

Sustainability Innovation

One Rip Away From Saving The Marine: More Sustainable Approach To Deal With Disposable Medical Masks

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Summary

Ocean occupied over 70% percent of the area on Earth. Indubitably, ocean played a major role in the course of human development. However, throughout past centuries, human have dumped countless pollutions into the ocean, forgetting the significance of it to humanity. Ocean have become our waste yard. With these pollutions parts of the ocean became uninhabitable to marine organisms, seriously damaging both the ocean and creatures that depend on it.

The outbreak of COVID-19 in 2020 only added to the situation. As the result of the pandemic, the usage of disposable medical mask increased drastically with it becoming a major source of household waste in the past year. With the usage of billions of masks in the past year, about 1.5 billion of them made it to the ocean, without being noticed by human. Those masks will certainly become killers of marine organisms, as the straps of the masks alone could choke animals to death.

We are aware that the health of ocean is significant to not just our environment but human as well, so we decided to focus on this topic. Unfortunately, people usually lack the knowledge about the situation that the ocean is currently in and the awareness to protect it. Our ultimate goal is to expose the danger faced by the ocean to the public and motivate them to participate in ocean protection actions.

In order to achieve this goal, we developed multiple solutions. After reading academic essays, visiting research institutes, analyzing survey about public awareness on the mask situation, and interviewing specialists from related industries, we developed solutions on various aspects: technological, managerial, and promotional. Specifically, our solutions range from utilizing the technology of sustainable and biodegradable masks to developing method to regulate the disposal of masks and finally increasing public awareness to properly dispose used masks.

Through conducting public and community managerial survey, visiting research institutes and mask manufacture factory, and public speaking in community center, we reached the conclusion that most people are willing to buy biodegradable masks despite its expensive price and to follow our "Break It" action when disposing masks.

Choose the Topic

Identify the Challenges

1. Inevitable usage of disposable masks during Covid-19

In order to prevent the spreading of coronavirus, people are required to wear masks in public areas. However, disposable masks only provide optimum protection in a certain period of time. For example, WHO recommends people to change masks every 4 hours. Most people use at least one mask per day and this adds up to an astronomical number of 3.4 billion used masks being discarded every day around the world [1]. Landfilling and incinerating used mask seems to be an effective solution, but not all masks are properly collected and discarded. When more than 7 billion people are wearing and throwing away disposable masks every day, plenty of used masks end up in the ocean and threaten the habitats of marine life [2]. As the pandemic continues, how to deal with this huge number of masks will soon become a more serious problem that people have to consider.

2. Lack of uniform standard in dealing used disposable masks

People's masks when wore are inevitably contaminated by bacteria and viruses. In hospitals, especially, patients carrying various viruses will contaminate the masks, which classifies used masks as a type of hazardous waste and should be collected by specialized garbage cans. However, most people would carelessly throw away used masks with other household wastes. The most common approach to deal with the used masks is to incinerate them with other wastes in order to produce electricity. However, in developing countries, used masks are not able to be collected and disposed of efficiently [3]. Instead, the masks would end up in landfills. As a result, the used masks will flow into the sea while bacteria and viruses still attach to the surface of masks and lead to more severe plastic pollution. Also, there is a lack of uniform standard internationally on the disposal of used masks. In the United States, the procedure in processing used masks include "segregation, sorting, storage, collection, transport and final disposal," especially incinerating the masks at above 850 degree Celsius at the final disposal stage. However, in some developing countries, they choose completely different way, landfilling, in dealing with their used masks [4]. This lack of standard procedure when disposing used masks makes it especially difficult to regulate and to ensure effective management of the used masks globally.

3. Disposable masks may release harmful chemicals

Disposable masks are mainly made of polypropylene (a kind of plastic). If being burned, the masks will release a great amount of toxics and harmful chemicals, including formaldehyde and acetone [5]. Burning polypropylene also results in

xylene, benzene, and toluene. Xylene is used in some laboratories to prepare tissue under the microscope, but can only be used in fume hoods due to its toxicity. Benzene is a dangerous chemical substance found in car exhaust and cigarette smoke and toluene is often found in paint thinners. These chemicals can cause eye irritation and breathing problems when people inhale them. Some of the discovered chemicals may also be considered cancerogenic [5]. As these toxic substances accumulate over time, they will likely influence people's health and pollute the environment.

4. Lack of public awareness

Most people believe that the disposing of masks does not belong to their responsibility and that the government would be in charge of this problem. They do not pay enough attention as long as marine debris and pollution do not affect their daily lives. The public is often unaware of the negative impact of discarded masks have on the environment and therefore does not realize that carelessly throwing away masks is a serious problem. On the other hand, throwing away masks without pulling off the elastic straps and cutting them into pieces may also entangle weak creatures and suffocate them, leading to more severe damage on the marine environments [6].

5. Difficulties for mass producing biodegradable masks

As disposable masks have become a more common source of marine debris, many scientists have been finding more sustainable methods to produce masks, such as using nano-silver composite aerogel or bamboo-made high-efficiency antibacterial masks [7]. Even though they have made great progress in biodegradable masks, the masks are still not in production due to many factors. For example, the production of these biodegradable masks may be costly, making them unaffordable for the public. The high prices may reduce people's interests in purchasing the biodegradable masks and to use ordinary masks instead. Moreover, few people have the awareness to use more sustainable masks due to the lack of knowledge of sustainability and protecting marine lives. This contributes to the low demand of biodegradable masks and high costs of actually producing the biodegradable masks. Finally, it is still unknown if biodegradable masks can achieve the same level of protection as that of traditional masks. More investigations may still be required to test the biodegradable masks.

6. Management capabilities need to be improved

6.1 Ineffective regulations on residents

Most people discarded their used masks after they have gone out in the daytime. Some communities in high-risk areas may also contain specialized trash bins to collect people's used masks to avoid the contaminated masks to continue spreading coronavirus. However, residents are not strictly required to do so. At the same time, the number of these specialized trash bins is not sufficient and therefore

not convenient for people to use. Therefore, the residents would throw their masks away with other household wastes, making the process of collecting and disposing used masks more difficult to execute.

6.2 Insufficient regulations at tourist areas

During the high season for tourism, plenty of people would choose to go to the beach to relax and enjoy their leisure time. Due to the COVID-19, the tourists are required to wear masks when they are traveling but few of them pay attention to the importance of throwing away garbage properly. Tourists may carelessly leave their garbage on the beach, including plastic packages of food and used masks. The garbage would later flow into the ocean and damage the marine environment. Although the local governments have established several regulations, for example, Hainan has required more actions to collect the garbage on the beach and more supervision on the actions, the huge flow of tourists could make this process challenging to achieve [8].

6.3 Poor regulations on fishermen

Fishermen or other people related to the fishing economy may influence the living environments of marine lives as well. Overfishing may hinder the food chain, reduce biodiversity in ocean and destroy ecological balance. In addition, fishermen tend to abandon their fishing nets directly in the ocean, when realizing damages on the nets. These abandoned fishing nets would become marine debris and continue to exert pressure on marine lives.

(See attached file for references)

 [References-challenges](#)

 [interview summary](#)

Identify a Root Cause

There are plenty of challenges of solving the treatment of medical masks and reducing their negative environmental effect. In order to identify the one and only root cause, our group has separated the possible root causes into two categories: short term and long term.

1. Short-term

Short-term root causes include the current material used to produce masks and the ways of dealing with discarded masks.

1.1 Material

Currently, the surgical masks are made from non-biodegradable materials. A mask normally has three or more layers, by which the outer and inner layer is made of non-woven fabric, and the middle layer, a melt-blown filter paper, is made of polypropylene that has a small fiber diameter with static electricity, giving it the ability to absorb bacteria and viruses' droplets and particles under the action of electrostatic absorption to achieve the role of filtering barrier [1]. However, polypropylene cannot be degraded. It takes about four hundred to five hundred years to degrade masks made by the current non-degradable materials. [2] The masks being blown into or being manually disposed into the ocean will stay in the ocean for hundreds of years, affecting marine lives and leaving the environment unhealthy. The animals may be entangled by the ear loops, and may even suffocate. Due to the epidemic, the amount of disposal of masks has increased drastically, according to Oceansasia, it is estimated that 15.6 billion discarded masks have entered the ocean. [3] The nondegradable mask is becoming a threat to marine lives' biodiversity. Biodegradable masks are still in the research and trial stages, by which two alternatives that are biodegradable are bamboo fiber and polylactic acid.

1.1.1 Bamboo Fiber

Bamboo fiber could be degraded, but its material cannot achieve the characteristic of the ear straps of surgical masks, as it is required to have elastic force. Thus, bamboo fiber could only be used for producing a degradable filter section of the mask instead [5]. Using bamboo fiber is not the best practicable way of solving the problem of degradability, as the ear straps may still be a threat to the animals in the ocean. Also, the cost of bamboo fiber-made surgical masks is five times higher than the market price of nondegradable surgical masks, and people may not be willing to buy daily used materials that costs five times more than what people are used to buying, despite it being degradable.

1.1.2 Polylactic Acid

Polylactic acid is a degradable material that can both produce the filter section and the elastic ear loop section of the surgical mask [4]. However, the status of this new

technology is that it is still in the research stages, as due to polylactic acids' specialty, the traditional accelerated weathering methods to test the durability of products cannot be applied to the polylactic acid made degradable surgical masks. Hence, the product needs to actually wait for time to pass to test the durability of this type of surgical mask. It also costs more than non-biodegradable masks at current market prices. People may not be willing to buy the new product.

1.2 Disposal

People, at this point, did not find a way to solve the problem of dealing with discarded masks that do not hurt the environment. The current main ways of handling masks are landfilling, composting, incineration, catalytic pyrolysis, and recycling.

1.2.1 Landfill

The method of landfilling non-biodegradable masks is the most commonly used way of dealing with discarded masks in the current time, as landfill waste investment is less, the processing capacity is large, and the technical requirements are not high. However, it occupies a large permanent area, and it can also damage the structure of the soil to varying degrees. The potential for pollution is large.

1.2.2 Compost

Masks can be turned into organic manure by composting, but the fertilizer effect of this kind of method is low, by which the sale is limited, and the prospect is not broad.

1.2.3 Incineration

The discards, through the process of incineration, would be used to generate electricity, having high efficiency, but burning masks also have threats to human health as, during the process, greenhouse gases and toxic gases such as ammonia and hydrogen chloride would be released and be inhaled by people. Some heavy metal particles will be discharged into the environment along with the tail gas after the process, thus more investments need to be put into how to deal with the exhaust problem, increasing the cost. [9]

1.2.4 Catalytic Pyrolysis

Catalytic Pyrolysis can degrade polymer materials such as polypropylene into small molecules. Synthetic polymers are usually derived from petroleum and would usually be degraded into different gasoline grades using the equipment. The cost of investment is very high and the profit of the product may not even cover the cost [6].

1.2.5 Recycle

Recycling and reusing the discarded materials could be put into effect through physical or chemical modification of the polypropylene material into new raw materials, producing new products. However, large investments are needed in the primary stages to support and fund the experiments, and the amount of companies specializing in recycling is not large enough to absorb the huge number of waste produced. [7]

2. Long term

From a long-term perspective, the management system of discarded masks is not in perfection, also, people' s awareness towards the environment needs to be reinforced.

2.1 Management

The management of masks is not solemn, and people are throwing masks unceremoniously. Currently, the management policy of masks is imperfect, causing the public to be unaware of the underlying threats of ill-managing the discarded masks. There are usually only garbage cans for household wastes in communities instead of a separate place for the used masks to be disposed of. Also, the lack of a punishment mechanism for littering masks has caused pollution and damage to the environment as well as not helping people to increase their attention on the threats of the masks that people use every day. People throw masks unconcerned because there is no rule to punish them. People do not need to pay for the consequence of not dealing with the masks correctly, as the current rules are jurally and subconsciously allowing citizens to throw the mask without any attention. The government does not make any rule that can compulsively force citizens to be concerned about the environment that people live in. [8]

2.2 Awareness

People' s awareness of the environmental problems is very weak, as they don' t consider it as a threat to their lives, they will just choose to not see the reality and keep living their lives. [8] This has become part of their subconscious, and when discissions have to be made, the primary scruple is not to coexist with the environment and nature, but their own benefits would be first valued, neglecting that nature will return the pain back to humans. This causes the results people are currently facing: 15.6 billion masks flowing into the ocean, overfishing, destroying the environment. [3]

To conclude, based on the above analysis, we have identified the one and only root cause of our problem to peoples' awareness. The inadequate regulations that have been set are all caused by the unconscious lack of attention to environmental protection. People's lack of urgency and demand for biodegradable masks is also caused by their subconscious lack of understanding of the harm to the environment.

(See attached file for references)

 [References for root cause](#)

Generate Solutions

In order to improve the current situation of the overuse of disposable medical masks due to COVID-19, we come up with solutions and categorize them into three categories: technological, managerial, and promotional.

Technological solutions

1.1 Replace disposable medical masks with biodegradable ones

A qualified mask consists of three layers. Two of which, the outer and inner layer, are made of non-woven fabric, and the middle layer is made of melt-down fabric. The major component of the fabrics is polypropylene, which takes hundreds of years to decompose naturally. Due to COVID-19, the number of used masks increases drastically and becomes a severe problem to the environment. According to NationalGeographic.com, up to 129 billion of disposable masks were used per month, which is equal to 3 million masks being used per minute. Another study has reported that China on its own discards 702 million face masks every day. In order to alleviate this problem and after intense research, we find out that the materials used for ordinary disposable masks can be substituted by polylactide (PLA), polycaprolactone (PCL), or natural fiber from kapok and bamboo [1]. Using these materials, masks can be degraded naturally in a shorter period of time, therefore, becoming more eco-friendly to the environment.

1.2 Replace ear loops of medical disposable masks with biodegradable materials

In fact, the ear loops of disposable masks exert more threat on the ocean and marine organisms than other parts of the mask. Marine organisms and birds are unable to break free from the entanglement with those ear loops. Therefore, marine organisms may be suffocated to death by these ear loops from masks [2]. In addition, ear loops are also difficult to recycle and harmful to the environment [3]. However, few researchers and companies have considered replacing the ear loops with more eco-friendly and biodegradable materials. We believe that replacing ear loops with biodegradable materials can result in less danger towards marine organisms and less pollution to ocean.

1.3 Devise mask splicing machines

Scientists have suggested that it is better for us to break used masks into pieces before throwing them away, because they might spread diseases and led to further pollution problems [4]. However, it can be dangerous for people to touch contaminated masks or used masks directly, since those masks might carry viruses or bacteria. As a result, we want to develop a machine that can cut the masks into

pieces automatically. Hint, this machine will cut the ear loops off before cutting the rest of the mask into pieces.

2. Managerial solutions

2.1 Managerial solutions for medical disposable masks within community

2.1.1 Set up specialized garbage cans for medical disposable masks in communities

Careless throwing of used masks has become a serious problem, but most local communities are still unaware of the importance of collecting and distributing used masks. In addition, masks are very light; therefore, it would easily be blown to other places such as the ocean when being improperly collected. In order to attach great importance to this problem and to decrease the number of masks carelessly discarded, community managers can set up specialized garbage cans in the community to collect used-masks so that people would not discard them carelessly. For example, community managers could set up one specialized used mask garbage can per department building.

2.1.2 Increase residents' awareness on the issue through posters, videos, or slogans

The community managers should implement some actual plans on educating and encouraging residents of the community to correctly dispose masks. Such plans and methods could be posters, videos, or slogans. Only when people themselves became aware and willing to improve the situation from the bottom of their heart, will they really start to act and behave in the right way.

2.1.3 Create punishments towards those who did not dispose their masks correctly

Community managers and administrators can punish people for carelessly throwing or disposing masks. For example, 50 to 200 RMB each time will be charged on the person who failed to follow masks disposal guidelines.

2.2 Managerial solutions for medical disposable masks on beaches

2.2.1 Provide water-proof bags for containing used masks to tourists

Due to the pandemic, tourists nowadays are required to wear masks when they visit other places. For example, tourists may wear masks on the beach but forget to bring their masks along with them as they depart, mindlessly leaving their masks on the beach. Moreover, sometimes, tourists will choose to throw away their masks just because sand appeared on their masks, increasing mask usage of the day. Water-proof bags could be used in this case to ensure that tourists' masks will not be "contaminated" with sand on the beach. In this way, the number of masks abandoned by tourists will decrease, and the bag might even make the mask stand out so that tourists will not forget to take them.

2.2.2 Set up specialized garbage cans for medical disposable masks on the beach
Although there are plenty of garbage left on the beach, according to our observation and interview with sanitation worker in Dameisha Park, Shenzhen August 9th, 2021, the number of garbage cans on the beach is enough, about one garbage can per 15 meters. However, there are no specialized garbage cans for medical disposable masks on the beach. Yet, every day, the sanitation worker could collect at least one big plastic bag of masks on the beach. Therefore, adding specialized disposable mask garbage cans could be a method implemented to reduce the number of masks left on beach by the tourists.

2.2.3 Broadcast on the beach to promote tourists to properly dispose used masks
The primary way of making announcements on the beach is broadcasting. The broadcast on the beach is often loud enough to reach even those who are swimming in the ocean. Almost everyone in the area will be aware of the announcement, so it would be effective if managers of the beach encourage and educate people on the beach how to correctly dispose their masks.

2.3 Generate a three-step procedure for disposing medical disposable masks in a more environmental friendly way

Masks have become a daily necessity for people after the outbreak of the pandemic, and along with it are countries, organizations, and individuals' struggle on disposing the huge number of used masks. A lack of unified international standard on medical mask disposal and the possibility of virus contaminating masks lead to most of the used masks today incinerated, releasing toxic and green house gases into the atmosphere. Or, those masks end up in landfills, taking hundreds of years to decompose naturally. A step ahead of incineration and landfilling could be added to allow people to do participate in facilitating eco-friendly disposal of medical masks. We designed a three-step procedure to help ordinary people to dispose medical masks in a way that help to prevent the entanglement of ear loops on marine organisms.

3. Promotional Solutions

3.1 Redesign ocean trash or used masks into artwork

Ocean trash could be redesigned into meaningful artworks that would make people ponder the contamination in ocean caused by human. In the process of creating these artworks, audience would realize themselves of the danger of carelessly discarding masks and the threat of ocean trash to marine eco-system. Participants of this event will be collecting trash on the beach and later use the collected materials to make their own artwork. Possibly, there will also be an exhibition showcasing the artworks created by the participants.

3.2 Advocate people to wear reusable masks in specific conditions

Indeed, medical disposable masks give wearer best protection against pandemic like COVID-19. However, in some occasions, it is not necessary to wear medical disposable masks such as when taking a walk in the neighborhood or in low-risk areas with no COVID cases. In those cases, wearing medical disposable masks could be a waste, because COVID is not an urgent threat, and reusable masks would be a more sustainable alternative. Posters, videos, and slogans could be designed and showcase on streets or communities to encourage people to wear reusable masks in specific conditions.

3.3 Use statistics on posters, videos, or slogans to improve public awareness

Statistics are straightforward for the audience to understand the impact of discarding disposable masks in the ocean. We will collect data and measure the extent of contamination of masks on the beach through two monitoring indexes: accumulation rate and standing stock of beach litter. Accumulation rate refers to the cumulative rate of litter in a regularly clean area in a certain period of time. Standing stock refers to the amount of litter in the monitoring transect in a certain point of time. Together, both two measures give us the approximate number of masks or litter in general on the beach. With those statistics, posters, videos, or slogans will appeal more to the audience, and our argument will appear more authentic.

3.4 Advocate “Break It” Action

As mentioned in 2.3, we have generated a three-step procedure for disposing medical disposable masks in a more environmentally friendly way. The name of the three-step procedure and the action is “Break It.” Step one: pull the ear loops of the mask off; step two: tear and rip the masks apart; step three: throw the fractured mask away. Note, if the mask is contaminated with virus, please use gloves when executing “Break It.” The removal of ear loops and fragmentation of mask will help reduce the risk of marine organisms becoming entangled with the mask, if the mask entered the ocean.

3.4.1 Gather support from community managers and put-up posters informing residents of “Break It” action

“Break It” posters will be created by our group members with diagrams illustrating and instructing residents how to correctly dispose masks, and to follow our “Break It” steps. We will communicate with community managers and persuade them to permit us to put up posters on the billboard or in the elevators in the community, which are obvious and notable positions for residents. We will try to contact managers of our own community as well as managers of seaside communities, because those are the communities that might have direct impact on the ocean. Through putting up posters, we believe that residents will be reminded daily, every time they saw the posters, to follow “Break It” procedure.

3.4.2 Use online platforms to inform and reach broader audience and raise their awareness

We will use a variety of online platforms, such as Wechat moment and Wechat official accounts, to spread our message to a broader range of audience, not just those around us. Posters and articles will be published on online platforms so that they will be easily accessed by everyone. Also, through online platforms, we will distribute surveys regarding people' s perception on disposable masks and ocean.

3.4.3 Gain support from our school and put-up posters on campus to influence our fellow classmates

Compared to adults and the public, as students, it is easier for us to influence and increase the awareness of those around us. Therefore, it is an excellent idea to post "Break It" posters around our campus. We will put posters in the hall way and in the stair way after school started. The hall way and the stair way are places where students pass most frequently in the day. Since, as young adults, we are the future of the world, influencing our fellow classmate meant that the future generation will be aware of the harm of disposable masks on ocean, solving the problem of people carelessly discard their masks everywhere.

3.4.4 Get in contact with celebrities or influencers to help us spread our "Break It" action

We will try to get into contact with celebrities or influencers who have a fair number of fans and try to persuade them to help us spread our "Break It" action. In this way, our "Break It" action will be spread to more people, influencing more people in following our three-step procedure.

3.5 Design volunteer teaching course and public speech

We are aware that putting up posters are not enough. Face to face speech and teaching to others will be more effective than simply drawing and putting up posters. Therefore, volunteer teaching course and public speech will be written in order to further enhance the audience' s awareness on the negative impact of discarding disposable masks.

The volunteer teaching course will be designed for children from 4thgrade to 6th grade. In the course, there will be interactive games with the children as well as informational sessions on the impact of disposable masks on marine organisms and eco-system. Specifically, we will intergrade our mask splicing machine into the course. In this way, those children will put together their own mask splicing machine. Hand craft will deepen the impression that the children have on the event, so they will remember more complete of the things taught in class. Moreover, we will teach our "Break It" action to the children so that they could start to correctly dispose masks and understand the meaning of it from youth.

Also, public speeches will be another way where we introduce our “Break It” action. In those public speeches, we will create interactive games with the audience to make it an unforgettable experience for them. For example, while we are introducing our “Break It” action, we could also provide them with material and offer them the chance to put together their own splicing machine. Straightforward statistics will also be included in the speech so that the audience would be able to visualize the effect of masks on marine organisms and eco-system.

With the kids and adults perceiving information through lectures with actual demonstrations provided to them face to face, they will have more profound memories about the process. They might even share “Break It” with their family after learning it from the speeches and courses, correspondingly achieving publicity.

3.6 Distribute survey to tourists on the beach to gain insight in people’ s perception on the relationship between disposable masks and ocean
Being part of the research process, we will visit the beach and examine the actual level of mask pollution due to tourist activities on the beach. Although there are information on the internet regarding number of masks entering the ocean and on the beach, it is better and more accurate for us to actually go to the beach and examine the situation ourselves. Our group members will design a public survey question and invite strangers on the beach to complete it. All of the questions are designed so that we could understand people’ s real perception on the ocean and disposable masks. We will analyze the data and accordingly test whether “Break It” action would be accepted by the public. After analyzing those data, we will take initiatives, which we describe in the previous sections to ensure people learn the consequences of carelessly discarding masks and the correct method of disposing them.

 [References - generate solutions](#)

Identify the Criteria

Criteria:

We are well aware that we cannot implement all of our solutions, so we need to evaluate each of our solution based on our criteria. There are four major parts of our criteria: feasibility, operability, measurability, and creativity. Feasibility and operability are each worth 25 points, because our solution need to be able to be implemented in the real world with our limited ability as students. Sustainability is worth 20 points as our solutions need to be sustainable. Otherwise, we just raised another environmental problem while solving the previous one. Measurability and creativity are both worth 15 points because we consider them equally important. We need to be able to measure the effect of the solution in order to know if its effective, and innovative solution are generally more accepted by the public.

Feasibility (25)

Feasibility is crucial when evaluating our solutions. Feasibility determines whether our solution could be implemented or not. Without the evaluation of feasibility, we might end up with action plans or solutions that cannot be implemented in real world, which is not helpful in actually saving the ocean. In our criteria, feasibility includes financial cost, labor cost, and support from authority, in total weighting 15 points.

1.1 Cost (13)

The cost of the product determines our solution' s feasibility as it contributes to the money we need to spend on it, including the labor, investigation and experiment fees. The solution is only feasible if its within our financial abilities. as well as whether the people would accept the solution or the product we make due to the relatively high or low market price. Therefore, 13 points is rewarded for the cost of the solution.

1.2 Authority Support(12)

With authorities in the environmental protection industries, our solution would become more credible and feasible. Authorities includes but is not limited to the government, but also include communities, experts, schools tourist areas such as the beach. Authority support will help with implementing the solution, but cost matters more, because if the solution is too costly, it will still be impossible to be implemented on a large scale even with authority support.

2. Operability (25)

Operability offers us an estimate probability of completion as a student, as well as the extent of the acceptance of the solution.

2.1 Public Acceptance (10)

The cost or the novelty of our solutions might cause the public to cast doubt on or feel restricted by them. Since our solutions are faced towards the public, our solutions need to be accepted by the public. However, public acceptance is not as essential as other evaluation factor like sustainability, so it is worth only 10 points.

2.2 Capability (15)

As high school students, we cannot solve the problem as the way professionals solve. We do not have access to special and advance technology; also, we do not have the knowledge and authority to make important changes involving government management system. Therefore, it is very necessary that we consider the capability of ourselves in actually achieving the solution. 15 points is awarded to the solution if we, as students, could actually achieve it. Compared with public acceptance, our capability is more important, so capability is worth 5 more points than public acceptance.

Sustainability (20)

Sustainability is also an important evaluation factor of our solutions. First, solutions need to be able to last for a continuous period of time. If it could only last for a short amount of time, the solution might be ineffective in the long run. Second, solutions need to be eco-friendly and beneficial to the society. The aim of our solutions is to solve the problem brought by disposable masks to the ocean, so it is of most importance to make sure that our solutions are sustainable, and not harming the environment. This is the reason why sustainability is worth 20 points.

Measurability (15)

We need to be able to measure changes that occurred during the time that we implemented the solution in order to know if our solution is really effective. When evaluating the measurability of the solution, we will predict the estimated number of audiences being impacted by the solution, the rate of the solution becoming effective, and the degree of which the solution helped in reducing the number of masks in the ocean in measurability. Measurability is also a major aspect of evaluating our solution, so it is worth 15 points.

4. Creativity (15)

To attract the public and ensure they would be willing to accept our solution, the solution must be designed with creativity. In our criteria, creativity measures the novelty and attractiveness of the solution. 15 points is awarded to creativity, since we believe creativity will greatly influence how others view the solution. The more creative the solution is the more people will more likely to appreciate and accept it.

Evaluate the Solutions

In order to calculate the scores of each solution that we have generated, our team has decided that everyone grade the solutions themselves, and then calculate the average by adding all the scores up and dividing it by 5. We have set the line of making the solution into action to 70, once the total score of the certain solution meets 70 or above, we decide to make the solution to action.

As shown in the table in the criteria section, we measured all of the solutions in the “generate solution” section. As a result, there are thirteen solutions that have exceeded 70 points.

We have evaluated to do “Replace ear loops of medical disposable masks with biodegradable materials” ,
“Devise mask splicing machines” in the technological portion;
“Set up specialized garbage cans for medical disposable masks in communities” ,
“Increase residents’ awareness on the issue through posters, videos, or slogans” ,
“Set up specialized garbage cans for medical disposable masks on the beach” .
“Generate a three-step procedure for disposing of medical disposable masks in a more environmentally friendly way” in the managerial portion;
“Use statistics on posters, videos, or slogans to improve public awareness” ,
“Gather support from community managers and put-up posters informing residents of “Break It” action” ,
“Use online platforms to inform and reach a broader audience and raise their awareness” ,
“Gain support from our school and put up posters on campus to influence our fellow classmates” ,
“Get in contact with celebrities or influencers to help us spread our “Break It” action” ,
“Design volunteer teaching course and public speaking” , and
“Distribute the survey to tourists on the beach to gain insight in people’ s perception on the relationship between disposable masks and ocean” in the promotional section.

 [Evaluate Solutions](#)

Make an Action Plan

 [Action Plan table](#)

Prototype and Test

| Prototype Design

In Prototype Design, we recorded the execution process for all of the solutions from the “Generate Solution” section that we decided to take action on. This includes three sections, which are technological, managerial, and publicity, corresponding with sections written in the “Generate Solution” section. All of these records are based on our actual actions, observations, research, and interviews.

Technological Solutions:

1.2 Replace ear loops of medical disposable masks with biodegradable materials
In the beginning, our group aims at actually designing and inventing biodegradable masks. Therefore, we visited a mask company in Fo Shan (which is located in Guangdong province, China), and interviewed the managers there. The managers expressed their agreements into producing degradable masks in the future, but they also mentioned that with the modern technology and demand, it would be almost impossible to sell these masks in the market. The reason is given below: the degradable material of bamboo fiber is five times more expensive than the usual material, so the public would prefer the cheaper one that obtains the same function more. Furthermore, bamboo fiber cannot be made into ear loops, their functions are limited only to make the rectangular part of the mask. In addition, another degradable material, the polylactic acid (PLA), can be turned into ear loops, but the cost of it is also high, which the company had addressed further concerns about the public accepting it.

Due to the factors listed above, we decided that the solution of designing biodegradable masks is not in our ability range to complete or to be tested.

1.3 Devise mask splicing machines

As we focused our topic on the separation of ear loops from the rest of the mask, we came up with the idea of designing a “mask splicing machine”. There are four pillars in the corners of the mask bin designed to tighten the ear loops, making it easier to be cut off. Then, there will be a thick layer of metal on the lid of the box, also having sharp blades. When people put the lid on, the blade around it will cut off the ear loop. There will be small bags on either side of the box, so when the ear loops are separated from the masks, they will fall into the little bags. The mask is pressed tightly against the bottom of the box, maximizing the box's capacity and ensuring that the public puts as many masks as possible. People will only need to

press the cover down and the ear loops will come off.

Managerial solutions:

2.1 In public places and within communities

We contacted two community managers in two apartments located in Guangzhou to gain information on how communities manage disposed masks currently, and their intentions of using the "BreakIt" action.

2.2 Managerial solutions for medical disposable masks on beaches

We contacted three beach administrators at Shenzhen's beach DaMeiSha and interviewed them about the current situations on the beach and their opinions towards the "Break It" action and "devise mask splicing machines".

2.3 Generate a three-step procedure for disposing medical disposable masks in a more environmentally friendly way

After a series of discussions in our group and researches, we came up with a standardized method of disposing of masks. The first step is to pull the ear loops off from the masks. The second step is to rip the mask into pieces. Then, the last step is to throw it in a trashcan. This standardized process will prevent marine species from being strangled by the ear loops and avoid the animals to suffocate from it. Based on the ideas, we designed a poster especially for advocating our standard way to dispose masks.

Promotional Solutions:

3.4 Advocate "Break It" Action

3.4.1 Gather support from community managers and put up posters informing residents of "Break It" action

During the trip to Shenzhen, we talked in several residential quarters to suggest them to implement this method and advocate their community to do the same thing. Many of the managers of those residential quarters agreed to hang up our posters after we convinced them.

3.4.2 Use online platforms to inform and reach a broader audience and raise their awareness

As a way to spread more awareness to the public, we used social media such as WeChat' s moment, to let people better understand the "Break It" Action. We also used all of the human resources we have, to spread the "Break It" Action to as many people as possible.

3.4.3 Gain support from our school and put-up posters on campus to influence our fellow classmates

We started a club in our school called "WeCare", and we want to further continue

the topic of Masks pollution in the ocean with our future club members. During the "Club Fair" event where we introduced our club to the students and teachers. In addition, we handed out surveys to students and teachers to get their opinions about the "Break It" action and overall awareness about protecting the environment.

3.4.4 Get in contact with celebrities or influencers to help us spread our "Break It" action

We tried to reach out to the Chinese Olympic gold medalist in the 87kg weight lifting competition and contacted her family members.

3.5 Design volunteer teaching course and public speech

We held some activities that invite the public to join and learn how to deal with abandoned masks. We went to a charity organization to give a speech about marine pollution and the "Break It" action to a group of primary students and their parents (about 20 primary students). During the speech, we shared the knowledge we learned from documents and specialists (in researches and interviews), and use those authoritative and precise data and studies to inform the students and parents. Therefore, leaving a deep impression in the public's mind to mention the damage of throwing masks carelessly.

3.6 Distribute survey to tourists on the beach to gain insight in people' s perception on the relationship between disposable masks and ocean

We designed a public survey to get a better sense of public awareness about marine protection and ways they dispose masks. We went to ShenZhen to the beach DaMeiSha, and distributed the survey to the tourists on the beach. In addition, to broaden our survey feedback, we also posted the survey online for friends and family members to fill out.

 [Offline Activity](#)





 [offline activities - school publicity](#)

| **Feedbacks learnt from users**

In the Feedback from users section, we recorded the quantitative and qualitative data collected from interviews with specialists; beach/community investigations; surveys; and actual feedback from the targeted users for their experience. In this section, we wrote the actual situation for each action, whether the action successfully worked or failed, and some experience learned from these tests.

Technological solutions:

1.2 Replace ear loops of medical disposable masks with biodegradable materials
The feedback from the mask factory managers shows that the cost of the degradable materials is very high, and it is unlikely to be implemented in the market because of low public acceptance.

1.3 Devise mask splicing machine

With this idea, we discussed this proposal with the managers in the Foshan masks production company. While showing endorsement with the idea, the managers also talked about the blades being dangerous because of their positions. Furthermore, we sent out a survey asking the public's interest in buying one of the mask splicing machines. Out of 315 responses, 37% of the participants are certain that they will buy and or are willing to use the machine; 28% of the people think this machine is unnecessary; 17% of them are unwilling to either make one by themselves or buy one; and 18% of the people are still uncertain about their decisions. Based on the feedback we got back from the masks company's managers and the public, we decided not to continue with the mask splicing machine further with the current situation.

Managerial solutions:

2.1 In public places and within communities

From the analysis of results from the feedback survey from community managers which included their opinion on the "Break It" action and the mask splicing machine, most of the community managers agreed that it is their responsibility to advocate for environmental protection in the community. Our "Break It" action and Masks splicing Machine receive overwhelming responses from them. Out of the 36 community managers, 33 of them said that they are willing to follow the "Break It" action and 31 of them said they are willing to use the mask splicing machine. In general, those community managers support these public benefit activities. Only about 5% of the community manager think that the residents in their community are unwilling to follow the "Break It" action.

2.2 Managerial solutions for medical disposable masks on beaches

From the three beach administrators we interviewed, all of them agreed that they have the responsibility to advocate tourists on the beach to be more environmentally friendly. In addition, three out of three beach administrators expressed the willingness towards using the "Break It" action and advocating tourists to use it.

2.3 Generate a three-step procedure for disposing of medical disposable masks in a more environmentally friendly way

Through the feedback we got from the parents that listened to our speech, 93.75% of the parents from the 20 parents who listened to the public speech we delivered in the community expressed their willingness towards using the method.

Promotion solutions:

3.4.1 Gather support from community managers and put-up posters informing residents of "Break It" action

During this process of communicating with the community managers, we also learned that hanging up information in the communities would require special permission or approval from the district manager. We were first refused by the community because we didn't have the approval, but after we tried hard to persuade the district manager, he gave us permission to hang out our posters in the residential quarters.

3.4.2 Use online platforms to inform and reach a broader audience and raise their awareness

From the 315 feedbacks we got from the public, 86.35% of the people expressed their willingness of using the "Break It" Action. This high rate of acceptance proves that our method is easy to operate, thus, the public is willing to cooperate with the "Break It" Action.

3.4.3 Gain support from our school and put up posters on campus to influence our fellow classmates

From the feedback we got from the "club fair" event in school, we received 37 survey feedbacks. 81.08% of them expressed that they realize the negative consequence that masks are causing to the ocean, and 75.67% of the students and teachers out of the 37 feedbacks expressed a positive attitude towards the "Break It" action.

3.4.4 Get in contact with celebrities or influencers to help us spread our "Break It" action

After we waited for several weeks, we still didn't get a reply from the gold medalist's family member, thus, we decided to not further conduct this action.

3.5 Design volunteer teaching course and public speech

After a week, we did an interview again through calling, gathering more feedbacks about their attitudes toward the "Break It" action. According to the statistic we got, 14 out of 14 parents understood the damage humans are creating to the ocean, and 93% of the parents expressed their willingness towards using the method. Furthermore, when we asked about their willingness to continue using the "Break It" action in the future, 68% of the parents said they will definitely use it, and 25% of the parents said they might use it.

However, in the call interview, we also received feedback from two parents saying that they are unwilling to participate in further "Break It" action because they feel like ways of disposing masks don't relate to ocean pollution.

3.6 Distribute survey to tourists on the beach to gain insight in people' s perception of the relationship between disposable masks and ocean
Until now, we got 315 feedbacks from the public, and the result shows that 66% of the people throw their masks away in regular bins without doing anything before disposing it. This gave us an idea of how the public is lacking the awareness to correctly dispose masks. Therefore, making the "Break It" action have a greater impact on the public.

[📄 Volunteering teaching course and public speech on "Break It" effect survey](#)

[📄 School promotion survey](#)

[📄 Public awareness survey](#)

[📄 beach admin survey](#)

[📄 community survey](#)

| Improvement for next iteration

Technological:

Even though the biodegradable masks are very expensive, but for the next step, we will try to contact a mask production factory to produce some masks, and try to sell them in our school or community.

Since we learned from our users that most of them think the mask splicing machine is unnecessary, thus, we decided to try to implement this machine in some areas with severe COVID situations next. Thus, this machine can effectively help them to not contact the virus directly when they are changing their masks. Also, we will be trying to revise the concern from the mask factory's manager about the safety of the blades attached to the machine.

Managerial:

We will keep tracking the community in Foshan that we delivered the public speech in, and we will monitor their use of the "Break It" action, and get feedback periodically.

Promotion:

We will try to spread the "Break It" action wider by forming clubs in our school that continue to promote the action. Then, as the club leaders, we will be leading our members to help promote the "Break It" action.

Team Credits

何雨甜 Yutian He (Claire) is responsible for deciding the overall topic, writing the initial draft of criteria, and finalizing the summary, criteria, and generate solution part. She has participated in field research in Dameisha, where she asks strangers on the beach to fill out our survey. She also went to Shenzhen Base of South China Sea Fisheries Research Institute and interviewed one of the researchers there. She also participated in the interview with specialists from Blue Fin.

杜康松 Kangsong Du (Kevin) is responsible for listing out the Challenge, modifying the “promotion solutions” section in Generate Solution, and simply writing the Root Cause. He is also responsible for finalizing the table of Action Plan. He comes out with the idea of making a Devise Mask Splicing Machine and designs the machine sample. Most of the time, he is responsible for interviewing professors and writing the interview outline. And he also implements the activities of offline speech of protecting the ocean.

申依桐, Yee Tung Shen (Grace) is responsible for identifying the Criteria, grading the Evaluation of Solution, and classifying and adjusting the Root Cause. She is also responsible for analyzing the past prized works. She created the “public awareness survey” and “community management survey” sections. She has participated in the Shenzhen Dameisha beach field research and the surgical mask manufacturing factory’ s visiting trip.

李佳镁, Jiamei Li (Victoria) is responsible for finishing the structure and content of Challenge, and completing the Summary. She finished writing the first version of technological solution and managerial solution from the part of “Evaluating the solutions.” She also organized all the information from interviewing the specialists and professionals and publicizing offline activities.

赵远宜, Yuanyi Zhao (April) is responsible for writing the initial draft for “promotion solutions” section in Generate Solution; “promotion solutions” section in Action Plan and Prototype and Test; making changes to Evaluate Solution; “Managerial solutions” in Generate Solution and “Managerial solutions” section in Action Plan. She is also responsible for designing and drawing the Devise mask splicing machine and “Break It” poster. She also created the “community management survey” , “community management feedback survey” and “public awareness feedback survey” .

Onsite Conference File

📁 第二次模拟视频

📁 演讲稿

📁 PPT

Judge Comments

" Congrats on exploring a very timely topic. I commend the team on a thorough use of references and citations while you have summarized the issue. I also really appreciated that the team thought about a large and complex issue, but then broke it down to what is practical as a school student as part of your criteria with 'capability' . I also applaud the teams action plan as well as the many efforts they did on the ground to move their ideas – this type of passion behind action will serve you all well in the future! Congrats!

The analysis could have been strengthened by bringing in two aspects – (i) identifying that in the case of a global public health crisis, environmental issues might take a backseat. The research around better mask options should always start with the question of whether they still serve the public health need (reducing contagiousness of COVID in this case) and (ii) while improperly disposed masks are a new issue that needs to be better addressed, they are still a small part of a very complex problem of marine litter/waste management that the world has not dealt with properly yet. Solutioning for mask disposal should bring in elements of overall waste management challenges. That said, I think the 'Break it' idea is among the most practical of the ideas that the team could have taken forward – this might frankly not prevent the material from ending up in the ocean, but it might prevent some marine organisms from getting snagged in the masks because of the loop.

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