

Sustainability Innovation

Of Non-woven Fabric And Melt-blown Non-woven: The Medical Masks Can Be Better Utilized

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Summary

Summary The ongoing COVID-19 disease significantly affects not only human health, but also the wealth of countries' economy and everyday routine of human life. To control the spread of the virus, face mask is widely used as primary personal protective equipment (PPE). While the production and usage of face masks significantly increase as the COVID-19 pandemic escalating, our team observed serious environmentally problem-- The waste and pollution generated during the process of mask manufacture and disposing. A large number of researches and published articles has recognized the fact that this potential environmental threat can be fatal for human society and the nature. Specific policies and action plans need to be made to prevent it from becoming the next plastic problem. So we decided to land on this urgent problem to see what the manufacture industry, mask business, and every individual under the pandemic strike can do to utilize the mask material in order to stop further waste and pollution. As we dig deeper into this problem, we summarized the root cause into three points: 1. The rising demand of Personal protective equipment(PPE) 2. Massive waste of face masks and related medical issues 3. The lacking public awareness of the proper disposing of waste masks and effectively using of the material. And based on the root cause, our challenge was specified into four areas: pollution, garbage system, production line and the manufacturing waste. Our ideas came out when seeing the survey that shows the lack of concern on mask recycling. To take some actual actions to deal with it, we built a website, not only to hear people' s voices, and also to provide solutions. As our website has been built and put into use, we went through the viewer' s comment and the clicking statistics. The conclusion we reached is to apply further means of internet propaganda that can expand our publicity and do our best to improve the quality of our website. We receive criticism and praise from our own perspective.

Choose the Topic

Identify the Challenges

Preface:

1. We analysis the challenges by first considering how discard masks draw on detriment, including general pollution(I) and recycling problems (II), and then the defects (III) and waste (IV) when masks are produced.

2. * includes some materials quoted from Google docs.

I. The pollution brought by discard masks

I.1 Hard to be degraded

Nowadays, the masks have been people' s daily supplies due to the pandemic. Discard masks takes 400 to 500 years to be degraded. It is the PP consisting the masks that hard to be degraded. The World Conservation Organization for Nature has warned that if just 1% of all masks are improperly disposed of, 10 million could be discarded every month. These masks are equivalent to 4,680 to 6,240 tons of plastic waste. They run into the ocean or hide in the land. However, it takes about 450 years for a face mask to be decomposed by the natural environment.

I.2 Ocean pollution

The ocean is one of the most important resources the earth provided with human. However, at least 1.56 billion face masks ended up in the ocean in 2020, according to a new report by ocean conservation group Oceans Asia. It is not rare to see that face masks are removed from the stomach of the dead penguin and they wrapped around the feet of the seagull. This is an emergent situation, because every creature in the life system plays their own role in the niche. This connects to human destiny: no one knows how distinction of one specie, caused by harm of the discard masks, draws on what series of consequences. Moreover, the ocean links to human destiny in another way. Sea food, with the development of the ships and so on, has become a normal food on humans' table. But what we do not know is that we are absorbing plastics while we enjoy those meal. As I state above, it takes hundreds of years to degrade the masks in the ocean, but when they are degraded, they become tiny particles of plastics, the micro-plastics. When micro-plastics are ingested by wildlife and enter the food chain, they can eventually affect the entire ecosystem. Humans undoubtedly are involved.

II. Garbage system is lack of efficiency

Garbage sorting has recently been systematically implemented in Chongqing. However, this plan is very inefficient in practice, especially the destruction of

discarded masks.

II.1 Classification problems by citizens

First of all, in the collection of the garbage, the residents need to go to the site and throw the trash into the trash can, the steps to make our daily garbage disposal becomes tedious, but the point is when communities concentrated garbage collection from each garbage station, people did not make a good garbage classification again. Instead, they mixing the garbage together and concentrated destruction to waste factory. During this process, medical waste that we put in masks and that gets mixed in. Even many public places like community and schools have set up yellow medical garbage bins to collect discarded masks. However, in daily life, due to the scarcity of garbage delivery points, medical waste delivery points are filled with residents' daily household garbage, such as snack bags, takeout lunch boxes or napkin balls.

II.2 Risks of virus infection

Improper garbage collection practices increase the risk of virus infection, as garbage trucks are often not sealed. Also, frequent opening of garbage bins for non-medical waste can greatly increase the risk of infection, and the virus can spread many times faster if the masks placed in them are not folded as required. Full exposure to the air allows the disease, whose transmission route is unknown, to spread, and the workers who transport the waste and destroy it at the dump are the worst victims. Of course, the passing of garbage trucks can also increase the chance of infection.

III. Problems of the production line

The third challenge is the production line of masks. Since the outbreak of the epidemic, we have initially experienced a great demand for masks and a huge vacancy in mask production. A large number of mask production corresponds to a large number of labor force. However, under the background of the epidemic, employees will continue to work in the face of the risk of infection. And recruiting a large number of temporary employees is also facing the lack of experience in making masks. Therefore, what we are facing is not only the problem of production, but also the most crucial factor to prevent the spread of the epidemic.

IV. Waste generated during the production of masks

While the abandoned face masks can be seen as a real threat to the environment, another concerning fact is the waste that generated during the production of masks. It can be generally divided into two areas: the large emission of CO₂ involved in the process of mask production and the waste of scraps and edge materials after the production.

IV.1 Emission of CO₂

First, the production of the face masks contributes to the emission of CO₂, which will potentially contribute to the global warming. There are three main aspects where the large emission of CO₂ is expected: manufacture, packaging and transportation. During the manufacturing, the processes of propylene, small aluminum strips and polypropylene in the production of N95 and surgical mask contributes the significant amount of CO₂ emission to the environments. Furthermore, production of fabric, sewing and weaving process of cloth mask fabrication also contributes the CO₂ emission to the environments. * Directing the attention to the transportation part, we can see there' s an even higher rate: the global trade network and disruption of PPE supply chain have been discussed by the Asian Development Bank (ADB). It should be noted that the energy consumption and environmental footprint of transporting could be quite different depending on the situation. For example, in the normal scenario, ship is utilized. However, in the emergency situation, which certainly includes the urgent transportation of personal protective equipment (PPE) between countries under the pandemic strike, plane is a better option even the cost and emission are higher, with an average of 17.1 times increases in energy consumption. *

IV.2 The waste of scraps and edge material

The scraps and edge materials after the mask production could be another serious challenge to the environment. The Melt-blown Fabric, which is a non-woven fabric that has a number of desirable properties including absorbency, bacterial barrier, filtering, resilience, softness and washability, in the manufacturing of medical and surgical masks. However, this kind of material can easily leave a significant amount of waste scraps and edge materials, causing environmental and economic problems. For example, due to the pandemic and waste situation, the price of melt-blown fabric rose from 20,000 yuan a ton before the epidemic to 500,000 yuan a ton, and sometimes are even unable to purchase. What' s more, not all mask scraps can be recycled as recycled resources. Composite, low-value category, hard-to-decompose materials are difficult to fit in this recycle process.

Identify a Root Cause

1. The rising demand of Personal protective equipment(PPE)

One year after the Coronavirus was declared a global pandemic, face masks have become ubiquitous in daily lives as they continue to be mandated in more public places. And, not only is everyone wearing masks, it seems like everyone is making them too. The result of this surge in usage and demand for masks, which had previously largely been made in Asia, has led to an unprecedented rate of investment in not just face masks but in their main raw material component—meltblown nonwovens. Both surgical masks and N95 respirators are disposable, explaining the high and recurrent demand. Once used, their external layer may become covered with germs. Moreover, humidity from the mouth slowly alters their filtering properties. Masks are therefore effective only for a few hours (four hours for surgical masks and one day for N95 respirators) and there is a risk of contamination when manipulating them or re-using them. Meeting demand for face masks has become one of the main issues for governments fighting the pandemic. Masks may play an even greater role in the next phase of the crisis, when lockdowns are gradually lifted and economic activity resumes, while the virus remains a threat.

2. Massive waste of face masks and related medical issues

This comprises disposable gowns made from polyester or polyethylene such as surgical masks, gloves, N95 respirators, face shields (polycarbonate or polyvinyl chloride) as well as hand sanitisation products with packaging made with polyethylene terephthalate (PET) for alcohol and other disinfectant solutions. The COVID-19 pandemic presents growing environmental consequences related to plastic use and follow-up waste. In this context, PPEs are critically needed. Most of these PPEs comprise single-use plastic. Therefore, it was found that, during the peak of the outbreak, hospitals in Wuhan produced more than 240 tons of waste per day in comparison to the 40 tons that was earlier produced during normal circumstances with most of the waste comprising plastic PPEs. Furthermore, COVID-19 face masks are a potentially high source of microplastic fibres, which have the possibility of being released into the environment. These emerging problems in solid waste management during and after the pandemic have been discussed from the perspective of novel study and environmental policies.

3. The lacking public awareness of the proper disposing of waste masks and

effectively using of the material.

There is a lack of special disposal sites for waste masks in many places. Most people do not dispose of waste masks properly to recycle them, but put them in random places, which not only causes secondary pollution but also wastes materials. People are not actually taking this into account, according to a survey, over half of the interviewee claim that they cannot find the proper place for waste masks. 59.8 percent of respondents said they could not find a special place to dispose of discarded masks, and 49.9 percent said there was a lack of scientific disposal methods. 76.1 percent of the respondents hoped to strengthen publicity to enhance residents' awareness of disposal, and 72.9 percent suggested setting up special bins for recycling waste masks.

 [survey data](#)

 [Data of the rising demand in global mask market](#)

Generate Solutions

i. Using biodegradable plastic for mask production

In the process of manufacturing and abandoning the mask, the large emission of CO₂ seems unavoidable and seriously damaging to the environment. However, the recent study has proven that the biodegradable plastic can reduce the CO₂ emissions by 30%-70% compared with the conventional one: Every plastic material is disposed of at the end of its useful life - by burning or, in case of many biodegradable plastics, by composting. Bio-based plastics are climate-neutral as each plant absorbs as much CO₂ in its lifetime as it emits when it is burned or it decomposes. They also have the unique advantage over conventional plastics to reduce the dependency on limited fossil resources and to reduce greenhouse gas emissions. What's more, it is highly implementable to obtain the biodegradable material. The biodegradable polymers can be obtained from different families like biomass production from agro resources such as polysaccharides (starches, lignocellulose), proteins, lipids and micro-organisms.

ii. Longer uses of each masks: reuse and recycle.

Adding a third layer to cloth face masks is now recommended for preventing the spread of COVID-19. Non-woven polypropylene fabric is the material of choice for this third layer. However, polypropylene (PP) is hard to be degraded: around 1% is recycled. Here is a solution that every person is able to do—use each mask longer. During the special period of COVID-19 pandemic, people change their masks frequently. The reason behind this is acceptable. People are protecting themselves. Most of people do not know how long the N95 can be used safely. As the result, they change them every time they wanted. Hence, if we inform people the knowledge about the safe usage of each mask and ways to elongate its uses, there will be less wasteful discard masks.

ii.1 Daily ways

The N95 mask is one of nine types of respirators approved by NIOSH (The National Institute for Occupational Safety and Health) to protect against particulate matter. N stands for not resistant to oil. "95" means that the concentration of particles inside the mask is more than 95% lower than the concentration of particles outside the mask when exposed to the specified amount of special test particles. 95% is the minimum. N95 is not a specific product name. As long as the product meets the N95 standard and passes the NIOSH inspection, it can be called an N95 mask. The powerful protective ability of the N95 mask lies in its electrostatic adsorption principle. Inside the N95 mask is a melt-blown non-woven fabric, which is made of

polypropylene, a super electrostatic fiber that can absorb static electricity after being treated with electret. This feature prevents the mask from being washable. Because static electricity is afraid of water, as long as the water, then it is useless. If you can't wash it, how can you reuse it?

First, ultraviolet sterilization can be one way. Ten minutes of medical ultraviolet light kills the germs. Then the life of the mask can be extended. Second way is to use a disinfection cabinet and sterilization lamp. Disinfecting cabinets and germicidal lamps can be used to eliminate germs on masks. To prolong its service life effect. Third, high-temperature sterilization is also useful. They can be stuffed into a bottle, sealed, and boiled in a pot, to kill bacteria and reuse. But you can't use the microwave to sterilize, because there is a metal strip fixed on the nose inside the amino non-mask, which will melt and catch fire after the near microwave.

ii.2 Proper propagation by the authoritative media and media that has significant followers

These useful ways can be posted on the authoritative social media. Citizens, especially the older one, did not have the access to these academic knowledge when they are in school, so that their belief count on the authorities. As for the younger one, the media that has significant followers can be the solution. For example, the schools official account can post these information online. The schools' officials not only have plentiful followers—their students and the parents—but also be able to call for the young to protect the environment. As the result, more and more people will begin to use their masks longer and even more properly.

ii.3 Government's help

In terms of the waste caused by the scraps and edge materials after the mask production, the individual reusing of mask could be an effective solution. The government should make sure that the reusing methods are brought into publicity and are displayed significantly enough to arouse public awareness. Reuse can be done using a strategy called mask rotation. In this strategy, rotation of the mask used each day can be carried out, allowing them to dry for long enough periods so that the virus is no longer viable. Proper storage for this technique requires either hanging the face masks to dry, or keeping them in a clean, breathable container like a paper bag between uses. In this way, the lifespan of the usage of face mask can be largely expanded in order to lower the pressure of the manufacturing end to reduce the waste of scraps and edge materials effectively.

iii. Recycling

The main waste of mask scraps and edge materials is the meltblown fabric. A proper industry chain of recycling meltblown fabric would make significant changes in bettering the current waste situation. First, what we need most is professional and well-established meltblown fabric recycling factories. There're few in the

megacities of china but if we are aiming at maximizing the utilization of waste scraps and edge materials, the government should engage in investing and developing more recycling factories. Second, in order to utilize the function of the current-existing industry at full extent, major factories could invest more in promotional marketing to build up their brand and visibility in society, to make it a public knowledge that the waste of meltblown fabric can be and should be recycled to help stop the further pollution to the environment.

Moreover, citizens ought to notify how to deal with the unusable masks. There is no perfect garbage disposal system, which gives many businessmen opportunities to make black money: steal discarded masks and resell them. This behavior greatly increases the risk of infection. For such problems in the recycling process, cutting masks can effectively reduce the occurrence of such behavior. Because the profit from re-cutting the mask would be greatly increased, the merchants' profit would also be reduced, and the re-use of the mask would not exist. This reduction in behavior can significantly reduce the risk of infection.

IV. Strategies for Government

iv.1 The government subsidizes the mask production.

Due to the urgent and mass need of masks, the factories would face large amount of cost, and then, the problem of investment to produce those masks. The effective way of solving this problem is the government's subsidy. With the help of government, factories would be allowed to withstand the mass production need of masks.

iv.2 specific department for transporting discard masks

The imperfect collection method of waste masks can also be solved with the help of the government. A special waste disposal department with special marks should be set up to transport waste masks. Of course, the transport vehicles must be sealed rather than open the doors at random. If citizens encounter unsealed waste transport vehicles, they can report them through identification marks. Effective tip-offs can earn rewards such as shopping vouchers, parking tickets and other rewards that can raise the level of consumption in the city.

Of course, in order to encourage residents to actively participate in the fixed-point delivery of waste, incentives can also be adopted to encourage more people to participate in the fixed-point delivery of masks. Some would argue that the rewards cost a lot of money, but they are tiny compared to the irreversible damage they do to the planet.

iv.3 Enhancing the training program of the employees.

The government is supposed to ask the mask company to add more training programs especially for new employees. In this way, employees are able to be

equipped with high skills of making masks and low possibilities of making mistakes during the producing process.

Identify the Criteria

1. Sustainability (30%)

1.1 To what degree expanding the sustainability will the mask still be effective to use? (10%)

1.2 Which solution achieve the balance between eco-friendly and significant pandemic prevention? (20%)

2. Profitability (15%)

2.1 Whether the innovation of Medical Mask Industry can attract investment and companies' accession? (5%)

2.2 Will the businesses and companies in the industry form an equilibrium rather than monopoly? (5%)

2.3 Can the interest link and fund chain among merchants remain stable?(5%)

3. Feasibility (20%)

3.1 Will the executive plan be approved by the government? (10%)

3.2 Will the operation technically possible? (5%)

3.3 Will the project's cost kept within the whole budget? (5%)

4. Positive Public Influence (25%)

Can the innovation help heighten public awareness towards personal protective equipment in different aspects and thus make the optimal usage of masks?

5. Flexibility and Controllable (10%)

5.1 Whether the solution are able to follow the change in conditions? (5%)

5.2 If the solution are proved to be improper, will the negative consequences able to

controlled? (5%)

Evaluate the Solutions

Criteria: sustainability, Profitability, Feasibility, Positive Public Influence, and Flexibility and Controllability. The five criteria will contribute to 10 scores at maximum. Each criterion will be ranked through all five of them.

1. Using biodegradable plastic for mask production

$$(1+2)+(0.5+0.5+0.5)+(1+0+0)+0+(0+0.5)=6$$

reduce CO2 emission, environmental friendly; need time and new technology to fulfill

2. Propagation of ways to reuse the masks by media

$$(1+2)+(0+0+0)+(1+0.5+0.5)+2.5+(0.5+0.5)=8.5$$

Lead to longer uses of each mask; will not exceed the budget; wide-spread on Internet

3. Reusing method, rotation of masks, implemented by government

$$(1+2)+(0.5+0.5+0.5)+(1+0.5+0.5)+0+(0.5+0.5)=7.5$$

Lead to longer uses of each mask; need time and new technology to implement

4. Establishing the meltblown fabric recycling factories

$$(1+2)+(0+0+0)+(1+0.5+0)+0+(0.5+0)=5$$

budget may be exceeded; no profit, supported only by government

5. Specific department for transporting discard masks

$$(1+2)+(0+0+0)+(1+0.5+0)+0+(0.5+0)=5$$

budget may be exceeded; no profit, supported only by government

Make an Action Plan

We decided to create a website, which we thought through to maximize the value of our ideas. It contains information about the use of masks, anti-epidemic news, mask advertisements, and the production process and materials needed for popular science masks. By putting these information on our website, and at the same time publicizing and attracting more people to browse and understand our website, we can improve people's environmental awareness of masks and popularize people's understanding of environmental protection knowledge in this aspect.

Prototype and Test

| Prototype Design

Please describe what is the format of your prototype and how you designed it. Explain the rationale behind your choice and how your prototype sufficiently represents your solution idea. Include attachments, specs, sketches or photos of your prototype.

1.What is our prototype?

Our prototype is a self-made website includes six sections: homepage, rules of chatting, science popularization, news of COVID-19, discussion group and a forum that allows our users to upload their works.

2.How did we design it?

web design is the process of creating the visual look and feel of a website.

These days “design” also incorporates the idea of “user experience” – which is a whole subject in and of itself, but for our purposes today it means web design isn’t just about how good our website looks, but how easy it is to do things like find information, important links and buttons, etc.

Hence “look” (what people see on our site) and “feel” (how easy it is to use our site).

Websites are built using the coding languages HTML and CSS, which tell a web browser how to arrange all the text on the site, what colors to make things, where to put images, etc. These website creation tools do the hard work of creating code for us, so we mainly focusing on designing our LOGO and FONT.

We used www.Bluehost.com as a web hosting and domain registrar for ourself and for our web development projects. With our own domain name, we are also able to get a professional email account. This is much more professional than a regular Yahoo or Gmail address, and we did received advertising cooperation from three different bands: CASETIFY, CHINAPLAS, and MIXIU. They are both investors and producers in the mask market.

For the next step, we' ll be diving into WordPress themes and how to use and customize them. We used the search bar to find a theme that suits our site, install it by clicking the Install button in the Details & Preview screen. We add pages and posts. Within the pages, we add features like images and formatting, repeating this process to complete the whole website.

At last, we review the structure of our website to make sure Title and tagline Colors, Typography, Background image, Menus and Widgets are all well-organized.

3.How does the prototype reflects our idea?

We selected the most economical and feasible way among all those listed solutions. Our ultimate plan is to spearhead a campaign that everybody can take part in, which is, to make knowledge of masks widely available and appeal to people to join the ameliorate of masks. By publicize the manufacturing process and materials on the website, we witnessed the growth of our users. Our internet page has had a total of 487.447 hits. With the development of our forum, we believe one day it will become an authoritaive seminar in the network.

 [Self-made Website](#)

 [Total Hits1](#)

 [Total Hits2](#)

| **Feedbacks learnt from users**

This part is absent or not available temporarily.

| **Improvement for next iteration**

Our improvement is closely based on feedbacks receiving from users: enlarging the extent of propaganda of our website and improving the quality of the information we convey in every articles. Our prototype is already built based on long consideration of trying to make the best of this campaign and to convey thoughts that we intended.

The purpose of the first improvement we' ve considered is aim to get more and more people involved in this campaign which we started. The more people, the bigger the possibility that people know useful information about masks and be aware of the importance of recycling and improving the use of masks.

Secondly, in order to ensure that people and our audience receive authentic and confirmed information or scientific evidence, we need to improve the quality of those articles. The quality of articles, which we considered as a significant facet of conveying our ideas and thoughts that we stick to, can therefore influence the degree to which our audience understands.

Team Credits

Summary - Li Mudi& Huang Endi

Identify the Challenges- Li Mudi \Huang Endi \He Wanling\Mao Yixuan\ Zhang Renwen

Identify a Root Cause- Hu Xiaoni

Generate Solutions- Li Mudi \Huang Endi \He Wanling\Mao Yixuan\ Zhang Renwen

Identify the Criteria- Hu Xiaoni

Evaluate the Solutions- He Wanling

Make an Action Plan-Hu Xiaoni

Prototype and Test

-Prototype design- Hu Xiaoni \Li Mudi \Huang Endi \He Wanling\Mao Yixuan\ Zhang Renwen

-Feedbacks learnt from users- Mao Yixuan

-Improvement for next iteration- Zhang Renwen

Onsite Conference File

Judge Comments

" Congrats to the entire team for exploring a very timely topic. I think the team did an especially good job in bringing in the public health issues along with the environmental issues when thinking through the problem – the exploration was not just about how to solve an environmental problem. The teams shows great skills in unpacking complex problems. I also really appreciate how the criteria included a practical measure and balance for usability of the mask vs environment. Kudos! While I find that thoughtful work went into identifying the problem from various angles (including understanding what the government' s role might be), I think the work on how to increase reach through communication could have been better explored. What other practical options do you have to reach the target audience? Through your schools? Your residential and apartment communities? Does the city have a role in helping promote this? Some more exploration of avenues to communicate your message would have been very welcome! I also found the introduction of profitability in the criteria to be quite unique among other similar explorations that I have seen on the topic. I hope the team plans to continue this work (and similar work) further in the future. "