

# **Sustainability Innovation**

## **A Sustainable System Of Disposing Expired And Unused Medications**

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# Summary

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Our group use a flow chart to clearly illustrate how our program develops.

 [\\_Summary\\_\(flow chart\)](#)

# Choose the Topic

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# Identify the Challenges

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1. Research and estimate of current magnitude of wasted and expired medications in China and around the globe

Hospital:

(1) Of the total amount of waste generated by health-care activities, about 85% is general, non-hazardous waste.

(2) The remaining 15% is considered hazardous material that may be infectious, toxic or radioactive.

(3) Every year an estimated 16 billion injections are administered worldwide, but not all of the needles and syringes are properly disposed of afterwards.

(4) Open burning and incineration of health care wastes can, under some circumstances, result in the emission of dioxins, furans, and particulate matter.

(5) Measures to ensure the safe and environmentally sound management of health care wastes can prevent adverse health and environmental impacts from such waste including the unintended release of chemical or biological hazards, including drug-resistant microorganisms, into the environment thus protecting the health of patients, health workers, and the general public.

Families:

(1) 71.68% of households have medicines in stock, of which 71.84% have expired medicines, 70.00% of households have expired medicines due to blind purchase, 53.40% of residents discard expired medicines with household garbage, and only 11.33% of residents have participated in drug recycling activities and 66.72% of the residents did not participate in the recycling, who are not aware of the drug recall activities.

(2) 74.3% of the respondents choose to throw away expired drugs directly, 18.5% of the respondents know the hazards of expired drugs, and 20.5% of the respondents know the point of collection of expired drugs. The establishment of the collection points for expired drugs in the investigated areas is incomplete, the publicity of the hazards of expired drugs and their correct treatment methods is not in place, and the people's awareness of safe use of drugs is not strong.

(3) The main reasons for keeping unused or expired medications at home were uncompleted treatment after recovering from their illness reported by 199 (82.20%) respondents, intolerable side effects of the medications 20(8.30%), change in the treatment regime 15 (6.20%) and forgetting to take the medications 8 (3.30%).

(4) 71.6% of respondents disposed of directly into the trash bin or sink, and, only 24.8% had the good practice that they use a designed recycling bin. Likewise, only 8.3% of respondents placed expired drugs into collection points nearly 3– 5 times in

a year, while 65.1% of participants never disposed of the expired drugs in the collection point, which was found a worse practice. The knowledge about expired drugs disposal among Guangzhou residents was found inadequate.

Pharmaceutical company:

(1) According to different attributes, HW01 and HW02 are two categories for medical wastes. Basically, each city has a company with special qualification for recovering HW01 and HW02 medical wastes.

(2) As for drug stores that have expired medicines can get in touch with manufacturer first, then the suppliers return them to the manufacturers, and finally the manufacturers destroy the expired drugs. This recovery chain minimizes the losses to pharmacies.

(3) Expired drugs in pharmacies can be handed over to the drug administration department for centralized processing. Especially some special drugs, their chemical components are detrimental to the environment. Such as penicillin, if handled improperly, its chemical components spread into the air with poor circulation like the indoor, which may cause the accidental allergy of the contact, and even endanger the lives of those infected people.

(4) Drugstores can also destroy the expired drugs by themselves. For generic, non-hazardous (or minimal) drugs that cannot be returned to the manufacturers, pharmacies can self-destruct them, depending on the nature of the drugs.

(5) If the expired drugs are fallen into the hands of illegal traffickers to renew packaging and re-enter the circulation field, they will cause serious damages to people's health.

2. A comprehensive review of current major disposal methods of wasted and expired medications in China and around the globe

Hospital:

For common drugs, the pharmaceutical department first fills in the scrap list of expired drugs, and approves it step by step. Finally, it reports the demands to the authorities for approval and the expired drugs are burned in a unified boiler. At the destruction site, leaders in charge and personnel from discipline inspection, audit, finance and security departments shall be present at the same time for on-site verification. Narcotic drugs need to be reported to the Food and Drug Administration, by the food and Drug Administration unified processing or supervision processing. The Drug Administration Law has made clear provisions on the production, sale and use of drugs, but there are no clear legal provisions and effective supervision mechanism for the recycling of expired drugs, especially for the scattered family recycling of expired drugs. The related treatment is basically spontaneous behavior of drug regulatory authorities, drug manufacturers and retail pharmacies. At present, there are mainly the following ways: first, self-destruction. The expired drugs of drug distribution enterprises and hospitals can generally be returned to the manufacturing enterprises, which shall burn and destroy the expired

drugs. Second, paid recovery. The FOOD and Drug Administration will cooperate with drug distributors on 3.15 consumer days every year for unified recycling and centralized boiler incineration treatment.

Thus, we can see that there is no standard institution which can help to dispose the unwanted and wasted medicine by extracting and recycling the active ingredient concentration.

Families:

For families, as the low awareness, complexity when coming to the disposal of drugs, and the fact that scientific ways of dealing with expired medications have not been wide spread to our people, we could see from previous studies and researches that most of the ways that our citizens handle with unwanted drugs, to a large extent, are under gauge. The majority of the families choose to throw the drugs away with domestic trashes. Meanwhile, about 20% of people let the drugs go into the toilet or just simply burn them. Another 20% chose a rather "less wasting" way of giving them to others. Only a tiny percentage of 1 chose to bury the medicines underground. Obviously, a huge problem states in the current situation of family disposal of drugs.

### 3. Environmental problems

The expired medicines can cause a wide range of environmental problems. First and foremost, during the process of disposing those expired medicines, there is certainly harmful influence to the environment. People cannot guarantee that all of those medicines are well stored. Most of the medicines can resolve and evaporate, undergo a chemical change, release the poisonous gas, and result in the atmospheric contamination. For example, when antibiotics expire, they often fail to work effectively against infection, causing infection to spread. If it is sodium nitroprusside and other drugs, after expiration, it will decompose to produce cyanide, which is a highly toxic substance, and may lead to cyanide poisoning in the atmosphere after using. In addition, the expired medicines can also pollute the soil and water. The toxic substance that made by expired medicines is able to diffuse to the rivers and lakes, and even mould. This results in the soil and water pollution, which lead to the various species in these ecosystems fall into danger. This will cause ecological chain be damaged, and the whole environment will be threatened.

### 4. Physical harm

The expired medicine will exert a negative influence on human body health. The process after medicine expired is unknown for most of people. As a result, many people who do not understand the impact may choose to take the expired medicines. However, this leads to a serious injure to their body health. The change in chemical components is the chief culprit. First of all, after the expiration of the drug, the content of active ingredients decreases, and the drug can not play its original effect. For example, vitamin C puts in the air for a long time, which is easy

to be oxidized. The oxidized VC is harmful to human body. Secondly, some drugs may be contaminated by the bacteria due to a long storage time. This is called the mildew. The serious bacterial contamination may occur after taking the drugs. For example, traditional Chinese medicine, especially granules, honey pills and other dosage forms, stored for a long time at a certain temperature. This will cause the mildew and the medicine will become a breeding ground for bacteria.

references:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4118550/>

<https://www.cnki.net/>

<http://zgypw.w.cxzg.com/>

[https://www.zyjjw.cn/news/jzdc/2016-02-18/309100.html?\\_t=t](https://www.zyjjw.cn/news/jzdc/2016-02-18/309100.html?_t=t)

<http://society.yunnan.cn/system/2021/01/25/031254358.shtml>

(<http://society.yunnan.cn/system/2021/01/25/031254358.shtml>)

<https://kns.cnki.net/kcms/detail/detail.aspxdbcode=CJFD&dbname=CJFDLAST2021&filename=PLHY202102001&v=nttJVvegOteEYInQtqFI8E5BO7qPiEDdb3Ct%mmmd2FBNAQaMajFKMLsWDHT1vP3zKbC1q>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7861449/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7861449/table/pone.0246418.t002/?report=objectonly>

<https://www.dovepress.com/assessment-on-the-impact-on-human-health-environment-water-and-soil-by-peer-reviewed-fulltext-article-RMHP#ref-cit0004>

<http://zixun.3156.cn/u10000a53808.shtml>

<https://health.sohu.com/20080317/n255756723.shtml>

<https://wenku.baidu.com/view/a8146a52360cba1aa811dae9.html>

# Identify a Root Cause

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## 1. The difficulties to create value from the wasted and expired medication

The validity period of a drug is a summary of the stability of the quality and efficacy of the drug in use. The quality and efficacy of expired drugs cannot be guaranteed. For engaged in recycling, countries do not have clear rules and regulations, and effectiveness of some chemical medicine western medicine may be recycled is feasible, but the cost and the high cost of reproduction, the manufacturer also not to do this thing, and I'm afraid is difficult to get on to extract an API certification national agency certification, so for the original poster paper, it seems the data are difficult to someone. Often, the amount of expired drugs is small and there are many varieties. Even if the total amount of active ingredients extracted can be recycled is small, it is difficult to achieve the scale of reproduction.

## 2. Lack of feedback mechanism

The Third rot cause is the excessive production of medications with a lack of feedback mechanism. Due to the information asymmetry among the pharmacies, the hospital and the patient, the production of medication is sometimes too much or too little to use. Although there is a feedback mechanism between medical institutions and the government at present, the medical institutions' feedback to the health administration department, and the health administration department's feedback to pharmaceutical companies do not have such subordination or jurisdiction. For example, there is a drug bidding and procurement platform in Shanghai, which will regularly collect data from hospitals to ensure the supply of some medicines in short supply. However, many clinical medicines need to be purchased in other areas, so the feedback mechanism in Shanghai cannot solve the bidding and procurement problems of all medicines in short supply. Without unified clinical drug monitoring system, the feedback mechanism cannot be used to analyze "which drugs are currently in use, how well they are in stock, and how big is the demand of the medication". We are lack of the big data system and policies to tell the manufacturers how much and how little they need to produce, so we can accurately solve the doctors' urgent needs, the patients' needs and the problems of excessive production of medications due to the lack of feedback mechanism.

## 3. Lack of donation mechanism leading to the unfortunate waste of useful medications

As for the whole medical system, it still lacks the donation mechanism. This leads to the unfortunate waste of those useful medications. In this modern society, the drug information does not match the drug themselves. People cannot receive the



accurate message of those medicines from those organizations that sell drugs. This exerts a negative influence on personal health since people do not have a correct perception of the drugs. Donation system plays an important role during the medicine recycling. Without it, it is difficult to have an integrated medical recycling. For example, there are many people who suffer from cancer and other diseases which require medical treatment. In the course of treatment, those people have to buy a large amount of drugs. If, unluckily, these people die because of these diseases, the various medicines will be left. Some of these may be donated to others who need help, while others may be discarded and never be used again. However, these medicines can be used again since they are not overdue products. This reflects the lack of the donation system. It is a great loss for abandoning those effective medicines. People are not able to use these "used drugs" correctly and efficiently. They may have to buy new medicines and finally these medicines are left as well. Again and again, the medicines are piled up which is more than detrimental. The lack of donation system adversely affects the whole medical recycling.

#### 4. High difficulty of putting into practice by the public.

##### (1) Low awareness

The fact that people do not take the problem of improperly handling medicines seriously may be a huge obstacle to our plans. People have been advocating to save water, save electricity, protect trees for years. However, the concept of correctly disposing unwanted or expired medications hasn't spread across the nation yet. Only a small proportion of the population knows the correct ways of disposing different categories of drugs. Moreover, not many recognize the great benefits of recycling drugs and the harm of not doing so. Therefore public's lack of awareness in carefully preserving and disposing medications has really made it more difficult to achieve a highly efficient system of disposing medicines.

##### (2) The loophole in human nature

It is in human nature that people tend to care less or become idle in helping with things that do not have a direct influence on themselves. People instinctively choose the easiest way to solve a problem that they do not really pay attention to. For instance, in this case, most would throw the drugs away along with other household wastes, or dump the drugs into the toilet. Furthermore, the indifference in human nature makes things worse. The truth is that most families would store the remaining pills in a drawer and forget about it. Not until next time when they need the pills would they care to check the expiration date, which results in large amounts of medicines wasted in the drawer.

The carelessness towards the proper handling of unwanted medicines do not only prevail in the public, but also in every aspect of government policies and social actions. When we dig down to the root cause of the irresponsible misbehaviors of medication factories, the dissatisfying speed of improving in related scientific fields, the low consciousness of the citizens, we could all find one same factor, which is the lack of awareness in governments themselves. Great differences could be made if

the gov implements stricter regulations on med firms, if the gov gives more financial supports on medical studies, if the gov pays more attention to socially emphasizing the significance of every citizen's action on dealing with medications, with the premiss of our government's care for this issue. Therefore, tracing to the very first origin of our current mess, the lack of awareness should not be neglected.

#### 5. Lack of regulation and supervision

Home expired drugs have been clearly listed in the National List of Hazardous Waste. However, for a long time, family expired drugs have not been specially recycled and processed, and most of them are directly thrown away as ordinary household garbage. Home expired drugs are faced with the embarrassing situation of no-one recycling, no-place recycling and difficult to recycle. Therefore, the unified recovery and scientific disposal of family expired drugs need to be paid more and more attention by governments at all levels. Governments are advised to enact more specific laws to regulate the unwanted medicine disposal process, establishing more complicated institutions to supervise the process. For example, the federal government and the Department of Health in Australia are funding free collection of all expired drugs. The free recycling program is called the National Waste Drug Recycling and Disposal Program. Under the plan's guidelines, Australia does not encourage people to dump medicines down the toilet or sink, let alone in the bin. Such hasty disposal can contaminate soil, leach into waterways and damage the environment. For all expired medicines, they should be sent to any pharmacy in Australia for collection.

# Generate Solutions

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To solve the complex problem of unwanted medication disposals, it is rather difficult to figure out a single solution to solve this huge issue. Therefore, we've separated our problems in three sections, the initial stage, the middle stage, the ultimate stage. The initial stage aims to reduce the over-selling of medicines, which is fundamental for the reduction of overall waste. On the middle stage, we offer channels to gather the drugs and ways to make use of the drugs without making chemical extractions. Finally, on the ultimate stage, we bring new born to medical wastes.

The initial stage:

## (1) Raise the awareness

Since one of the root cause we find is lack of awareness, we come up with the solution of raising the awareness. Basically, we use our official account to publish our original passages and upload the videos about the benefits of dealing with the unwanted medicine. Also, since we are the high school students, we can get access to many high school, so we also decide to give the speeches in those schools and first to raise the awareness of the high school students. Furthermore, we decide to set a Medicine Day. Thus, with such access, more people can be advocated to recycle the medicine.

## (2) Feedback mechanism

The feedback information collected along the supply chain could help the manufacturers to rethink of the most appropriate production quantity and refuse to overproduce. The different distributors and consumers along the chain could give feedbacks to the manufacturers as an important reference, including pharmacies in different communities, care-homes, hospitals and etc.

## (3) Reduction of over selling

In order to truly reduce the amount of medication wasted, our attentions should be put on its source. Thereby, as approximately 74% of medicines are sold in hospitals, this could be a huge breakout for us. Nowadays, for making more profits, many doctors would try to recommend patients to buy extra drugs which are almost useless for their illness. Moreover, in many situations, as in most hospitals medicines are boxed, making it hard for doctors to specify the dosage for one single illness period. Therefore, the amount of prescriptions made exceeds the actual used amount. Overall, these phenomena are a huge cause for the waste of drugs. Thus, on the one hand, stricter restrictions should be made on the amount of medicines

prescribed and sold in hospitals. On the other hand, changes should be made on the packaging of medicines sold especially in hospitals to control the waste of drugs.

#### (4) The Medicine Cabinet

Medicine companies should work together to launch a cabinet filled with standing drugs, and provide every family one for free. Every month, there should be a salesman to check on the cabinets and charge for the medicine used. Meanwhile the salesman should also take on the responsibility to take away the expired ones and refill with new ones.

The middle stage:

##### (1) Sort

Basically, medicines often come in some of the following preparations:

-Liquid: The active part of the medicine is combined with a liquid to make it easier to take or better absorbed. A liquid may also be called a 'mixture', 'solution' or 'syrup'. Many common liquids are now available without any added coloring or sugar.

-Tablet: The active ingredient is combined with another substance and pressed into a round or oval solid shape. There are different types of tablet. Soluble or dispersible tablets can safely be dissolved in water.

-Capsules: The active part of the medicine is contained inside a plastic shell that dissolves slowly in the stomach. You can take some capsules apart and mix the contents with your child's favorite food. Others need to be swallowed whole, so the medicine isn't absorbed until the stomach acid breaks down the capsule shell. Different kinds of medicines need to be treated in different ways. Our groups, thus, come up with this solution to call on people to sort their unwanted medicine according to their types. Then, in this way, after recycling, people can deal them more easily and accessibly.

##### (2) Utilize current facilities for the recalling of unwanted medicines.

For the recycling and re-usage of unwanted medicines, the step before the chemical disposals is significant. We need to insure that the medicines are of no harm and stored well. Apart from that, our goal is to gather as much medicines as possible to make the best of our resources. As it could be tough to set up a brand new system for medication recalling, we think it is the best to make use of our systems.

Garbage classification system: As there is already a garbage classification system that is built almost everywhere in China, it is not hard to add a new section to it specially for the recycling of medicines.

Delivery system: With the massive development of food delivery and express delivery industries, delivery men are our "most familiar" strangers in life. We often see delivery men with a high frequency and thus, they are a perfect channel to help us gather the drugs.

Drug stores: Buying medicines at a drug store is one of the moments that people most tend to remember their expired drug at home. Moreover, as drug stores are usually equipped with a professional doctor to take in charge of iatrical affairs, we could get some help from these doctors to help do the sorting of drugs.

### (3) Pass-on program

The donation of drugs can help those who have no economic ability to buy drugs in order to obtain the certain medical security. For example, some poor-family patients with serious diseases such as heart disease or cancer have no economic ability to pay the medical bills. The donation system can relieve their burden and make them have greater expectations for the success of treatment. The drug donation mechanism can also make full use of those unused drugs, which will make full use of resources, and ensure the rationalization and popularization of those resources. In addition, centralized destruction of drugs is avoided, that is, environmental and social hazards caused by drug destruction are avoided.

The final stage:

#### (1) Basic method

In this day and age, there is a basic method for disposing the expired medicines, which is the burning of the landfill. Those expired drugs will be gathered to a certain place and wait for the next step of processing. This location should be a more than appropriate place for the burning. The place should be open to some extent. It needs to maintain that the burning will not affect people around that location. The personal security should be ensured. The reason why people prefer this kind of basic method is that it is able to guarantee that those detrimental expired medicines can be destroyed completely and there is less hazardous substance left. This does not exert a negative influence on both environment and people.

#### (2) Technology

Deterra products prevents drug abuse and protect the environment through safe, permanent disposal of safe, convenient and permanent disposal of unused, expired or unwanted prescriptions and over the counter medications. Developed under federal contract awarded by NIDA, Deterra' s patented technology is independently lab-tested and scientifically proven to deactivate drug by proprietary activated carbon, rendering them inert, unavailable for misuse and safe for disposal. To be more specific, Deterra products (pouches, containers, kits, and accessories) come in multiple sizes so users can deactivate and dispose of an individual prescription or remove a large number of leftover pills, capsules, patches, films or creams from their medicine cabinet.

#### (3) API extraction

In general, there are a lot of different chemicals in pharmaceutical ingredients.

About 8 percent of the ingredients are toxic after expiration, 79 percent fail, and the remaining 13 percent can be reused. However, few pharmaceutical companies will re-extract these ingredients. Our group hopes to find a more appropriate way to help them extract the active ingredients of expired or unused drugs.

# Identify the Criteria

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## 1. Feasibility

Is the plan feasible? Are we able to persuade capitals to join by the details given? Do the regulations support our solutions? Do solutions do no harm on physical health? Is there an essential issue ought to be tackled which would halt the progress of our implementation? Can solutions last long to have a larger impact?

## 2. Cost

Since the disposal of medications involves the production of med factories, the daily lives of families, a efficient cost is necessary. Does the cost match its outputs? Is it cost-efficient?

## 3. Effectiveness

Effectiveness evaluates what effects can be made after the implementation of the solutions. What percentage of the medications can be disposed within our plan? Does the solution solve households, pharmacies, and hospitals' difficulties of disposing expired and unwanted medications?

## 4. Public acceptance and popularization

Will these methods spread throughout the society? Can all of the people accept these kinds of methods? What is the degree that people truly accept these solutions? Will they keep trying these solutions all the time? Won't they return to the original form after a short time? Will these solutions achieve success?

## 5. Sustainability

The disposal of medicines is a problem need to be addressed in the long term, for the production of numerous medicines are growing annually with the development in our industry and biological sciences. Hence, we need the answer to the question that will it be long-lasting? Or will it be just a short-term solution? Moreover, as the major existing ways of disposing unwanted medications, such as incineration, have brought both destructions and contaminations to the environment, it is significant that our solution also takes care of the environment. Therefore, we need to ask ourselves, does it cause new environment problems? Is it environmentally friendly? Can it help with our current environmental problems?

# Evaluate the Solutions

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Based on the criteria we generate, we grades our solutions accordingly. We also make the SWOT analysis about these solutions to help us better find the top solutions that suitable for our plans.

 [evaluation sheet](#)

 [SWOT analysis](#)



# Make an Action Plan

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## 1. The initial stage:

In the initial stage, we are trying to raise the public awareness and reduce the over purchase as well as selling of medications by conducting the following measures.

### (1) Online tracking

We have created a website that could enable families and individuals to track the quantity and functions of their medications. Specifically, after purchasing the medication, users will scan the valid code so that the information will be uploaded online in terms of their functions, quantities as well as expiration dates. Our program will record the the usage deadline and set up multiple functions, including medications' instructions and clarifications. It can also remind users to have the medicine in time by sending notifications. Moreover, before the next purchase, they could review the inventory of medications they already have in case of extra purchasing.

Most importantly, the program will send message three days before the medicines are expired. Only after the users have clarified the message, the program will remind individuals the convenient locations of medication return, donations and recycling station after they no longer need the medications.

### (2) Medicine Recycling Day

Drug Enforcement Administration will set a medicine recycling day, aimed to encourage pharmacies and clinics to organize activities in the outreach of the communities and the advocacy of the pharmacists in promoting health. This will lead people to focus on the contribution and value of pharmacists and to improve medication consciousness and reduce medication errors, in order to protect the patient safety and ensure that expired medications are disposed correctly. To further encourage the self-awareness and public awareness of recycling expired drugs, we can provide free on-site medications consultation by experts, blood pressure measurement, or coupons used in corresponding chain pharmacies to exchange new drugs.

### (3) Articles in WeChat official account

In order to raise the awareness of the public, publishing articles and newsletters is also an effective way. Our official account Model COP has enjoyed a large number of followers, so we use it as a platform to post many passages about the dangers of the unwanted medicine to the physical health, environment and the economy. Also,

passages about how to deal with unwanted and expired medicine are also published. Medicine recycling day is also the day that we publish many passages that call on people to take action with us to recycle the medicine properly.

#### (4) Lectures in schools

Our group members come from many different high schools in Shenyang, so we have access to many schools, giving lectures about medicine. Currently, we divide our passages into types: basic knowledge about medicine, the danger of unwanted and expired medicine and how to deal with the unwanted medicine properly

#### (5) Reduction of over selling

In order to truly reduce the amount of medication wasted, our attentions should be put on its origins. Thereby, as approximately 74% of medicines are sold in hospitals, this could be a huge breakout for us. Nowadays, for making more profits, many doctors would try to recommend patients to buy extra drugs which are almost useless for their illness. Moreover, in many situations, as in most hospitals medicines are packaged in boxes, making it hard for doctors to specify the dosage for one single illness period. Therefore, the amount of prescriptions made exceeds the actual used amount. Overall, these phenomenon are a huge cause for the waste of drugs. Thus, on the one hand, stricter restrictions should be made on the amount of medicines prescribed and sold in hospitals. On the other hand, changes should be made on the packaging of medicines sold especially in hospitals to control the waste of drugs.

#### Action plan:

Apart from calling out for government to strengthen the restrictions on the amount of prescriptions in hospitals, we designed an innovative sorting and packaging mechanical process. By this process, the packaging of medicines should be made into small pockets customized for each day, and only for one single treatment cycle, so that when the illness is cured, there won't be any medicine left to get expired. Moreover, in this way, it could also remind the patients to take medicines on time each day. By the way, the material for the packages should be in small paper bags or small ones made with green materials instead of plastic boxes.

## 2. Middle stage:

The middle stage is the one in which unwanted and expired medications are collected, in which part of the valid ones could still be passed on to the new users while the other expired ones sorted and delivered to the appropriate places for careful treatment in the final stage.

#### (1) Utilize current facilities for the recalling of unwanted medicines.

For the recycling and re-usage of unwanted medicines, the step before the chemical

disposals is significant. We need to ensure that the medicines are of no harm and stored well. Apart from that, our goal is to gather as much medicines as possible to make the best of our resources. As it could be tough to set up a brand new system for medication recalling, we think it is the best to make use of our current systems.

First of all, the garbage classification system: There is already a garbage classification system that is established almost everywhere in China and the expired medications belong to the hazardous rubbish category. The only challenge for this system is the enforcement of this policy and also to make sure garbage sorting system is universal in all parts around the country.

Therefore, with the help of Chinese existing garbage management program, our group decides to build small boxes and put them on the top of rubbish bins. These boxes will help to collect unwanted medicine. In order to make it easy for people to sort their medicine, we will simply divide unwanted medicine into four types: liquid, tablet, capsules and poisonous medicine.

There's no need to worry whether people can correctly make a difference between these types of medicine, since they use our website to follow clear instructions. Apart from most of the medicines that are rather benign to people and also the environment, however, about 12% of the medicine is poisonous after expired and they need to be treated seriously. For instance, the fentanyl patch is an example of a product that contains a powerful opioid medicine that can be dangerous to people who's not prescribed for. This adhesive patch delivers a strong pain medicine through the skin. Even after a patch is used, a lot of the medicine remains. That's why the drug comes with instructions to flush used or leftover patches. So through the help of our instructions online and also the rubbish collecting box, it is easier to recycle and reuse the wasted medicine. People can simply carry different kinds of medicine to corresponding factory for the next step.

Second, the delivery system: With the massive development of food delivery and express delivery industries, delivery men are our "most familiar" strangers in life. We often see delivery men with a high frequency and thus, they are a perfect channel to help us gather the drugs. When people order a food delivery or a express delivery, they could also fill out a form for drugs recycling on the application, which includes information about the drug's name, expiration date, amount and forms, etc. This information is automatically sent to the delivery man's account and when the food arrives, the delivery man takes the medications with him. When a day is over, the delivery man goes back to their hubs to submit the drugs and get extra paid for their work. The donator also gets related credits or coupons based on the value of the drugs.

Third, the pharmacy stores: Buying medicines at a drug store is one of the moments that people tend to remember their expired drug at home. Moreover, as drug stores are usually equipped with a professional doctor to take charge of medical related

affairs, we could get some help from these doctors to help do the sorting of drugs. Therefore, through using our website on phone or computer, every time people need a new medicine and before they actually go to the pharmacy, they could track their inventory: to make sure they won't buy extra ones that they already possess and also to see if they've got some medicines that's out of date. So they take the expired ones with them to the drug store, and hand them to the classifying doctors and get coupons for it.

## (2) Pass-on program

Since some of the medicines such as cancer medicines are more than expensive for some families, buying drugs becomes a problem for those people. Without the drugs, people cannot receive a good treating effect. Expensive medicines also bring a large burden for normal families. Thus, establishing a suitable donating system is a better choice for those medicines that might be abandoned.

First, the hospital and other organizations, such as drug stores, should build a specific department or working station for collecting the medicines that are not be fully used by patients who do not have chances to use them. For example, some patient switch to other prescriptions or some might passed away leaving a lot medications unused. For these medications, their family members are able to provide these regular organizations with those medicines and get some money. However, a licensed doctor should be working in this station to do inspections on the donated medications to make sure the package is still valid and intact without being contaminated. On the other hand, the regular organizations should provide a platform for those people in need to sign up. After making the collection, these organizations should notify those in need of the available medications.

Second, on our website, we have also set up a page for medication pass-on program. Like the system that is based in physical establishments like pharmacies and hospitals, on our platform, we also enable people to upload their information online. The donor provide the information of their unwanted medications in terms of functions, purchasing source as well as expiration dates while the potential receivers provide their needs. Then the website automatically match the two parties and send the valid medications to the potential people in need.

In order to create a positive cycle, medications are passed-on with financial benefits for each party. Those people in need are able to receive these "second-hand" drugs with a relatively low price while the donors are also compensated by selling these medications, which will help to relieve the burden of their families.

## 3. Final stage:

In the final stage, we aim to make sure that the wasted medications are appropriately disposed, treated and the utmost value could be abstracted from them.

## 1. Technology: Deterra rubbish disposing pouch

Deterra is a high tech product chemically reduce the toxic substance in medicines. This could be used in households and medical institutions like hospitals to maximally reduce the negative impacts of wasted medical rubbish.

For household, this pouch bag will permanently destroy prescription and over the counter medications in three simple steps with multiple sizes from the comfort of home. First, a user deactivates their prescription drugs, pills, patches, liquids, creams and films by open the pouches and place their medications inside. Then, they fill halfway with warm water and wait for a few minutes. At last, they seal, shake and throw the pouch, and the medication will be completely disposed in trash.

For business : employers today face staggering costs in healthcare expenses, lost productivity and increased safety risks associated with employee opioid and other drug misuse. Providing employees with an at-home drug disposal option can help prevent risks before it starts, saving the companies' costs in healthcare expenses for times.

For Healthcare: hospitals, pharmacies, and clinics has a larger amount of medications to dispose in a day than the households' , so there should be products with larger capacity to fit the demands. Deterra container has a large capacity to dispose enough amounts of unwanted and expired medications for healthcare agencies. Container is designed for continual use, so the medical care personnel will tracking circles included on label and follow the instructions, putting the liquid medications in liquid only container and the solid in solid only one separately.

## 2. API Extraction

Details are shown in the prototype design.

After the unwanted medicines are all collected, they will to sent to a special industrial station in the pharmaceutical manufacturers. The Active Pharmaceutical Ingredients (API) will be purified, distilled and distracted from those medicines and reused in the production of new ones. The cost saved in this process could also be a positive stimulation for medical manufacturers to carry out the recycling in the second stage.

[API of Aspirin Extraction](#)

[Pass-on program& Encyclopaedia of medicine](#)

[safe disposal of expired drug](#)

[The image of donating system](#)

[Action Plan Flow Chart](#)

 Technology

 Action Plan Flow Chart

# Prototype and Test

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## | Prototype Design

- [safe disposal of unwanted and expired drug](#)
- [Pass-on program& Encyclopaedia of medicine](#)
- [The image of donating system](#)
- [Moderate amount of medication](#)
- [unwanted medication bin](#)

## | Feedbacks learnt from users

The result of our questionnaire showed that the average score of the evaluation to our plans made by the public is 7.918. Reduction of over selling got the highest score, and utilize current facilities for the recalling of unwanted medicines got the lowest one. Also, from the answers to "What are some of the problems of our solutions", we can see that many people concern the privacy and think our program is kind of complicated.

- [Feedback Chart](#)

## | Improvement for next iteration

### 1. Raise the awareness

Since we plan to use the website to raise people's awareness of properly disposing the medications, whether this website is influential and widely used by a large amount of people decide how much effect it is going to create. The more widely-used it is, the more possible it is for people to be advised and reminded in the most appropriate ways of disposing their medical rubbish. Therefore, the next step we decide to take is the promotion of this product in marketing stage, by utilizing a range of ways to make this website not only more user-friendly, but also more popular among Chinese citizens. Apart from necessary advertisements and promotions, we hope to insert these functions in other already mature and popular app and programs among Chinese people. For example, we will try to devise a Wechat mini program that can be embedded in Wechat app, the ubiquitously used

app program in China and also, we will design a function that can be added to PayPal pages.

## 2. Deducing the prescription

In our actions plans, we have presented the idea and prototype of the sorting machine that is used to customize the daily prescription for patients by separating the small units of medication from their original packages and re-organize them into small ones. The next step to be taken is to ensure that this machine is both convenient to use and economical to operate in the settings like pharmacies and hospitals. On the one hand, in terms of the design, we will improve the efficiency of this sorting machine to make sure that it can process large amount of medications on daily basis without frequent breakdowns. On the other, we will also try to minimize the cost of the machine and the packaging materials it will consume. Apart from plastic bags, we will also consider more environmental-friendly materials that will not pose a threat to the mother nature by itself.

## 3. Garbage classification system

If we hope to effectively carry out the garbage classification system, the public awareness to do according to the system is the most vital part in the plan' s success. We will continue to raise their awareness by educating the public through our website and making the website more and more influential. Besides, some help from the government is also needed.

## 4. Pass-on Program

The potential risk brought about by this program is the appropriate use of the medications after they are passed on to the new users and therefore, it is our future plan to ensure their proper use. First of all, by stressing the importance of inspection and professional suggestions, we can make sure that medications within the usage period and with perfect wrapping will be passed to the next user. The misuse of the wrong type or the contaminated medications should be totally prevented in the very first place. Besides, the sensitive issues like the protection of private information will also be properly addressed through the anonymous donation process .



# Team Credits

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Sutong Yao is responsible for the overall program, assigning tasks.

Mingke Tian is responsible for the flow chart and prototype design.

Kexin Geng is responsible for generating solutions.

Chenrong Zheng is responsible for the organization of the criteria and evaluation.

Baiming Zhang is responsible for the action plan.

Junkai Feng is responsible for the action plan.

Xinyi Chen is responsible for collecting feedbacks from our users.

Yuxin Wang is responsible for the collecting feedbacks from our users.

Qinyue Xie is responsible for the improvements.

Enning Zhang is responsible for the improvements.

Dongcheng Liu is responsible for summarizing the root causes.

We all worked together on every part of the project.

# Onsite Conference File

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📁 [SI 演讲稿](#)

📁 [SI PPT](#)

📁 [SI第一次模拟视频](#)

📁 [SI第二次模拟视频](#)

# Judge Comments

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" The team did a good job in exploring an often underappreciated and overlooked issue, namely the end-of-life treatment of medicines, including hazardous ones. The flow chart in the summary is a very helpful tool to highlight the issue, and how you have arrived at your solutions – congrats for developing a concise graphic to summarize your work. Kudos to the team for identifying lack of feedback mechanism as a root cause - this is a very insightful finding.

It would be very helpful to further explain and understand the environmental impacts of disposal. Is there significant harm being caused to justify an intervention from an environmental perspective? I recommend the team explore the implications to water, air and soil quality further to see if the improper disposal of medicines is a significant enough issue – there is significant amounts of research happening on these questions now. If the answer is no, the issue is primarily social and one of operational management for the hospital and pharmaceutical industry.

I also appreciate how the team has systematically broken down the lifecycle into 3 stages and have identified drivers and barriers in each stage. It is useful to keep in mind that consumer privacy is key aspect and any system that asks users to upload their medical info will need to account for privacy concerns. Similarly, drugs often tend to be misused, so collection systems will need to build in safeguards to prevent misuse between discarding and safe disposal.

As you take your work further forward, please remember to adequately cite references to other research. Again, great job in systematically working through an underappreciated issue and identifying some practical solutions. Good luck in taking forward this and other similar topics of significant social and environmental interest!

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