyage onwards to its next destination - in figure 3.2 we have assumed this will be the UK.

Figure 3.2: Planned route for the RRS Sir David Attenborough to take on its way back to the UK, allowing for the plastic to be dropped off into reliable hands.

Plastic Bottle Village

- Plastic Bottle Village is an organisation that creates earthquake resistant, energy saving houses using plastic bottles for residents and tourists of the island - quite literally creating a little village of plastic bottles. We expect to collect a vast quantity of plastic bottles, but we also made contact with the creator of the project Robert Bezeau and he has ensured us that any kind of plastic will be of great use to them in their designs. We believe that Robert Bezeau's vision to reuse plastic in this way is precisely what the world currently needs. Through media coverage of our project we hope to make people more aware of clever solutions such as this and hope to inspire businesses and entrepreneurs across the globe to set up projects like this and thereby help prevent the world's un-recycled plastic to end up in the oceans and world heritage sites like Henderson Island.

STAGE 4. GETTING THE MESSAGE OUT

BBC

- We have already been in touch with the BCC, who naturally have close ties with the research vessel RRS Sir David Attenborough, and have received confirmation that they are going to get one of their journalists to film and document (and work) when the project is set to go. Furthermore, they said that would like to hold interviews with some of the volunteers once the task has been completed.

Please see the Commercial Proposal for **Cost structure** and **Revenue Stream**

3.1 What is the Legal Entity Recommended for the Project?

We have decided that the legal entity we recommend using for this enterprise that will deliver this proposal is a Private Limited Company. We are fully aware of the fact that this choice of legal entity will require a large quantity of work and will not be easy to get it on its feet and running, but we believe that the advantages of this choice outweigh its disadvantages, especially

in the long run. The following break-down of benefits and deficits will justify this choice.

Advantages

- Increased chances of gaining investors. For a project such as this we surmise that there will be higher chances of getting investors to become share holders than partners. The reason for this is that a partner will be more inclined to invest only if they see our company's enterprise being of low risk, because they have more to lose if something goes wrong. A shareholder, on the other hand, although they too may be risk averse, can only lose what they invested into the company in the first place.
- Once an investment into a share has taken place, it cannot simply be removed. This guarantee is very necessary for a project like this, where we are fully reliant on all funds to remain throughout. If we were to ask for a loan from a Bank to help fund this project, they might, if they feel our business is doing badly ask for repayment of the loan - something we cannot afford to have happen in a project like this [5].
- Profit shares can wait until enough profit has been made. The shareholders have to wait until the company decides it has made enough profit to give out dividends. Although we are not expected to make any profit for this project, because we are giving the collected plastic to a charitable organisation in Panama, the company itself may continue similar work in the field of recycling plastic in the future and will perhaps for a different project make a profit, whereby finally the shareholders can be paid.
- Retained profits are taxed less than that in a partnership [6].
- The company can live on. Since this is not a partnership, if certain members of the company decide to quit after this project, the company can still continue onwards with a new set of staff. As mentioned above, it is expected that the industry of reusing wasted plastic will only increase and we think it would be advantageous to become a stakeholder in this industry as soon as possible, for the more experience the company will gain in the near future, the more of a leading role it will be able to play in the years to come.

Disadvantages

- Time consuming work creating legal documents. In a partnership this task would be less time consuming, but given that the actual removing of the plastic is only going to start in the second year of the project, there should be enough time to do the paperwork.
- Less experience and expertise. This is a definite disadvantage of setting up a private limited company, but we are determined that we can get to an adequate standard by the time the project is to be undertaken.

3.2 How have the Resources been Organised?

The organisation of resources is a vast task that needs to be done effectively and efficiently. To most efficiently utilise the resources, we have broken down the resources into three stages: 1. The office (which works using the PESTEL framework), 2. Fundamental resources for the cleaning process and 3. Miscellaneous resources. The figure below shows a flow chart of how the resources are connected with each other in order achieve the purpose of this project. Human resources in the office, each subsumed to the larger PESTEL framework (stage 1) will organise the fundamental resources for the cleaning process (stage 2) **and** all the miscellaneous resources (stage 3) needed to maintain the stage 2 resources and stage 1 resources.

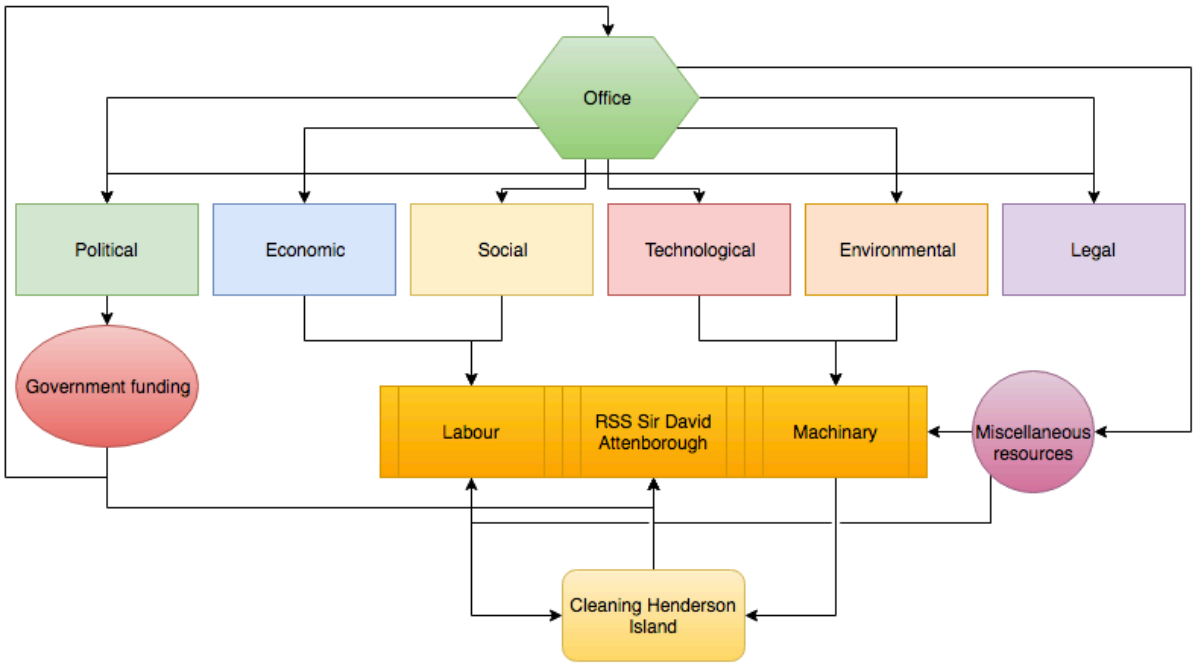


Figure 3.3: Flow chart of how the resources have been organised.

Stage 1: The office[1]

- A key resource for this project is administration, office staff will be working a year before the actual enterprise begins, during the enterprise, and a year afterwards. It is their job to gather political, economic, social, technological, environmental and legal resources throughout the entirety of the project. For example, technological resources will include organising the beach cleaning '*surf rake*' from the family owned corporation H.Barbers and Sons.

Stage 2: Fundamental resources

- This includes all machinery and human labour needed for the cleaning of the beach, such as the *surf rake*, RRS Sir David Attenborough, volunteers, etc. (see the technical proposal for all the fundamental resources needed to clean the beach).

Stage 3: Miscellaneous resources

- These are all other resources needed to maintain the project. These include:
  - Laptops, telephones, fast internet connection etc. for the office staff.
  - Fuel, repair kits, instructional papers, mechanics, etc. for the beach cleaning machinery.
  - Water, food, medicine, at least one qualified doctor, sun cream, mosquito repellent, hand sanitisers, etc. for the volunteers and crew.

[1]This may seem like an unconventional way of using the PESTEL framework, as it was designed as an analytical tool to identify how different factors may affect ones business strategy. We thought, however, that we could use it as a means of effectively organising the office too, because it covers all key aspects needed to make sure our business runs smoothly, as each category acts as a check on the other categories. For example, the technological resource '*surf rake*' will also need to be checked by the person in charge of the environmental aspects of the project, to make sure it is 'environmentally' suitable for the project.

Chapter 4

Technical Proposal

4.1 Systems Selected to Complete Tasks

In order to remove all the plastic from the beaches, we are chartering the *RRS Sir David Attenborough* [7] for 60 days. It is a research vessel capable of holding $2100m^3$ of cargo as well as transporting 60 passengers and 30 essential crew members to Henderson Island. While the RRS Sir David Attenborough cannot dock at the beach, the ship comes with a crane which can lower shipping containers onto a cargo tender capable of reaching the shore. The vessel will prepare for its journey by filling up on fuel, food, equipment and staff at the Port of Antofagasta in Chile for it's voyage to the island.

Taking into account the journey to the island from Chile and the return journey to Colón Island, Panama, we will have 38 days on the island to execute our clean up solution (see appendix on page 40 for calculations). The vessel can carry 660m³ of aviation fuel, given that it consumes fuel at a rate of 177 g/kWh at full load.

4.1.1 Stage 1: clearing by hand

All the pieces of plastic larger than $10cm$ in diameter must be collected manually from the beach. This will be done by having forty people walking along the beach with four tractors with trailers on them (total 42 people). The people will fill one of the trailers, which is slowly driving along the middle of the beach, while the other tractors (initially wait for the first tractor with a trailer to fill up) unload at the ship, this means that the people do not have to wait for the tractors to come back and can continually work.

Assuming the beach is, on average, $100m$ wide this means that theoretically each person will have to clean $2.5m$ of beach. However since the tractor will be in the centre of the beach the workers near it will be able to clear their section of beach much faster so, to optimize efficiency, they should not distribute themselves evenly but be in a higher density on the far edges of the beach, where they are furtherest from the tractor. Taking all of this into consideration we estimate that this will be a slow process and which is why we will be bringing the boat's full capacity of 60 people to clean the beach within the given time frame. Ideally forty people will be cleaning at one time, therefore leaving eight people ready to swap in so that the workers can take breaks. The workers can also take turns driving the tractors, if they are qualified.

4.1.2 How long will this take?

Looking at photos of Henderson island we are going to assume that there is 1 large piece of plastic for every $5m^2$. Let's say the people walk on average at $2.5km/hour$ $(0.7m/s)$ and the median distance each person will be from the trailer is $25m$. This means that the median time taken to walk to the trailer will be about $40s$, therefore there and back is $80s$ and we are allowing $80s$ to pick up and unload the rubbish, therefore we are going to use the estimate that each piece of rubbish will take around $2minutes$ to clear. This will obviously differ depending on how far each person is from the trailer and the mass of the plastic they are collecting, but this is just an estimate (keep in mind that the workers should be distributed in such a way that the $100m$ width of beach is all cleared at the same rate). This means that each person can clear $5m^2$ in $2minutes$, meaning all 40 people can clear $1 \times 100m$ in $1minute$.

Therefore the tractor should be moving forward at about $1m/minute = 60m/hour$, so it is clearing $60m$ of beach every hour. This is quite slow that it would make more sense for the driver to drive the tractor forward a metre and then get out and help collect before getting back in and moving forward another metre.

Using this technique it will take $100minutes$ of constant work to clear $100m$ along the beach. So it will take $5500minutes = 92hours$ i.e. 12 eight hour days to clear $5.5km$ of beach of the large pieces of plastic.

Tractor or quad bike?

Initially we planned to use quad bikes for this process as it would be more practical to transport them to Henderson island as they are smaller and lighter, however as they have a smaller engine and can only pull a trailer which has a capacity up to $0.5m^3$. As stated earlier we are using the assumption that for every $2.5m^2$ there is 1 large piece of plastic, so for every $100m^2$ there will be 40 large pieces of plastic. Let us say $1/3$ of the plastic collected has a diameter of $30cm$, and $2/3$ $10cm$. This means that for each $100m^2$, $0.36m^3$ of plastic will be collected, but considering this calculation was made treating the plastic as complete cubes, while realistically a lot of the space in the trailer will be made up by air gaps in between the plastic - we will assume that the collection of plastic from $100m^2$ beach can fit in one $0.5m^3$ trailer. This would mean that for every metre travelled the quad bike will need to be changed, which is not practical. Therefore a bigger trailer would be needed. And to pull a larger trailer (sometimes referred to as a *trolley*) we need a more powerful engine. Hence we are bringing tractors.

How many tractors?

The trolley has a capacity of $3 \times 1.6 \times 0.4m^3$ = 1.9m^3 , meaning it will be full after $5m$ $(500m^2)$ i.e. every $5minutes$. If the ship is moored in the centre of each beach (which are about$2.5km$ long each excluding the western beach) then the tractor will have a medium length of just over $1.25km$, say $1.3km$ to the ship. This means it will have to travel $2.6km$ to get to the ship and back, if the tractor is travelling at $12km/h$ then it will take about $13minutes$ to travel this distance, allowing for $7minutes$ to unload - so each trip takes $20minutes$. Therefore we recommend taking four tractors with trolleys so that the workers cleaning the beach can work continuously for $20minutes$ and then have $5minutes$ rest.

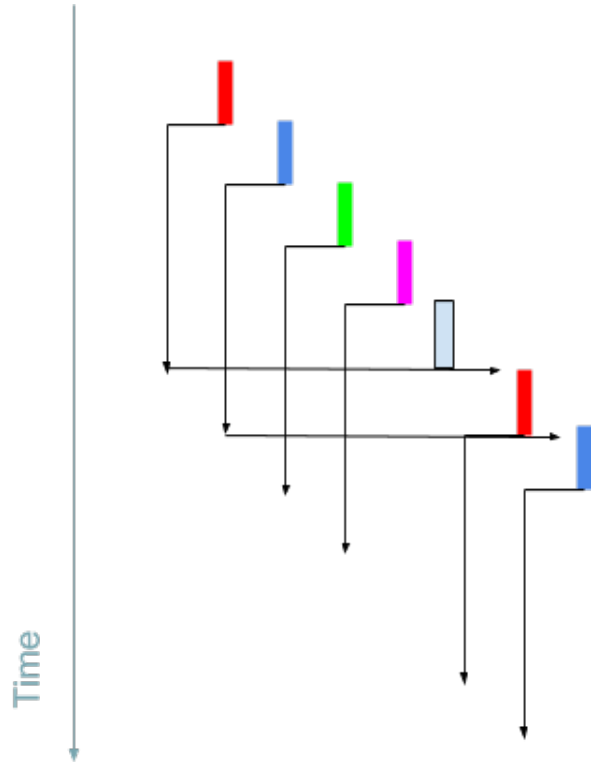


Figure 4.1: Figure showing how tractors should organise themselves. Each coloured line represents each tractor doing $5minutes$ of following the worker, the thin black arrow shows the $20minutes$ (it is $\times 4$ longer than the coloured lines) given for the tractor to go to the ship and unload. From this diagram one can see why four tractors would be needed and how they would take turns as to allow a $5minute$ rest for the workers (the rest is represented by the light blue line with a black outline). The black horizontal arrow represents the tractor returning and the cycle restarting.

As stated earlier, stage 1 can be completed in 12 days. During this time we estimate that around $300m^3$ of plastic will be collected (calculated by: volume of hollow sphere of diameter 25 cm / 5 $\times$ total area of beaches).

4.1.3 Stage 2: *Surf Rake 400HD* and Tractor

For stage two of our clean up solution we will be using a *H.Barber Surf Rake 400HD*[8]. The *Surf Rake 400HD* is built with the purpose of cleaning littered beaches and is used around the world ”on six continents and in over 90 countries” [9].
The *surf rake* needs to be towed by a tractor, we will be using the *John Deere 4520* [10]. It has all the the specification the *surf rake* requires.
The result of these two pieces of machinery working together is the entire beach will be cleared of plastic. This stage should be completed in 25 days, as we have 38 days in total on the island, 11 days are used in stage 1 and 2 days will be needed to set up and prepare.
To calculate the time taken to do this stage we have divided it into three parts, these three parts will have to be calculated for each beach (Eastern beach, Northern beach and western beach):

1. Cleaning time: The time for the tractor to drive over the whole surface area of the beach, hence cleaning it of debris, it will do this in strips travelling parallel to the coast.
2. Turning time: The time taken for the tractor pulling the *surf rake* to turn 180 degafter cleaning each strip of beach, we have decided to include this as, it is not negligible as the driver

will have to slow down dramatically to be able to perform such a tight turn.

3. Unloading time: This is the time taken for the tractor to go to the shore where the rubbish will be moved from the *surf fake* to a small boat - which will then go to the SS.David Attenborough whilst the *surf rake* is towed back to where it stopped cleaning and continue.

Cleaning Time
Continuing to use the assumption that the beach is $100m$ wide and from the technical specification that the *surf rake* is $1.8m$ wide[11] we calculate that the tractor driver will have to go back and fourth over the length of beach 56 times to cover the width of the beach. Therefore the tractor pulling the *surf rake* must cover a distance of the length of each beach $\times 56$. The time taken in the table below has been calculated with the *surf rake* travelling at $10km/h$[11].

Beach	Beach length (km)	length x 56 (km)	Time Taken (hours)
Eastern Beach	2.2	123	12.3
Northern Beach	2.9	162	16.2
Western Beach	0.35	20	0.2h = 12 mins

Turning Time
The turning time for each beach is calculated assuming the tractor will turn 180 deg after each strip with a radius of $1.8m$ and it will perform these turns with a speed of $2km/h$.
Therefore:

$$\begin{aligned} TurningTime(hours) &= Radius(km) \times \pi \times NumberOfTurns \times TurningSpeed(km/h) \\ &= (1.8/1000)\pi \times 55 \times 2 \\ &= 0.63\ hours \end{aligned}$$

Unloading Time
According to the article in The Guardian *"38 million pieces of plastic waste found on uninhabited South Pacific island"*[4] there is an estimated 17.6 tonnes of plastic on the beaches of Henderson island. we have assumed that all the beaches have the same spread of plastic on them and so divided up the total mass of the plastic into the ratios of the lengths of the beaches. Calculating how many trips the *surf rake* would have to make back to the boat based on mass would not be sensible as the plastic has not been compacted so the main limiting factor will be it's volume. So, using a report on *"Material Bulk Densities"*[12] we have made an estimate of the volume of plastic on each beach to be $18kg/m^3$. Then from this volume I have removed the $300m^3$ that will have been removed in stage 1. I have then divided these values by the volume capacity of the *surf rake*, which is $1.5m^3$, to find the number times the *surf rake* will have to be emptied - which are called trips in the table below.

Beach	Volume of plastic(m^3)	Trips
Eastern Beach	280	187
Northern Beach	370	247
Western Beach	45	30

From the table one can see that, since the *surf rake* will have to be emptied 187 times to clear the eastern beach alone, it would take far to long for it to drive to the unloading point

and return to where it was cleaning every time it gets full. Since there are still three remaining tractors with trailers which were used in stage one, these can be used to assist the *surf rake*. Once the *surf rake* is full it will be emptied into a trailer attached to another tractor. The *surf rake* can then continue cleaning whilst the other tractor goes to the shore and is emptied onto the boat. From section 4.1.2 under the heading "How many tractors" I calculated that travelling to the unloading point (at the centre of each beach) and unloading will take about 20 minutes for the Northern and Eastern beaches (this allows for 13 minutes to travel and 7 to unload). For the Western beach it will take 10 minutes (this allows 3 minutes to travel and 7 minutes to unload).

So, as it is assisted by the other tractors, the *Surf Rake 400HD* will only need to go to the ship on every 4th trip. Adding;
$187 \times 20 = 3740\, minutes = 62\, hours$ to the time taken to clear the Eastern beach,
$247 \times 20 = 4940\, minutes = 82\, hours$ to the time taken to clear the Northern beach and
$30 \times 10 = 300\, minutes = 5\, hours$ to the time taken to clear the Western beach.

Beach	Unloading Time (hours)
Eastern Beach	62
Northern Beach	82
Western Beach	5

Transporting the plastic from the unload point to the RRS. David Attenborough
Forty-eight labour workers and six mechanics/drivers work in rotation during Stage 1. Stage 2 only requires the six mechanics/drivers. This means there are forty-eight remaining labour workers who will supporting those driving the tractors in Stage 2. These support workers can be divided over three primary jobs, helping move the plastic from the: *surf rake* to the trailers, from the trailers to the unload point and from the unload point to the RRS. David Attenborough. The move from the *surf rake* to the trailers and from the trailers to the unload point can be done by hand. The workers will be wearing working gloves and so should be well equipped to do this.
The move from the unload point to the RRS. David Attenborough will be done via a small boat. The workers will put the plastic onto the boat and drive it up to the RRS. David Attenborough- which is equipped with a crane to move the plastic from the small boat to a holding container on the RRS. David Attenborough.

Total Time to Clean Each Beach During Stage 2
The total time for each beach is:
$Total\, Time = Cleaning\, Time + Turning\, Time + Unloading\, Time.$

Beach	Total Time to Clean (hours)
Eastern Beach	75
Northern Beach	99
Western Beach	7

This means that the total time spent on the beaches cleaning them will be around 180 hours. Leaving 20 hours of the 200 hours (25 eight hour days) originally available to complete stage 2 to move between each beach. This is a fairly small time frame to move where the ship is moored and set up the unloading point, as this will have to be done twice. Therefore it is unlikely that all the beaches will be completely cleared within the time frame, although aiming to clear 90% of the plastic is feasible.

4.2 Justification For This Choice

A number of ideas were considered before arriving at our final choice, ranging from clearing the whole beach manually to using a range of machines that would collect and sift the sand.

Alternative Proposal 1
One method of cleaning the beaches would be to collect all the rubbish manually. The benefits of this is that clearing by hand would minimise the disruption to the wildlife, due to the low level of noise pollution and the precision of which workers could collect the plastic - avoiding any wildlife they might find. Utilising this method of collection would also amount to a relatively low cost. However it would be very time consuming and challenging to remove debris from beneath the surface of the sand, and so would take much longer that the time available. There would also be risks associated with workers being exposed to the sun and wind for long hours as well as the possibility of injury due to the physical nature of the work.

Alternative Proposal 2
Another method considered for cleaning the beach is by using machines that displace- sift- and replace the sand. The main benefit of using such machines it that they can remove a very small size of plastic particle, and generally clean the sand very thoroughly. However, they can only be used on dry sand, which would be very limiting. This could be implemented one of two ways, either by:

- Using a small ”walk behind sand sifter” such as the H.Barber *Sand Man*[13]. This would be simple to carry out, possibly using a number of these machines as they are quite small and do not require a tractor, they are simply controlled by someone walking behind them. The main drawback to this technique is that these machines are expensive and, since we would need a large number of them to be able to clean all the beaches during the 38 days available the total cost would end up being very large.

- Using a large, stationary sand sifting machine to clean the sand. This would require workers, tractors and trailers to transport the sand from the beach to the stationary sand sifting machine, which could either be set up at a camp or on the boat, where it would be thoroughly cleaned and then returning the sand to it’s original destination. The primary problem with this method is that it would cause a large impact to the ecosystem on the island. This would be due to the sand being removed and probably not replace exactly as it was before. Also such a large stationary machine would require a very large amount of fuel have emission and noise pollution.

Our Approach
Our approach avoids using sand sifting machines all together and instead uses the *surf rake 400HD* thereby avoiding the problems associated with displacing the sand, but compromising the size of partial that would be removed. The *surf rake* can also be used on wet or dry sand and is big enough that we only need one, thus reducing the amount spent on renting machinery. We use the method outlined in *Approach 1* as little as possible- only for the large pieces that the *surf rake* cannot collect.
We chose the *H. Barber surf rake 400HD* because it can be operated on wet and dry sand and it is the second smallest model in the product range, meaning it has the benefits of being fairly compact [11] while being very efficient in covering a large area of the beach in an hour. The *surf rake* picks out the plastic from the the sand at depth up to 15cm using a series of plates it has attached to a conveyor belt. Thus the clean up will be very extensive.
John Deere is popular brand for compact tractors due to it’s reliability, in 2015 John Deere had a 30.2% market share[14].

4.3 Key Features and Benefits of the Proposal

The technique for cleaning the beach described above maximises the volume of plastic that can be removed from the beach in the limited time available. Some of the key features are explained below.

1. **Stage 1: Collecting Larger Pieces by Hand**
   The benefits of this technique for clearing the beach is that disruption to the surrounding wildlife is minimised during this process. The workers collecting the plastic should be made aware of what wildlife could be within the sand and be careful to avoid disrupting it. They should also mark the location and notify the mechanics/drivers if they come across any plants or animal that should be carefully avoided during stage 2. Clearing by hand also does not produce a lot of noise pollution and is fairly reliable.

2. **Stage 1: Using the tractors pulling trolleys alongside the people clearing by hand**
   Unfortunately, by using tractors alongside the people clearing by hand we lose some of the befits listed in point one. Namely, there will be some noise pollution associated with the running of the tractors and the tractors could break down - reducing reliability. However, since we are using four tractors; the effect of one tractor breaking down would slow the processes but would not affect it so greatly, especially if the qualified engineers that we are employing for the purposes of repairing the machinery fix the broken tractors repair it within a couple of hours.
   The reason we are utilising these tractors is that it would be far too time consuming and strenuous for the people clearing by hand to carry all of the rubbish they collected to the unload point. By using the tractors as a means of transporting the collected plastic to the unload point we are able to increase efficiency and therefore be able to clear a larger percentage of plastic in the given time frame.

3. **Stage 2: Using the *surf rake 400HD***
   There are many important benefits associated with using the *surf rake 400HD*. The main benefit is that it is clear form the calculations in section 4.1 that using the *surf rake 400HD* is much faster and more efficient then cleaning by hand. If we were to attempt to clear the whole island by using the method described in Stage 1, but for plastic of all sizes, we doubt that we would be able to clear more than 40% of the surface beaches, let alone attempt to remove plastic from beneath the sand. Another key benefit that using the *surf rake 400HD* offers is that it can clear a depth of 15cm [11], if we were to do this by hand people would have to manually turn the sand over with shovels, this would be far too time consuming and laborious. The *surf rake 400HD* can also collect smaller and finer pieces of plastic with it's hook mechanism, which people may otherwise have trouble spotting and therefore miss.

4. **Stage 2: Using the tractors pulling trolleys alongside *surf rake 400HD***
   This is a similar concept as described in point 2. By using the other remaining tractors we increase efficiency, hence reducing the time taken to clean the beach. Also, since four tractors are required to carry out Stage 1, it would be an inefficient use of resources to not use them during Stage 2. One should also consider that since the primary function of the *surf rake* is to collect debris from the sand, it is considerably more expensive to obtain the the trolleys, therefore it would be a poor use of resources to use the *Surf Rake* to transport the collected plastic to the unload point. Hence, we are using the three remaining tractor with trolleys to transport the collected plastic from the *surf rake* to the unload point. Another key benefit of utilising the three remaining tractors as this saves fuel, as the total distance that the three tractors with trolleys are covering and the total

mass of plastic they will transport is same as if the *surf rake* would work alone, however the trolleys are lighter than the *surf rake*, therefore less power and so less fuel is needed to pull them.

4.4 Prioritised Technical Risks For All Proposals

Our Proposal

Tractors can be dangerous machines when driven recklessly. During stage 1, the tractors will be driven slowly and staff hand picking the plastic will be instructed on how to carefully approach the trailer to avoid collision or injury. To reduce the risk of injuring staff we will hire drivers who have experience and are also mechanics and therefore should understand the machines limitations. Sand can be a tricky terrain to drive over, but drivers will be trained on how best to do it. Dry sand requires you to drive slowly at a steady speed in a straight line. While on wet sand has less restrictions on speed and direction, you can't stop in fear of getting stuck. We have chosen a brand of tractor which is commonly used with the *surf rake* over sand, thus should cope with the task safely.

With safety in mind, maintenance of our machines is very important (see section 'Provisions Made for Operational Service and Support of Technical Elements' on page 24).

The *surf rake* "excels and rock and shell removal" [15]. Thus the risk of something large going unseen by labour staff, and then the *surf rake* hitting something large and damaging/destabilising the machine, is small.
It is worth noting that this proposal does have its risk for wildlife. Any animals that nest in the shallow sand are at risk of being killed by the *surf rake*. Will the *surf rake* is advertised as being quite, noise pollution risks disturbing the wildlife, stressing them and affecting there breading.
Plastic is transported off the island on the boat via the cargo tender. There is a technical risk that someone will get hurt while the *surf rake* is emptying, or loading the rubbish and travelling with it on the cargo tender or while using the crane to left the rubbish up on the RRS Sir David Attenborough. Training will be given to staff on how to do this safely.

Alternative Proposal 1: all clean up is done by hand

With no machines, this proposal had far less technical risks. However this system is very inefficient for collecting plastic. Thus, while it would be safer for staff, we wouldn't meet our objective goal for leaving the beaches clean. This also has reduced risk for wildlife.

Alternative Proposal 2: sand shifting- machine only

Using a large, stationary sand sifting machine and all the tractor related risks of our current proposal with the addition of the removal and return of the sand will cause the terrain be more uneven and more dangerous to drive over. More tractors and will be needed to make this method efficient, thus along the narrow beaches there is a larger chance of collision. This method causes most disruption and will be worst for the local wildlife.

4.5 Standards Applied to the Proposal

All features of the proposal are according to current UK legislation. Personal and protective equipment that will be used, and more specifically head helmets, muck boots, protective coats

for wind and rain, are in agreement with the Standards and Markings for Personal Protective Equipment OM 2009/03. The equipment used, from the tractor and the *surf rake* to the portable toilets, will be technically sound and checked according to current legislation [16] [17]. Also, since the tractor is a category F vehicle, the driver isn't required to have anything other than a category B license. Furthermore, all employees will be trained for the tasks they will have to do on the island and will be covered by Employer's Liability Insurance and Medical Insurance [18]. Knowledge on first aid is also a virtue we will look for. On the island all employees will work accordingly to "The Health and Safety at Work etc Act 1974 (HASAWA)"[19] and they will store the collected plastic with their health as a first priority.

4.6 Provisions Made for Operational Service and Support of Technical Elements

Our clean up proposal requires the use of tractors, trailers, and the *surf rake 400HD*. A fault in any of the machinery would slow down the project, reducing its efficiency. We are hiring six members of staff (referred often as 'mechanics/drivers') who will have prior work experience in mechanics- particularly with tractors. Thus they will be capable of performing maintenance work on the isolated island, as well as driving the tractors safely on the beaches.
As mechanic/drivers, they will be able to work towards cleaning the beaches until the machinery is unusable due to damage/breakdown and then shift their attention and time to fixing the problem. During stage 1 of the plan, a breakdown would not reduce the number of staff capable of hand picking the litter - only the efficiency of moving the plastic on to the boat as there won't be a tractor-pulled trailer. During stage 2, a breakdown would be far more damaging in terms of efficiency; however if the tractor breaks, we will have a 3 others not in use which can rotate in to maintain a fast pace. Unfortunately if the *surf rake* fails labour staff will have to return to the beaches to hand-pick the rubbish as in stage 1. We will ensure that the mechanics/drivers have access to the tools they will need as well as spare parts to common issues, and the machine hand-manual. With these things, along with their experience and know how, all likely problems should be fixable quickly.

Chapter 5

Commercial Proposal

5.1 Customer Needs

5.1.1 What problem will the proposal solve?

Henderson Island, which is part of the Pitcairn group, a UNESCO World Heritage Listed site and untouched by human activity, is covered by 18 tons of plastic waste. This is the highest density of anthropogenic debris ever recorded on earth. Although the island is one of the most remote places on the planet, it is also one of the most polluted places, purely due to our poor disposal of waste. According to an article in the Guardian[20], ”nearly 38 million pieces of plastic waste, with 68% of those buried 10 cm below the island’s surface, are covering the remote island. 13,000 new plastic items are estimated to be washing up every day. Bottle caps and cosmetic jars have become the new home for the crabs living on the island.” Our aim is to visit the island and remove the plastic from the 3 main beaches of the island. We also plan to raise awareness to how as a society, we should take responsibility for the environment we live in.

5.1.2 What is the benefit to the customer? How much is this benefit worth?

Our customers are going to be from a range of different companies that are concerned for environment and understand the extent of impact that plastic disposal has on the ecosystem of Henderson Island. One of our main customers is the UK Government. The RRS Sir David Attenborough will be provided for the project from the UK Government. This will boost the government’s public image concerning environmental issues, whilst at the same time drawing attention to importance of proper waste disposal. By funding the project, the government will increase its image to other countries.

Plastic Bottles Village, which we are working with after the beach cleaning from the plastic, will benefit the most. Their company is specialising on building houses out of recycled plastic, therefore by selling them huge amounts of plastic, their company could flourish, whilst they are recycling the plastic and putting it to a good use. This could increase their profits, whilst it has a low environmental impact and reduces the excess plastic on the planet.

The project is a good opportunity for our university’s Bristol RAG Volunteering Society, which will be providing us with volunteers, to promote their cause, gain popularity and receive funding from key organisations to grow the society and organise environmental projects overseas.

The Beach Clean (Marine Conservation Society), are providing us with volunteers, by sending their people, they advertise their organisation and their cause and similarly will gain popularity

for funding from other organisations.

As it was referred on the above sections, a BBC journalist will film and document the trip. The project will therefore become known to the public and all the above customers will be referred. Their work therefore will be known, thus they'll become known, more popular, will attract fund organisations, more volunteers and customers.

Our approach is a well-developed plan on the plastic's life cycle, it is efficient, it has a low impact on the environment and has a low level of hazard. This project is a great exposure for our customer's company. We are forming key partnerships with key organizations we are planning on campaigning against re-disposal of plastic.

5.2 External Business Environment

PESTLE stands for the political, economic, social, technological, legal, and environmental factors that are going to affect the performance of the company's project. Political decisions and situations due to external political bodies could affect the progression of our project. Visas for our employees that are travelling from the UK to Chile could be an issue; if not all visas are approved we would face reductions in crew which will lead to a decrease in efficiency. In other words, part of our project depends on the UK having good relations with Chile at the time.

Another political issue is Brexit. At the time of travel, the pound could be weaker therefore cash currencies could be an issue. If the exchange rates for the British pound are low, it could mean that more money will be need spent to buy the fuel and equipment we will be importing into Chile, thus we need to look at the rates constantly to make sure we get the best deal.

By carrying out PESTLE analysis for our provisional commercial model, we can see that economics and the uncertainty of the future has the most affect on the company. The fuel price, which is something that constantly changes, is one of the factors that cannot be controlled. However it can dramatically increase the cost for our project depending on the national and international economy. According to our calculations the fuel price we suggest is 0.62 per litre. Funding therefore is an important aspect for the progression of the project. We plan to get funding from a variety of different sources that have an interest in our cause. In return for funding, though publicity we hope to increase their market share by advertising their contributed to the project.

Our aim is to make people aware of the pollution and problems that plastic causes to the environment, which lies under the social factors.

Technology will play a very important role as well, since the boat we are using is designed with the latest technology and will make the journey more safe and comfortable. The machinery that will be used to clean the sand will also affect the project since it will make the job easier and quicker.

The environmental factors are very important on the current project and we need to ensure that we limit pollution to its minimum. Our goal is to clean the beaches and leave the island in a better place than we found it. Thus, we need to make sure that by cleaning the beaches we won't disturb the island's wildlife. We looked into the rarer species living on the island and their breeding seasons and we aim to avoid the peak mating time to reduce the effects of stress, caused by human presence, since this could have a negative effect on the species population.

We need to keep noise pollution at its minimum and ensure that our sand cleaning machines do not emit excess amounts of carbon emissions. By only taking with us 4 tractors we are aiming to avoid any disturbance on the island's ecosystem.

Finally, what is the legal responsibility we have towards our employees and how the laws could affect out project? By visiting a UK overseas territory island all the UK laws apply there too. Thus, in case we do not follow any of the health and safety laws as well as all the laws that lie for our employees including employer's liability insurance we could be in trouble and we could face charges. That could negatively affect the image of the company. Our company ensures that our employees are obliged to follow the law, otherwise there will be consequences. Uncertainty in our business could affect the behaviour of some buyers and suppliers, thus making sure that the above issues will not be a problem is part of our deal with your company.
[21], [22]

5.3 The Selling Price for this Proposal: how that has been derived and what margins have been estimated.

The price has been estimated to £1,000,000. The price is divided into two parts. The employee's salary and the equipment cost. The salary for each profession has been estimated according to the average salary that corresponds to each profession. Those were taken from the UK Government website.A 20% bonus was added to all the salaries of the people that are going to travel overseas, due to the increasing risk that comes with spending two months away from home in the open ocean and travelling abroad. Then for each salary the number of months that each person will work for was calculated. Then according to the amount that each salary cost the tax was calculated according to the amount told by the UK government through their national website. Employer's Liability Insurance and Medical Insurance were added for each employ. With the company tax, the salaries were calculated in total to be £529680,00. The equipment that will be hired was estimated by finding the cost it worth from the company's website and then it was multiplied by the amount of the machines that will be used. The total was estimated to £118350,00. Other expenses, including vaccinations, food, flight to and from Chile and tools to work in the sand and fuel for the machinery were calculated to cost £ 124738,00 and the other equipment was estimated to cost £10480,00. The prices are analytically shown on page 29.
The project will need three years to be completed, including the year before the trip and the year after the trip, therefore we will need £450000.00 for the first year to begin with. The price is estimated according to the salaries of the office staff as well as the deal we will do for the machinery , £450000.000 for the 2nd year which is when most of the money will be put into effect and £100000,00 on the year after to pay the salaries of the office staff and other expenses.

5.4 Key Financial Planning Assumptions

To calculate the final price for the project, some assumptions have been made. The price of oil was calculated according to an average of £0.62 per litre. However, the price is not stable, therefore it depends on the rate the day the oil will be bought whether the price will be higher or lower. Another assumption is the cost of the return tickets to and from Chile. We estimated the price to be £950.00 for each person although, depending on the time the tickets are bought the price could be lower. Adding to that, we assumed that all the visas of our employees will be approved and therefore the cleaning will be done on time. Last but not least, the amount of

£29,000 has been currently estimated for the end of the project. It is assumed that the money is enough to cover any unexpected costs and thus we are never in overdraft, thus no interest has to be paid on any money that will be borrowed from the bank.

5.5 Profit and Loss Flow Forecasts for the First Three Accounting Periods

Table 5.1 shows how much money we are asking for over the 3 years, and how that money will be spent. Tables that show the breakdown of staff, machine hire, and equipment costs are on page 29.

	Accounting Period		
	April-March year 1	April-March year 2	April-March year 3
Payment	£450,000.00	£450,000.00	£100,000.00
Fixed Costs:			
Office Staff	£114,981.47	£114,981.47	£114,981.47
Boat Staff	£0.00	£333,080.74	£0.00
Machine Hire	£0.00	£118,350.00	£0.00
Other Equipment	£0.00	£10,330.00	£0.00
Other Expenses	£0.00	£124,738.00	£0.00
Total Loss	£114,981.47	£701,480.21	£114,981.47
Net Loss	£335,018.53	-£251,480.21	-£14,981.47

Table 5.1: Profit and Loss Forecast

5.6 Cash Flow Forecasts for the First Three Accounting Periods

Table 5.2 shows our predictions of how our bank account will look at the start and end of each accounting period. We have just under £70,000 left for overhead expenses. This overhead is to cover any extra minor costs that we have not identified in the cost breakdown (which you can find on page 29).

Accounting Period	Opening Balance	Total Receipts	Total Spending	Closing Balance
April-March year 1	£0.00	£450,000.00	£114,981.47	£335,018.53
April-March year 2	£335,018.53	£450,000.00	£701,480.21	£83,538.31
April-March year 3	£83,538.31	£100,000.00	£114,981.47	£68,556.84

Table 5.2: Cash Flow Forecast

5.7 Key Commercial Risks to Forecasts with Best/Worst Case Scenarios

The best case scenario would be that the clean up is a success. This would entail the boat leaving the island in next to spotless condition, no staff members suffer from any injury, all the machines fulfil their function without breakdown, and the collected plastic is all recycled and

kept out from landfills. In addition to these positive outcomes in the best scenario, the project will cost approximately how much we have predicted- give or take a few thousand pounds.
A commercial risk to this forecast, that may lead to a worse scenario, is that fuel costs and foreign exchange rates may fluctuate out of our favour. If extra expenses arise, or payments are not made promptly, we run the risk of going into overdraft. This would cause the project to run into debt, as there is not enough overhead in the budget to cope with interest rates on any unestablished overdraft with the bank. Especially as interest rates are expected to rise [23].
While there is no alternative source of finance, a potential plan B if spending is heading vastly over budget is to sell the collected plastic to cover the hole in the budget. However, plastic prices have been falling in recent years due to it being cheaper to buy new raw materials [24], [25]. Recent social and political changes may dramatically affect this. As corporations and governments are seeing the damages of producing more and more new plastic without regards to where it ends up, many will seek all new alternatives [26] while others will want to use recycled plastic more. Another change in policy which may effect prices is the introduction of restrictions on imported plastic China will accept from January 2018 onwards. This is predicted to cause huge rises in UK and USA pollution. The ban will increase the supply of plastic "being stockpiled and at risk of ending up in land fill" [27] and not recycled.

5.8 Estimate of the Most Likely Financing Requirements to Implement the Project; How much Capital is Required?

This project requires £1,000,000. We request that this is payed in installments over three years.

Year	Payment Required
1	£450,000
2	£450,000
3	£100,000
Total	**1,000,000**

Table 5.3: Payment Breakdown

This money will be used for paying for staff, hiring machinary, and other expenses such as food and vaccines. Table 5.8 shows the breakdown in cost of staff members.

			People			
Role	**For trip**	**Weekly**	**Tax Weekly**	**# Staff**	**Total NI**	**Pay per Role**
Cook	£4,800.00	£560.00	£55.61	2	£953.38	£9,600.00
Doctor	£12,000.00	£1,400.00	£171.53	1	£1,470.29	£12,000.00
Labour	£3,600.00	£420.00	£36.29	48	£14,932.39	£172,800.00
Mechanic/driver	£5,280.00	£616.00	£63.34	6	£3,257.59	£31,680.00
Cleaner	£3,600.00	£420.00	£36.29	1	£311.09	£3,600.00
	For 3yrs					
Office Staff	£75,000.00	£480.77	£44.68	4	£27,880.42	£300,000.00
				Total	£48,805.16	£529,680.00

Table 5.4: Staff Salary and Employers National Insurance Tax Contributions

The table 5.8 shows the salary of each role, and the national insurance tax contributions owed by the company. The tax was calculated using guidelines from UK government HM Revenue and Customs [28].

	/Person	Total Cost
Medical Insurance	£1373	£96110
Employer's Liability Insurance	£49	£3430

Table 5.5: Cost to Insure all Employees in Year of Employment

The price of employer's liability insurance was a quote from insurer AXA [29]. The cost of health insurance used in our calculation is the "average premium for UK private health insurance" [30].

	Salary+Tax+Insurance
Boat Staff	£333.080.74
Office Staff	£344,944.42

Table 5.6: Total Cost for the Boat Staff and Office Staff

Table 5.6 sums up the cost for both staff teams (office staff and workers taking the trip on the boat).
Table 5.7, 5.8, 5.9 shows the other costs.

Machine Hire	Cost	Quantity	Total
John Deere 4520	£22,025.00	4	£88,100.00
400HD Surf Rake	£14,950.00	1	£14,950.00
Tractor Trailer	£3,825.00	4	£15,300.00
		Total	£118,350.00

Table 5.7: Fixed Costs: Machine Hire

Other Equipment	Cost	Quantity	Total
Portable Toilets	£630.00	5	£3,150
Clothing	£115.00	60	£6,900.00
Tools to Work in the Sand	£43.00	10	£430.00
		Total	£10,480.00

Table 5.8: Fixed Costs: Other Equipment

Other Expenses	Cost	Quantity	Total
Vaccinations	£236.00	58	£13,688.00
Food	£40,000.00	1	£40,000.00
Return Flights to Chile	£950.00	58	£61,750.00
Fuel	£0.62	15,000	£9,300.00
		Total	£124,738.00

Table 5.9: Fixed Costs: Other Expenses

The cost of the vacinations was caculated by first identifing the vacinations recommended for travel to Henderson island, then finding the cost of getting the vaccines at superdrug [31].
Cost of portable toilets [32]

Project Total: £931,443.16 allowing some overhead we require **£1,000,000** to turn this proposal into a live project.

Chapter 6

Corporate Social Responsibility

6.1 Describe the Ethical Model Applied to the Proposal

Examining all the models that could be applicable in this case it seems most likely that a Kantian approach would be the best method to approach the ethical evaluation of the project.
The first possible model to use would be a virtuous model, this is the most basic and least in depth of all the models, it purely states ‘what would a virtuous person do?’. However this is a very subjective approach, what may be virtuous from my perspective could be nothing more different from someone else’s. This is mostly due to virtue being very vague, meaning that it contains the most form. I think this is an excellent check to make sure that we are following a basic guideline and can be a perfect mental check whenever making a decision, however in this case it just is not specific enough compared with the other alternatives.

The next model to highlight would be the ethics of care, which comes from the feminist philosophers, and examines actions on the characteristics of: Attentiveness, Competence, Responsibility, Responsiveness. I think this is excellent but doesn’t contain enough about the environmental impact in its core message and in general is very poorly suited for analysing this specific situation due to factors we will later explain. However following the 4 areas we should find a good measure of how our project performs:

Attentive	This is mostly focused on recognising the needs of others. In this project we see that on this island there is a need that cannot be internally satisfied in that there is a high level of pollution that needs to be cleared. If we have correctly recognised this need then the project is very strong in terms of its attentiveness.
Competence	Competence is one of the weakest points of this project. We are simply a team of 7 Students who are in the second year of their studies, in whole this would require much more logistical skill that we could provide. However, in the hypothetical sense of us acting as though we were an international company this would entirely be down to the size, skill set and experience of the company.
Responsibility	This island is a British Overseas Colony (a throwback to the highly ethical days of empire) and are therefore the responsibility of England to help and care for them. Therefore by cleaning this island we are merely following our ethical duty, and any actions less than a complete solution is a failure on our part. When England decided to conquer and claim land thousands of miles away it took on a responsibility and currently that is being ignored. So this proposal is the minimum that England should do, and is better than the current course of actions.
Responsive	This project is very slow in therms of how responsive it is being. The pollution problem has been widely known for some time now and it still hasn't been dealt with, therefore we feel this project is very poor in terms of how responsive it is, however, the more time goes on, the worse it will become

Overall we feel that in examining this model there are not enough factors that can be used to differentiate between different proposals and in terms of the competence evaluation; in this situation, the worst case is a terrible failure as we are mere students, and any hypothetical is just that, hypothetical and cannot be examined.
Kantianism is the method that we suggest is best for this evaluation, it puts the burden of evaluation on the intentions of an action. Kant also believed that all beings are logical and that therefore there are underlying reasoning, or Maxim, for any actions. Moreover, we should look into the reasoning behind our actions. On first thought they are highly pure. We are deciding that there is an island which has a problem and we are helping to solve that problem. Which is very good. However we must also think that this is our responsibility, as mentioned before, and thus cleaning the island is the minimum we should do on our own territory. However, we think that overall, following the intentions for our actions and the maxims behind them for the best way to ethically assess this proposal.

Utilitarianism focuses on the other side of an action from Kantianism. It follows that intentions have no consequence and the outcomes and effect are the only way to evaluate an action. Because outcomes can only be seen after a project, this model is unsuited in this case. It is especially a shame as Utilitarianism includes the impact on animals as well as humans. The phrase that can best describe utilitarianism is that is should maximise the well-being of sentient entities. And therefore we think that utilitarianism would be best in practise as a way to analyse this proposal after its completion.
The final model to examine is the theory of social contract, that people follow and built in social contract and that they should follow this. We personally feel this is too vague as I believe that culture and upbringing has a huge influence on what individuals see as a 'good' action and therefore would find it hard to apply this model to the proposal

6.2 Environmental Impact of the Proposal

6.2.1 Methods of Evaluation

To assess the environmental impact of the project, we shall evaluate using a method based on a ESIA (Environmental and Socio-Economic Impact Assessment) used by BP [33]. We shall rate 4 categories on a scale from 1-3 and then sum the totals to create the total score for the project. BP also used a further receptor sensitivity scale which would evaluate how intense the impact was on specific groups using key on-site indicators and then would look at the two separate scales lined up to give an overall assessment of the impact of the proposal. However, the receptor sensitivity scale is mostly based on field work and on site assessments to which we do not have access. So while that would be the ideal way to assess the project, it is not feasible for this specific case so we will be using some factors based on BP's indicators to analyse our proposal.

Determining the Magnitude of Events:

- Extent/ Scale (The size of the area affected)
    1. Up to 500m from the event
    2. 500-1000m from the event
    3. 1000m+ from the event
- Frequency
    1. Once
    2. Up to 50 times
    3. More than 50 times
- Duration
    1. Up to one week
    2. One week to one month
    3. More than a month or permanent change

These individual scores are then added together to give a total score which can then be compared using this table

Table 6.1: Event Magnitude Scale Comparison Table

Event Magnitude	Score (Summed Result)
Low	3
Medium	4-6
High	7-9

In BP's method, they had one final value of intensity which would look at the change in the environment using fieldwork and surveys of the area. However, this is not appropriate for us, so instead we will only look at the magnitude of the event and then find ways of minimising the chance of it happening.

Table 6.2: Magnitude Assessment of Environmental risks

Event	Extent	Frequency	Duration	Overal
Accidental Damage to Animal's young (including eggs)	2	2	2	6
Human waste left on the island	1	1	3	5
Noise pollution for animals on the island	1	3	3	7
Toxic emissions from machinery	2	3	3	8
Carrying natural predators or disease	2	3	3	8

From this, it can be seen that the toxic emissions and noise pollution pose the greatest risks to the island. In this proposal, we will detail how we will reduce the likelihood of these occurring.

6.2.2 Accidental Damage to Animal's young (including eggs)

This is a serious concern as we could accidentally wipe out an entire generation of breeding, seriously damaging the mating cycle of the animals. Henderson Island is mostly inhabited by birds, however they breed in the trees and on the mainland of the island, so due to us only focusing on the beaches, we don't need to worry about these, therefore the proposal shall avoid all of the mainland and trees. Of a larger concern is the impact on the Green Sea Turtle which has been seen on the island and therefore could lay their eggs in the sand. The project on the island finish before Sea Turtle nesting season starts [34]. However, we will also make all workers aware of what the turtles and their eggs look like, so that if by some chance they find some then we can make sure that it is protected and not damaged.

6.2.3 Human waste left on the island

The aim of the project is there to clean up the man-made rubbish from the island, therefore we don't want to leave anything of ours behind -it is counter-productive. Therefore, we will use portable toilets and the waste shall be taken back with us to be disposed in the proper manner. Staff can dispose of any litter they may produce with the rest of the rubbish leaving with us. For this it seems very sensible to use the same attitude as is seen in Antarctica 'leave no trace of your visit' except in our case we do want to make a change, so maybe a good alternative is 'leave no negative trace of your visit'.

6.2.4 Noise pollution for animals on the island

This is possibly the most difficult to eradicate during our visit because working without making a noise is nearly impossible. Therefore we are going to work only during the day and stay as far as possible away from the majority of the wildlife population of the island. This should be relatively easy as most of the wildlife lives in the centre of the island and we are only focusing on the beach, however, we are still close enough that we may affect them. In the project we are using tractors, which quite loud, but less than the quad bike alternative and any other, quieter, means of transport would just mean that the project would draw out longer increase the time of the disturbance. This seems like the best method that we can use and we will be working only during the day, therefore, hopefully will minimise interference with the animals on the island.

6.2.5 Toxic emissions from machinery

This is a serious concern for us, we are using tractors on an island and they are diesel powered, therefore we will be giving off unburned hydrocarbons, carbon monoxide, nitrogen oxide and particulate matter. There is not much we can do about this as there is no alternative method of power on the island and at this time electrically powered vehicles is not a viable option.

Therefore, we will have to use diesel engines, but before we go will will check their catalytic converters and if necessary upgrade them so that there is a minimum of emissions from them.

6.2.6 Carrying Natural Predators of Disease

This has been a huge historical problem in journeys of the past. Islands like Henderson have their own ecosystems and in the past humans on exploratory missions have accidentally brought rats on their ships. Rats are a major problem on the bird life such as the Henderson Crake which is a small flightless bird [35]. The RSPB (Royal Society for the Protection of Birds) are well aware of this issue and are trying to decrease the rat population to help the birds thrive [36]. We shall make sure that there are no additional animals other than humans on the ship by checking thoroughly before leaving on the voyage. This should also be less of a problem as the ship is going to be docked some way from the island and then transport to the island will be by rib. This is a huge worry in the project but with the right precautions the chance of it happening will be minimised.

6.3 Community Development and Involvement

Throughout this project, we hope to have support and involvement from the general public. When a global crisis arises, such as plastic pollution threatening our oceans, community growth and involvement are key to the success of a project like this and finding a long term solution. We want as many charities and campaigners to be involved in this project as possible. One such community involved in the project is the plastic village where we will be donating what we collect. The role society plays is shown in the table:

Media	Publicises the problem
Public	Donate or make changes to their life style.
Environmental groups and NGO	Supply human resource and experience
Large corporations	Fund and technical support
Plastic Recycling Companies	Provide an environmentally appropriate method to reuse the plastic collected

Chapter 7

Operational Proposal

7.1 Resources Required to Deliver the Project

Resources are divided into human resources and equipment needed. Human resources include office staff working from home, in the UK, who will be responsible for the organisation and smooth progression of the project. Crew members are also essential for the completion of the project. This includes the boat drivers, the pilots, the boat cleaner and the two cooks who are coming on the trip to operate the ship as well as the worker who will be cleaning the beach. Qualified engineers will be needed to operate the machinery for the application of both stages of the project, whilst 48 less qualified individuals will be needed to manually collect the plastic. A trained doctor will also be on board to take care of minor injuries and potential illnesses.
Food, clothing, tools and medicine are coming from the U.K. Food and drinking water will be brought from Antofagasta, Chile.We estimate that each person will require £10 for food per day. Essential tools including muck boots, coats for wind and rain and helmets will be given to each stage 1 and stage 2 individual. Shovels, tarmac rakes and other tools needed to work on sand will also be bought for the trip. For convenience, 5 portable toilets will also be brought.
Finally, the machines for Stages 1 and 2 and their fuel. Four powerful tractors, namely the John Deere 4520 and one 400HD *surf rake* will be brought from the U.K. They will be used to fill the four 18-ton shipping containers with plastic from island.15,000 litres of fuel is prepared.
All the resources above are needed for 2 months while operating on the island.

7.2 Project schedule with summary and duration of activities

Our plan for cleaning the island is summarised in the table below:

Day	Activity
1-10	Travel from port of Antofagasta to Henderson Island.
11-22	Operate stage 1, cleaning by hand
23-47	Operate stage 2, cleaning by machines
48	Final clear up work and get ready for return
49-60	Return from island to Colón Island, Panama

This table, however, only illustrates the ideal situation. Consider any emergency that may affect this time plan (mostly delay) then the final arrangement could be:

Day	Activitise
1-10	Travel from port of Antofagasta to Henderson Island. While in ship, take risk assessment and basic training
11	Arrive at island, unload all equipment
12-21	Operate stage 1, cleaning by hand including review
22-46	Operate stage 2, cleaning by machines including review
47-48	Final clear up work , summary about the project and get ready for return
49-60	Return from island to Antofagasta

We estimate unloading from the ship will take around one day. Time is needed for them to get used to the island and the working conditions.
At the end of each stage, there is a review period which aims at checking the work done so far and if anything goes wrong, to fix the problem as soon as possible. This period is not fixed to the final days in the stage, in fact, there should be a daily assessment for each day's work. The final review is just a final look to make sure everything is going well in order to get on to next stage.
The reason why the return journey takes longer is due to the ocean currents, as well as having a heavy load of plastic to carry.
The final two days on the island is not just to make sure everyone is ready for boarding and start getting loading, but also to make sure no trace of our staying on the island is left behind. The island should be left as if it has not been inhabited by and humans.

7.3 Operational Safety and Health Risk Assessment

As this island is unfamiliar to everyone, all the possible dangers need to be considered. All the risk is based on three main parts; disease, environmental hazard and human operation. To reduce the harm brought by disease, a doctor comes with the crew, who understands how best to prevent the spread of infections and disease. Henderson Island is a tropical island, mosquitoes and flies are common on this island, and as a result, several infectious viruses such as malaria could be easily spread. The doctor needs be equipped for a range of eventualities, this means having having the resource to help with illnesses such as seasickness, diarrhoea, the flu as well a injuries such as large cuts and bruises. The project is planned to be carried out in Autumn, when the weather on Henderson island should be at it's mildest, however the weather could be extreme. Heavy rain could cause delay and seasickness during the journey to the island. Also if the sun is strong and people are exposed to if for long hours, people may get sun stoke. Because few humans have been on the island before, we have limited knowledge about creatures living on the island, some may be harmful to humans. The best way to be safe is to keep distance from all of the animals and insects on Henderson island as much as is possible, this will also help reduce our impact on the ecosystem of the island. The best was to minimise all the risks associated with the project. These are described in the table below:

There are two additional categories in the table, one of which describes the likelihood of the risk occurring and the other describes how serious we think that risk is. The rating of the risks is given from 1 to 10, where 1 represents a very low risk and 10 a very high risk. The likelihood/chance of a risk occurring is given as a percentage from 0 to 100. It is very difficult to estimate the likelihood of a risk materialising, but we have done our best to be as realistic as possible.

Table 7.1: My caption

Potential Risks	Chance of this risk occuring (0 - 100%)	Risk rating (1 - 10)	Managing these risks
Sun stoke	70%	7	Using sunscreen, wearing long sleeved clothing and wearing wide brim hats.
Infectious diseases	30%	9	Appropriate supply of anti-inflammatory medicine and making sure everyone has had the appropriate vaccinations.
RSI (Repetitive Strain Injury)	40%	5	We will have group stretching sessions after work and the doctor will provide massages and oils to those in more need of a remedy.
Injury from machine or other objects	10%	7	Medical kit and trained doctor will provide the necessary remedies.
Dehydration	30%	6	Water will be provided and we will encourage everyone to take regular drinking brakes
Seasickness	20%	4	We will have appropriate medicine if this occurs.
Home sickness	50%	3	There will always be someone to talk to about feeling homesick. The staff will encourage after work games and create a friendly and safe environment
Exposure to plastic chemicals	80%	6	We will provide hand sanitisers to avoid getting any skin damage or infections from the plastic.
Fatigue	70%	4	The work will be strenuous, but there will be enough food and water to hopefully fix this.

According to *Health and Safety at Work etc Act 1974*[37], a safe accommodation must be provided. To reduce cost and keep distance with the wildlife, all employees will be living inside the RRS. David Attenborough, where there is sleeping quarters, a kitchen and eating area.

Chapter 8

Appendices

Time on the Island

Time on the island = 60 Days - (Chile to Henderson Island) - (Henderson Island to Colón Island, Panama)
The RRS Sir David Attenborough travels at a rate of 13-15 knots, 24 hours a day.
The distance from the Port of Antofagasta, Chile to the Henderson Island is approximately 3150 Nautical mile
Assuming the vessel only manages to average 13 knots, it will take 10 days, 2 hours and 15 minutes. However we could be there in under 9 days at the top speed. The distance to Colón Island, Panama is approximately 3711 Nautical mile
Assuming the vessel only manages to average 13 knots, it will take 11 days, 21 hours and 25 minutes. However we could be there in litter over 10 days at the top speed.
This leaves 38 days on the Island. All distances and time was calculated using aqua plot, a route planner for maritime supply chains [38].

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