Sustainability Innovation

The Unsavory Business That Has To Be Done Right: Strategies To Sludge Treatment In China – An Environmental Economic Perspective

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Summary

In this projects, we focused on sludge treatment of municipal waste water. Sludge is the by-product after waster water goes through initial depositing and filtering in municipal sewage treatment plants. Unlike other treatment of toxic waste, sludge treatment is quite complicated since sludge is both a source of contamination and resource. If poorly treated, sludge will cause significant environmental damages. If treated properly with advanced technology, multiple components of sludge can be transformed into valuable resources. We identified the technical, political, financing and environmental challenges for sustainable sludge treatment and conducted thorough analysis on this subject.
During our research, we came upon this cutting-edge new technology called sludge charring. We quickly realized that this treatment method has the potential to become THE solution for sustainable sludge treatment. Sludge charring consists of dewatering, energy-efficient drying, high-temperature charring, resulting in a kind of special compound absorption material. On top of its economic, environmental and technological advantages, we see great commercial potential for the application of the compound absorption material (CAM). It's much cheaper to make than active carbon, its market contender and show similar or even stronger absorption capability for total volatile organic compound (TVOC) absorption such as methane and formaldehyde. There are challenges for its commercialization, such as unfamiliarity, lack of publicity and brand effects, unappealing aesthetics etc. We designed solutions for these challenges to make CAM a strong market contender.
The biggest selling point of CAM is its environmental benefits. We conducted a simple quantitative analysis of its externality and concluded that for every 100 grams of CAM sold, 2.2 tons of waster water can receive more sustainable treatment, or in other words, 4.46 days worth of waster water by one individual can be treated more responsibly. In combination with its cheap price, we developed a marketing strategies for commercial CAM application. We designed commercial products for customers to created added value, established commercial partnership as well as e-commerce business strategies. We wanted to make a great products as well as send our environmental messages to raise awareness of this issue.
During our tour of sludge treatment plants, to be honest it wasn't a pleasant experience. The smell is overwhelming and the work is undoubtedly unglamorous. Yet no matter how unsavory this business is, it is one thing that has to be done right. We hope that our efforts can provide insights into how sludge charring can gain market competitiveness and achieve more sustainable sludge treatment in the future.

Choose the Topic

Identify the Challenges

1. Introduction
Public concerns, particularly over pollution, are likely to be ignited by anything but the "intangible threats" that escaped media exposure, for one thing, the disposal of the sludge. The improper disposal of sludge, the leftovers of our daily social life, poses substantial hazards to sustainable living environment. We aim to choose the optimal sludge treatment technology and promote its application in this project.

2. Industrial and Technical Challenges
Currently, there are several means for sludge treatment commonly practiced by factories and plants: sanitary landfill, coordinated incineration in cement kiln, anaerobic digestion, aerobic composting, independent incineration, and sludge charring etc. However, they share some common problems, such as excessive energy consumption, emission of toxic pollutants, lack of advanced clean technologies, and the waste of resources. The approaches can be more difficult for us to implement in reality. High levels of microbial pathogens; complex heavy metals, salts, and other components; a large number of available components such as N, P, K, and organic matter can be the initial barrier for this technology. (See Attachment for further information)

3. Political Challenges
Different cities may have different criteria for the disposal of the sludge. To further illustrate, the industry standards of environmental protection departments and housing and construction departments have different requirements for the maximum allowable concentration of heavy metals and organic pollutants in sludge, as well as different requirements for the amount of sludge applied to farmland. The industry standard of the housing sector hopes to promote the reasonable space of sludge land utilization. The environmental protection sector and the agricultural sector are more concerned about the effective utilization of nutrients and the prevention of the accumulation of heavy metals and organic pollutants into the food chain from the perspectives of fertilizer efficiency and food safety. The disparate goals and criteria of different bureaus certainly will cause chaotic situations when exercising the method.

3. Financing Challenges
Besides, the insufficient fund can be another reason. The government cannot pay attention to every kind of pollution that this method cannot be propagated to more and more towns and benefit people due to the neglect. The mainstream resource of

sludge charring comes from household utilities. Nevertheless, according to our research, most of the towns in our country do not reach that standard. Statistics show that among 32 large and medium-sized cities in China, the average residential sewage treatment fee is 0.81 yuan/ton. Only a few cities, such as Beijing, Shanghai, Nanjing, Chongqing, and Kunming, are higher than the proposed standard of 0.95 yuan/ton. Meanwhile, except for Beijing, Shanghai, and Nanjing, most large and medium-sized cities failed to meet the minimum standard of 1.4 yuan per ton.

4. Environmental Challenges

Sludge, if poorly treated, can be extremely detrimental to the environment. Sludge is rich in organic matter, which provides breeding grounds for bacteria, pathogens, and parasites. Heavy metals, such as copper, lead and cadmium, and toxic organic compounds are concentrated in sludge. Their introduction to the human food supply can cause severe public health crisis. On top of primary pollutions, that is pollutions directly caused by sludge, secondary pollution can also be a huge issue. First, sludge has a high concentration in salt. If directly introduced to soil, it will raise the electric conductivities of land and destroy the equilibrium of different nutrients for crops. The absorption of nutrients will be hindered, and it will damage the root system of plants directly. After application of sludge to agricultural land, if that particular area observes large precipitation and loose land structures, elements like nitrogen and phosphor will be diluted and transported into local river systems and underground water system, raising concern for local drinking water safety.

5. Capacity Challenges

As the Chinese economy develops rapidly, the amount of sewage and sludge produced has been increasing with it. Overall, industrial sewage and sludge production in China has been decreasing in recent years but municipal sewage and sludge production is exploding. In 2010, municipal sewage production has reached 59 billion tons and municipal sludge production has reached 9.08 million tons. It has been projected that in 2020 municipal sludge production will reach 60 million to 90 million tons. There are 3362 sewage and sludge treatment plants in China, capable of treating 11 million tons sludge. The shortage will be around 60%.

5. Sludge Charring and its Strengths

Municipal sludge contains 75% to 85% water after dewatering. In cities like Shanghai and Tianjin, the thermal capacity of sludge is about 1500 – 3300 kCal / ton of solid mater. Due to its high thermal capacities, municipal sludge shows great potential for charring. In order to convert sludge into charred material, it will go through advanced dewatering, energy-efficient drying, high-temperature charring, resulting in compound absorption material.

Through research, we conclude that sludge charring can be the most environmentally friendly and economical method at hand. First, the reduction rate is more than 87%, resulting much less mass than before. Water will be evaporated

during charring, resulting in water content of less than 1%. Part of the organic matter will be decomposed into gas. Second, most toxic components will be converted into carbon-based charcoal and the rest will be converted into gas, which can provide energy for the process. Charcoal will not ferment naturally and bacterial, parasites, and pathogen will be completely killed under 650 degrees Celsius temperature. Heavy metal will be crystalized under anaerobic high temperature environment, which will be stabilized and not be released into the environment. The entire process is also environmentally friendly. It will produce waste water with low concentration of toxic matter, which can be released without processing into municipal sewage system. The whole system is anaerobic, which will not produce PCDDs.
More importantly, sludge treated in this way can produce cheaper compound absorbent material. Not only it is safe to use, it shows great potential for further commercial application. It’ s absorption rate of Total Volatile Organic Compound (TVOC) is 10%, far exceeding the required absorption rate of 4% to be qualified as Level 1 Active Carbon. Its safety has been established to meet all the national standard even for drinking water. Most impressively, the cost of compound absorption material (CAM) is 1300 rmb/ton. The market price for active carbon is around 5000 rmb/ton while it requires natural organic matter such as tress and baboo to make. CAM has far superior absorption effects and much lower cost alongside its environmental benefits, making it a strong market alternative for active carbon.

6. Application of CAM and Obstacles
Applications of CAM include gardening material, industrial energy source and building materials etc. But we want to focus on its absorption effects and its commercial application in particular absorbing formaldehyde in newly renovated homes and offices and new cars, since it would provide the most added value for this product. However, customers may not prefer the compound absorbent material process with sludge charring. Compared to the products in the market, the customers are not very likely to buy the products. People can be more confident in the product that they are familiar with and products that are beautiful and attractive. However, the appearance of this kind of compound absorbent material cannot be so appealing since it's darker, and more dense. Besides, customers can also be suspicious of the procedure of this method due to unfamiliarity. In the final analysis, these kinds of the product come from sludge, the waste from our common life, that the usefulness and function are suspected from some groups of people. Moreover, consumers in this market, due to long term marketing of activated carbon producers, has established psychological association between formaldehyde absorption with active carbon. It’ s hard to reach out to consumers and promote sludge CAM.

Comparison of Sludge Treatment Strategies
Sludge Treatment By Counties

Identify a Root Cause

Top-down policies with mixed messages

Industry Regulation and Standards

The lack of government funding as mentioned before can be further attributed to the overarching policy structure of Chinese sludge treatment. Currently there are 5 national regulatory entities with jurisdiction over sludge treatment in China. The Ministry of Housing and Rural-Urban Development is the main government agency overseeing sludge treatment and disposal. The Ministry of Environmental Protection focuses on secondary pollution prevention. The Ministry of Agriculture regulates sludge agricultural reuse and the Forestry Bureau regulates sludge forestry reuse. The National Development and Reform Commission provides investment and funding for sludge treatment projects. The responsibility of sludge treatment is decentralized, meaning that local governments hold primary liability. There are also 10 standards concerning sludge treatment in China, which can be further subcategorized into: 1. national standards 2. ministry standards 3. technical regulations and guidelines. Note that national standards are mandatory while ministry standards and technical regulations are for reference only.

Financing Mechanism and Issues

According to our interview with industry insiders, the reason why sludge treatment lacks consistent funding is that sludge treatment usually acts as a subsidiary of sewage treatment. In 2013, government investment in sludge treatment and sewage treatment was 1.7 billion and 23.8 billion yuan respectively, meaning Sludge treatment only accounted for 6.7% of overall total investment. As a result, contracts are signed between local governments and water waste treatment plants (WWTPs) with unreasonably low prices, shifting the responsibility of sludge treatment from local governments to WWTPs. In major Chinese cities, the municipal water waste treatment fee attached with the municipal water fee is in average 0.81 yuan per ton. Only in very few cities like Beijing, Shanghai, Kunming etc. does the municipal waste water treatment fee exceed the suggested price of 0.95 yuan per ton. Industrial waste water treatment fee in major cities also lies far below the suggested 1.4 yuan per ton standard. Besides, most local governments do not charge a separate fee for sludge treatment. Even for those who do charge for sludge treatment, the revenue only covers sludge dewatering, leaving local WWTPs with no financially viable choices other than the cheapest treatment methods or even illegal dumping.

Failed Attempts

Upon further reflection, we discover two rather conflicting principles dictating sludge treatment legislation in China. On one hand, local governments, especially of less developed regions, view sludge treatment with a "get-it-over-with" attitude. What they seek is stabilization and environmental damage containment with minimum costs, as evidenced by the low-price contracts mentioned before. On the other hand, though tremendous efforts have been made in exploring new technical routes of sludge treatment, the lack of expertise and inter-governmental coordination has resulted in numerous admittedly gallant, extremely expensive, yet failed attempts. Projects like Shidongkou dewatering-incineration plants in Shanghai and Tangjiaduo anaerobic-drying plants in Chongqing were initiated with foreign state-of-the-art technologies and of course high expectations. Both were discontinued due to unbearably high operation cost and incompatibility with local environmental, political and economic condition.

Orienting through Bureaucratic Jungle

The will to proper sludge treatment by the government is undoubtedly strong. Yet different agencies seem to act according to their own standards. Environmental protection agencies simply can not deal with the huge amount of poorly treated sludge so the best they can do is to limit secondary pollution of illegal dumping. Local governments want to encourage better cleaner solutions with no real way to sustainably finance them. Agricultural reuse meets obstacles with different standards from Ministry of Agriculture and Ministry of Housing and Urban-Rural Development. The former wants to ensure food safety while the later wants to encourage sludge reuse as fertilizer. The examples could go on, but the underlying problem is the same. The practitioners of the industries often find themselves sandwiched between conflicting objectives and real progress can hardly be made. The mixed message from different departments makes it really hard for WWTPs to find the right middle ground and pursue in the right direction.

Generate Solutions

To reach our objective of more environmentally and sustainable sludge treatment, our solution would be a two-pronged approach. First we will focusing on raising the awareness of sludge treatment in general as well as sludge charring in particular. Second we will design, market and manage our CAM products to generating more profits for sludge charring WWTPs.

1Sludge Treatment Awareness

1.1 Set up promotion events

In order to raise the awareness concerning a sustainable practice on processing the sludge and other environment affairs, It is the government or relevant organizations that can set up promotion events illustrating the significance of adopting an eco-friendly way for students and citizens. Students and citizens are who are concerned with the environment and consequently take the concept into practice. In particular, thus, we can set up events either in a university or in a community. It’ s viable to invite experts to take charge of these events and instruct attendees upon the concept of an environmentally-friendly way to process the sludge.

1.2 Film a promotion video

Given the prevalence of the Internet, it’ s possible for a promotion video(PV) to propagates the concept of the environmentally-friendly way to process the sludge. We can film a PV to convey our comprehension of this concept by demonstrating the contrast between the conventional way and the newly introduced way of charring the sludge. Moreover, we can illuminate the situation of sludge processing in our nation. Through this visual method, more people will get acquainted with this new concept.

1.3 Establish a website

There is a demand that the new concept should have a stage to demonstrate itself, of which a website can be an option as a result. We can introduce some problems we are facing and what we are doing to resolve these problems. In addition, we can show the outcome of the charring technology through the model which can be displayed online, or introduce the whole procedure of it.

2. Marketing of compound absorbent material

2.1 distributor to sell the compound absorbent material through partner organizations.

2.1.1 The first way is cooperating with community service providers who repair, maintain, and manage residential property and its supporting facilities. They also provide community recycling and sanitary services. So in newly developed housing estate, especially those who have just been decorated, the demand of the residents for compound absorbent material to absorb formaldehyde and clean the air is high. Community service provider could help us reach potential customer once the terms of our partnership are agreed upon.
2.1.2 The the second way is cooperating with IKEA. As we know, IKEA mainly sells about 10,000 products including sofa series, office supplies, bedroom series, kitchen series, lighting series, textile series, cookware series, house storage series, children's products series, etc. And these are all the new furniture. Furniture in general contains a lot of adhesive material with some amount of formaldehyde. When the consumers want to buy the furniture from IKEA, IKEA can sell furniture with compound absorbent material.
2.1.3 The third way is cooperating with local automobile dealership. The reason for this cooperation is that cars are made up of many parts. If the harmful gases and odors in these parts are not cleared out adequately, it will be detrimental for passengers for a long time. The harmful chemicals contained in automobile decoration materials include benzene, formaldehyde, acetone and xylene, can also cause air pollution in the car to varying degrees. These harmful gases are all need compound absorbent material to absorb.
Now the way we cooperate with these entities is to sell the compound absorbent material below market price, and we will sign a year-long cooperation. In the first quarter, our profit sharing can be 1:9, and in the second quarter, 2:8, and so on. If they want to sign the second year of cooperation with us, the profit sharing can be set to 4:6. This is the best discount we can give our partners.

2.2 ways to sell absorbent material directly to customers
2.2.1 Ads on social media
Nowadays, social media has entered the stage of rapid development. With the advent of mobile phones and computers, there has also been a major shift in how people receive advertising messages. Instead of reading newspaper or magazines, most people will skim many ads during using different social media apps. Thus, we can collaborate with those apps. We plan to make an advertisement tweet or video about our composite adsorption material and put it on various social media platforms, such as Weibo, Twitter, and Facebook. Our AD tweet will explain the environmental benefits of composite adsorption material and the extended products. Videos can be presented in the form of speeches. At the end of the article and video, we'll put a link for people to buy our products. In this way, when people who care about the sludge treatment or some environmental issues see our ads in those apps, they are likely to click them and be attracted.
2.2.2 Online E-commerce Platforms and Live streaming
With the development and popularity of electronic products, people are gradually

changing from offline stores to fast and convenient online shopping. Under the introduction of the anchor, the live broadcast allows customers to know more about the real appearance and other details of the goods. We prepare to work with the network anchors on several major shopping and video platforms such as Taobao and Tik Tok. The cooperation mode is that we send the composite adsorbent material and other derivative products to the network anchors with a great number of followers, especially in scientific and environmental areas, and then those social media influencers sell our products in their lives. During the live, the master will depend on the selling points of the products that they decrease the negative impacts of sludge to the environment because the materials originate from sludge. About the cost, we will pay the anchor the hiring fee and the sales commission of 10%-15%.

2.2.3 Aesthetic and Versatile Product Design

Instead of selling CAM in plain packages, we can use design to created added value for the products. For example, pillows filled with CAM can be marketed for both its comfort and absorbent effects. Children's dolls can also be filled with CAM for health-conscious home owners.

Identify the Criteria

Sustainability
1. Is the benefit generated from the charring solution large enough to keep it work?
2. Can it be used for multiple times in order to achieve energy saving?
3. Is it the best way to deal with sludge, compared to other solutions?
4. Will it cause new environmental problems?
Environmental friendliness
1. Will there be any harmful substances released while charring?
2. Will the solution intense the problems of the sludge instead of slowing it down?
3. Is it beneficial for the living things such as trees and insects?
Feasibility
1. Is the solution practical for dealing with the sludge?
2. Is it complex? Do we have enough time to research and implement the solution?
3. Is it directly associated with our target?
4. Will it be effective and really beneficial for the users?
Problems that the solution might face
1. Will the government or other organizations that we need to cooperate support the plan/solution?
2. Do we have enough fund to start the solution?
3. Will it be popular among the users? Will they like this method?
4. Will there be any flaws with our plans?
Economic benefit
1. Are we gaining economic profit through this solution?
2. Are we selling the products online or offline, ou both?
Health guarantee
1. Is the solution good for people’ s health?
2. Will there be any components of the product that may be harmful to the users?
Quality guarantee
1. If people put our product in the places needed to be cleaned, will the product be good for those places? (Will it be corrosive or contaminate the environment because of poor quality?)
2. Will the quality of the product bee good? Will it really be beneficial for the places needed?

Evaluate the Solutions

scoring sheet

Make an Action Plan

1 introduction

1.1 Overview

Better sludge treatment is easier said than done since there is a lot of variables involved. Our solution will provide strategies for three main stages of sludge treatment: sludge production, sludge treatment and marketing of resulting products. After evaluating our solutions, we decide that not one single solution will provide a complete response to the current situation so we will combine them together. In the identifying root cause section, we realize what we can do to resolve those issues is limited since we do not have the ability to change government policies. What we can do is to start small and provide real sustainable solutions for the WWTPs and the general public.

1.2 Sludge Production

Compared with developed countries, one major problem with sludge treatment in China is the fact that municipal waste water collection system is not independent with rain collection system. The part of wastewater that can be utilized as resource, the volatile suspended solids (VSS), has low concentration due to dilution by rain water. This significantly adds transportation costs to waste water treatment and decreases the efficiency for resource utilization. Another reason municipal waste water in China has low VSS content is due to lack of popularity of kitchen garbage disposal devices. Food waste in Chinese cities is mostly disposed either with sorting or without sorting as garbage, not entering municipal waste water system. Because of this, we will promote kitchen garbage disposal devices to raise the VSS content.

1.3 Sludge Treatment

During our research, we find there is a lack of understanding of what sludge is and how it is produced. People generally confuse sludge with silt, which is the natural sediment of water body like rivers or lakes. In order to raise awareness of sludge and its treatment, we will conduct a series of education campaign to illustrate what sludge is, how it is treated, what will happen if sludge is poorly treated as well as what we can do to help.

1.4 Marketing of CAM

In order to create added value for sludge charring WWTPs, we will explore commercial use of CAM. Currently, the CAM produced are mainly sold to agricultural and industrial companies at relatively low prices. To make sludge charring more competitive in the sludge treatment market, we will design products directly for consumers to create higher profits. And all of our profits will contribute to lower the overall cost of sludge charring treatment. We establish partnership with a local sludge charring treatment company, Anhui Baihe Environmental Technology

LLC., who will provide their CAM material and we will sell them with a higher margin. All of our profits will be used to enhance manufacturing efficiency as well as increase the company’ s competitiveness in the market.

2. Sludge Production and Promotion of Kitchen Garbage Disposal Devices

2.1 Why people are not buying kitchen garbage disposal devices

According to our survey, most people have never even heard of kitchen garbage devices. Those who understand what kitchen disposal is also have serious doubts when deciding to buy one. Some of the concerns include high prices, clogging, smell, safety, and maintenance costs. Also, some people believe that mixing food waste into municipal sewage is detrimental to the environment, a misconception that is hard to dismiss. For existing household, installing a garbage disposal system requires experienced plumbers to do it properly. For new home owners, the decision to get a garbage disposal is not very common. For real estate developers of furnished houses, installing garbage disposal will add costs with no significant marketing advantages.

2.2 Home appliance store commercial partnership

We established partnership with a local home appliance store, Anhui Hi-Season Home Appliance Company, to promote the sale of garbage disposal devices. First, we provide training for sales staff to explain the environmental advantages of garbage disposal devices so that they can introduce the benefits to potential consumers. Also, we will provide flyers and brochures that are displayed alongside garbage disposal devices in-store to inform customers.

2.3 Community Campaign

We will hold community events in local neighborhoods to promote the sale of garbage disposal devices. For newly developed communities, we will set up booth alongside other decoration service providers since it will attract mostly homeowners looking to decorate their new home and they are in the market of kitchen appliances and garbage disposal devices. For older communities, we will set up demonstration booth in community service provider office since that is where most resident will visit regularly. On top of the environmental messages, we will focus on demonstrating the convenience of kitchen disposal devices. If people can see directly that they can just dump their leftover food directly into the sink without any concern of clogging, they will be more likely to purchase one.

3 Commercial Use of CAM

3.1 Market Analysis

Industrial and commercial use of active carbon is a huge industry in China. In 2019, the Chinese active carbon production has reached 1.2 million tons per year, resulting in a market worth 10.59 billion rmb. The industrial use of active carbon can be broken down into different categories as shown in attachment 1. As illustrated before, CAM has showed absorption properties similar to existing active carbon products, making it a strong market alternative to active carbon. Our partner

company, Anhui Baihe Environmental Technology, is capable of treating 100 tons of municipal sludge per day, resulting in about 5 tons of CAM daily. Right now, its CAM products are sold mainly for industrial uses at low prices, for example industrial waste water treatment and the dyeing waste water filtration. We will develop products that are sold directly to the consumers to create added value so that the cost of sludge charring can be lowered, which enables it to reach wider application.

3.2 Environment Benefit: An Oversimplified Quantitative Analysis

The fact that CAM can be sold at higher prices can really help better sludge treatment. The following quantitative analysis is a gross simplification of the problem. But we want to calculate by selling 100 grams of CAM at 70% of the price of commercial active carbon, how much sludge can receive safer and more sustainable treatment. It makes some assumptions. First, we assume that active carbon is a homogeneous product, with uniform absorption effects and prices. This assumption is false since the price and quality of active carbon can vary by a lot. We will calculate the average retail price of active carbon by averaging the top 5 best seller of active carbon products on the e-commerce platform Taobao. Second, we define "better sludge treatment" as using carbon charring treatment instead of the prevalent sanitary landfill method, which constitutes around 80% of current sludge treatment in China. Third, we assume that our operation will remain on a small scale and the market price of CAM as well as active carbon will remain unchanged for the foreseeable future. Fourth, we will assume that the profit of retail sale of active carbon online is 10%, which we believe is an underestimate. Without these assumptions, the problem becomes too complicated for us to quantify. See attachment 2 and 3 for the analysis. In conclusion, we found that by selling 100 gram of CAM, 0.88 kg of sludge can be treated by carbon charring instead of sanitary landfill. To put that in perspective, by selling 100 grams of CAM for commercial use, the sludge of 2.2 tons of municipal wastewater can be treated far more environmentally friendly and sustainably! In 2019, the annual water consumption per capita in Anhui Province is 180 tons, which mean that 100 grams of CAM can better treat sludge of waste water produced by one individual in 4.46 days in average.

3.2 Product Design

Our products will consist of two main categories.

The first category is formaldehyde absorption material in plain packaging. We create small and portable packages of CAM about 14cm * 10cm * 5cm wrapped in white 2-flied clothes. We choose this dimension because we can fit 40 packs of CAM nicely in number 3 standard cardboard box (43cm * 21cm * 27cm) with adequate room for shipping protection without any waste of space. Each package will contain about 200 grams of CAM. It can essentially be put anywhere that needs TVOC (total volatile organic compounds) absorption. For example, in regular household it can be put inside cupboards, cabinets, desks, dining table etc. where there are potential formaldehyde sources. In offices, it can be put in conference rooms, bookshelves, break rooms etc. Because we are not putting CAM in fancy packages, our target

customers would not care too much about aesthetics. We will choose cloth packaging material with the cheapest price while maintaining structural integrity. Also note that one bag of this plain package CAM can provider better sludge treatment for 8.92 days of water use.

The second category is toys with absorption effects. We will establish partnership with local stuffed animal manufacturing companies to create a series of toy products. Instead of filling the animal with just cottons, we will put CAM into the filling of the stuffed animal toys. The size will be around 35cm * 45cm * 40cm. We will make sure that our products are aesthetically pleasing, comfortable to hold and environmentally sustainable.

We also will make the environmental benefits of CAM products more visually accessible. To achieve that, for each CAM product in plain package, we will print in bold fonts that "This little bag can provide sustainable sludge treatment for one week worth of wastewater! Thank you for choosing CAM". "One week worth of wastewater" is actually an underestimate but we believe it can be better conceptualized by our customers since "8.92 days" isn't as easy to understand as "one week". We believe by doing so our customer can take pride in their purchasing decision hence promoting the sale of CAM.

For our toy products, we can adjust the message according to the character of the toy itself to evoke stronger empathy. First, we can calculate the amount of wastewater that can be better treated by the amount of CAM used. Second, we can use more aesthetic way to send our messages. For example, if the toy is a stuffed monkey, it can try to have a sense of humor by adding a cartoon dialogue box on the packaging. It can say things like "Not only can I rule all the jungles your eyes can reach, but what's inside me can also treat your wastewater for X weeks, so that my jungle is always green." (X being the number we calculate before) (Pardon me for the unintended alliteration)

3.3 Pricing

CAM's main advantage over active carbon is its cheap prices. So, we will sell CAM at 70% of market price of active carbon in order to gain market competitiveness. To be noted that this strategy only works for CAM in plain packages since the majority of the cost of these types of products is the CAM material itself. Toy products can be much more expensive than CAM in plain packages. And the major cost for them isn't the CAM filling, instead they mainly cost money on manufacturing of the toys, transportation cost and marketing. Its price advantage over existing toy products is miniscule. We will try to establish partnership with local manufacturers who will offer the best deal and position our toys from other aspects other than cheap price.

3.4 Sales: Partnership Organizations

3.4.1 Community Service Providers and Developers

For newly developed communities, it's very common for community service providers or real estate developers to offer absorbent material for property owners when delivering new homes. And new home owners are primary customers for

absorbent material as well. So naturally we want to cooperate with them to reach out to our potential customers. Firstly, we can sell CAM products directly to community service providers and developers. Since they are likely to purchase our products in bulk, we can offer wholesale discounts in order to sell more CAM in a short time. Most developers would also appreciate the environmental messages that our products send because at early stages of new home delivery, household air quality is a huge concern for both the property owners as well as the developers. Second, we can set up promotional booth in community centers where there is huge traffic of people daily. We can split our profit 20 -80 with community service providers in return for the space they provide.

3.4.2 Home Furnishing Company

Because of the environmental messages our products send, our ideal home furnishing partner would also have the reputation for environmental awareness. Companies like IKEA fit these criteria. Products sold by IKEA proudly advertise their environmental friendliness so our product would fit right in with rest of the home furnishing products. For CAM with plain packaging, little modification is required except for printing the IKEA logo on the packaging. And due to the brand effect of IKEA, products are generally sold with higher margins which mean higher profit for us. We will negotiate profit sharing scheme with IKEA but due to its huge annual sale and customer base, we will be able to sell a lot of CAM consistently, which is great for WWTPs to have continuous demands.

3.4.3 Automobile Dealership

New Car owners are also a huge part of potential customers of CAM. And displaying stuffed animals in car is very popular as well. So our absorbent toy products can fit this market perfectly. Most car dealerships will offer small gifts to new car owners. So, we can establish partnership with car dealerships by selling our CAM toy products directly to them. We will need to make some modification to our existing products. We can add car logos to the toys so that the toys can help car dealership to advertise its brand. Also we will make our toys smaller so that it can fit better in cars. We will also design support mechanism so that our CAM-filled toys don’ t bounce around when cars are moving. On top of toys, we can use CAM to make other car accessories as well, such as seat cushions, ottomans, pillows and more.

3.4.4 Live Streaming with Social Influencers

Short videos and live streaming have become a huge part of the Chinese e-commerce ecosystem. Consumers follow their favorite streamers for various reasons and make purchasing decisions with the impression of their streamers. We can establish partnerships with streamers who care about environmental causes and sell our CAM products on their platform. On stream, we can show demonstration of the effectiveness of our products by conducting live experiments. Also, streamers can better explain the logic behind our environmental messages than information brochures and posters. Streamers can visit sludge charring WWTPs, conduct interview with industry insiders and even show the consequences of poorly treated

sludge. If consumers can experience our products on stream, it’ s more likely for them to decide to purchase our CAM products.

3.4.5 Arcades and Doll Dispensing Machines

Doll dispensing machines are really popular in China. People pay a certain amount to have a chance at getting their favorite dolls from a mechanical claw that grabs the dolls in a glass container. Our CAM toys are great candidates for these types of machines. First, these machines are extremely profitable, so if we can establish partnerships with the arcades, our products can also have a higher profit. Second, we can incorporate our messages into the game design. For example, every time the claw misses a doll, we can play cartoons voice acting that explains although you didn’ t get the doll, you are contributing to better sludge treatment, which will make a miss a much less bitter pill to swallow.

3.5 Sales: Directly to Customers

3.5.1 Physical Stores and why it won’ t work

We initially planned to open a store selling CAM products. But we quickly realized that our products cannot realistically sustain the operation costs of a physical store. With the development of e-commerce in China, reasons for physical stores that sell products instead of providing services to exists are vey few and our CAM products doesn’ t have any of these reasons. First, customers don’ t need to experience our products before buying it. The absorption effects aren’ t something that can be experienced physically in the duration of their stay. Second, our products can be easily shipped and last essentially forever so consumers don’ t really need to come into the store to get them. Third, our products have a low value density, meaning that they take a lot of space to store but revenue for each unit amount of space required is really low. We simply can’ t afford to store large amount of CAM in-store since it would cost a lot of rent.

3.5.2 Online E-commerce Platform

We will establish online shops on various e-commerce platforms to sell our CAM products. First, we will identify our target customers by associating our products with the right search keywords. As mentioned before, people generally equate active carbon with formaldehyde absorption so CAM would be a product that most people have never heard of. We will name our products not just “CAM”, but try to explain its functions in its name to better reach target customers. Words like “absorptions” “clean air” “new home” “new car” “health” “environment-friendly” etc. need to associate with our products. Second, we will create a thorough user manual, products detail, pictures, videos as well as qualification for its absorption effects so that consumer can have all the information they need. And our environmental messages will set us apart from the competition by advertising its connection to better sludge treatment. Also, we can compare CAM with active carbon by pointing our that active carbon are made from trees and bamboos, which is causing harm to the environment.

3.6 Sustainability

The CAM material is fully sustainable. If disposed in soil, it will not only naturally

decompose, but it can create horticultural benefits for the soil. CAM is highly porous, enhancing the permeability of water and air of soil. It’ s heavy metal will be crystalized and will not naturally release. For CAM in plain packaging, we will put signs on the cardboard boxes to remind users to recycle it. For toy products, we will encourage users to share them and when they are done, they are made of cotton and CAM, both of which are fully decomposable naturally.

attachment 1: Chinese Active Carbon by industries
attachment 2 market price of activated carbon
attachment 3 environment benefit analysis

Prototype and Test

Prototype Design

Attachment 1 Compound Absorption Material (CAM)
Attachment 3 CAM Toy Product (400g of CAM inside)
Attachment 2 CAM in plain package (200g of CAM inside)
Attachment 4 - more CAM toys with 400g of CAM inside

Feedbacks learnt from users

1. We gave out free samples to our friends and family members. The median age of our surveyees is 17 with a total of 21 surveyees. For each participant, we gave them 2 packs of CAM in plain packaging. And after 4 days of trial, we conducted interviews with our participants to collect their experience and advice on our products.
2. The result is less than satisfactory. 10 out of 21 participants reported that the CAM products provide better air quality of their household. 11 out of 21 participants reported that there is no significant difference between air before CAM and air with CAM. This might be due to short periods of trial time, limited quantity of CAM as well as lack of testing.
3. 18 out of 21 participants reported that our environmental messages are very convincing for them to choose our products. 3 out of 21 participants reported that they do not understand the relationships between CAM products and better sludge treatment. We did not include a written documentation explaining its environmental benefits, we only explained by speech to our participants.
4. All of our participants responded that if our price is significantly less than what is on the market, they will be willing to choose our products. But only 3 of our participants reported that they are confident in the absorption effects and environmental friendliness. The rest reported that due to lack of verification of its absorption effects, they are not entirely confident in the unfamiliar CAM products.

Improvement for next iteration

1. Since TVOC absorption can be not easily perceived, customers can not see the absorption effects, which will lower their confidence in our CAM products. For the next iteration, we will make the absorption effects more visually accessible. For example, we will improve our product design. We can put a special chemical material that changes color according to the air formaldehyde level so that customers can see the improved air quality themselves. Second, we can bundle our products with formaldehyde testing equipment, which is fairly inexpensive, with our products.
2. The logic behind CAM products and better sludge treatment and waste water treatment is quite complicated. We put a lot of effects of advertising the environmental benefits of our products, so we need to do a better job explaining why for our customers. One way we can do this for the next iteration is by establishing a website. On this website there will be comprehensive information about sludge treatment methods, their strengths and weaknesses and their environmental importance. For either CAM in plain packages or toys products, we will attach a QR mode right beside our environmental messages that direct customer to our website.
3. For the next iteration, we will try to obtain proper qualification for its absorption effects. Not only will this improve the confidence of our customers, but we can also expand our markets into foreign markets with foreign qualification. Also we can send our products to our partners at the University of Science and Technology of China to verify its absorption effects and sustainability. In ideal situation, our products can be qualified as having the same or better absorption effects so our products can be legally referred to as active carbon, so that our products can enjoy the established market prevalence of active carbon for TVOP absorption.

Team Credits

Xihan Sun is the leader of the project. She is responsible for generating solutions and identifying the criteria.
Mengyuan Yang is responsible for the marketing strategies of CAM.
Taozhi Yang is responsible for identify the political challenges of sludge treatment and sludge charring.
Junru Qiu is responsible for conducting customer research, feedback and ideas for next iteration.
Molin Zhu is responsible for popularization of kitchen garbage disposal and environmental benefit analysis of CAM.

Summery, evaluation of solutions and improvement for next iteration are completed collectively.

Onsite Conference File

Judge Comments

" Great job by the team in picking up and exploring a challenging and ‘unglamorous’ topic as they rightfully identified! Great job in laying out the problem as well as exploring the various features of charred sludge. It is also commendable as to how far along they were able to take this work.
While the explanation of the government side of WWTPs, financing and options are well done, It would have been good to see the root cause analysis dig deeper into the social side of how CAM could be utilized – it’s more within realistic control of what can be done and would have help set up the rest of the project well. For instance, while the barriers are somewhat well identified, what other drivers can be identified for a product that deals with a problem that’s not always visible? I encourage the team to continue thinking about these.
The team has done an excellent job of researching a number of options on how to use CAM. For the purposes of this exercise, it might have been helpful to focus in on one or two solutions in detail. This would have allowed more of an exploration of the sustainability benefits of charred sludge and would also have helped set up the criteria section better. For instance, what is the energy usage compared to other options? What is the water usage?
Good job overall and best wishes in pursuing this further.
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