Problem Chosen	2020 MCM/ICM Summary Sheet	Team Control Number
E		2022495

The Battle Plan Against Plastic Waste

Summary

From the 1950s up to 2018, about 6.3 billion tons of plastic had been produced worldwide, of which around 9% has been recycled and another 12% has been incinerated. In view of this serious plastic waste problem, countries and organizations worldwide are taking actions. As current efforts are far from enough, we need a more effective plan to deal with this global crisis. Under this condition, the International Council of Plastic Waste Management (ICM) raised a series of tasks for our group. In this report, our work is stated as follows:

1) Considering the factors associated with plastic waste, we develop a weighted combination model to estimate the maximum level of plastic product waste that can safely be reduced without secondary pollution. We use nine relevant factors which can be classified into three categories (population, resource, development) as input and the theoretical recycling rate as output. We select 6 countries that is considered to have achieved the maximum recycling level for their own conditions. We collect these countries' data and use Multiple Regression Analysis to figure out the relationship between maximum plastic recycling rate and the situation of the object region.

2) We explore the calculation method by looking at in which ways can plastic waste be reduced to reach an environmentally safe level. By analyzing the structure of plastic industry, consumption and waste management, we design a calculating method and use a tree-like graph to clarify it. After that, we choose California as our object and compute its theoretical recycling rate. Besides, we introduce Environmental Cost of Plastic Waste (ECPW) to help define environmentally safe level and measure the environmental impact of plastic waste.

3) Based on the previous model and discussion, we set a target for the minimal achievable level of global plastic waste and discuss the impacts to reach. We combine the results in task 1 and task 2 and discuss the influence to realize the target from perspectives of people's life, environment and industry.

4) We identify the equity issues by analyzing the difference between countries and divide the countries into two groups according to the pressure caused by plastic pollution. Suggestions are given based on the characteristics of two groups and we put forward the importance of promoting the communication between two groups.

5) We write a two-page memo describing a realistic global target, the timeline to realize it as well as possible circumstances.

Finally, we analyze the strengths and weaknesses of the methods we proposed in this paper. The research can also meet the need of the ICM and make reasonable assessment about plastic waste management.

CONTENTS

1 Introduction

1.1 Background

cheap, light, resistant and versatile - plastic has undeniable advantages. But unfortunately, due to human's overuse and low efficiency of recycling, the plastic has a huge negative impact on land and ocean, threatening the wildlife as well as human beings. if there is no intervention, the mismanaged plastic will bring about an escalating environmental crisis.

The first synthetic plastic - Bakelite - was produced in 1907, marking the beginning of the global plastics industry. However, rapid growth in global plastic production was not realized until the 1950s. From the 1950s to 2018, about 6.3 billion tons of plastic has been produced worldwide, of which only around 9% has been recycled [1].

"There is no such thing as 'away'. When we throw anything away, it must go somewhere." As Annie Leonard, the Executive Director of Greenpeace USA, pointed out, the same goes for plastic waste. Large amount of plastic waste enters the environment and put creatures in nature at risk. Some studies point that 90% of seabirds contain plastic debris in their bodies[2][3]. Faced with the severe problem caused by plastic waste, countries and organizations around the globe are taking measures from different factors such as resources, consumption and disposal of plastic waste. The efforts devoted are far from enough currently. To deal with this global crisis, a more effective plan is needed.

1.2 Problem Statement and Analysis

Faced with the environmental crisis caused by plastic waste, the International Council of Plastic Waste Management (ICM) raised a series of tasks. To deal with these tasks, first, we develop a weighted combination model to estimate the maximum level of plastic product waste that can be mitigated without further pollution. Second, we discuss how much plastic waste can be reduced taking certain measurements and impacts into account. Here we select California as our target region and analyze its inherent conditions to calculate the final result. Third, a minimal achievable level for global plastic waste is set and we explore its underlying impacts. Fourth, we identify and address the equity issues that arise from the global plastic waste crisis due to regional differences. Finally, we propose a short memo describing the target in task 3, the timeline with possible circumstances.

Through the above analysis, the flow chart of this report is shown in Fig.1 as follows.

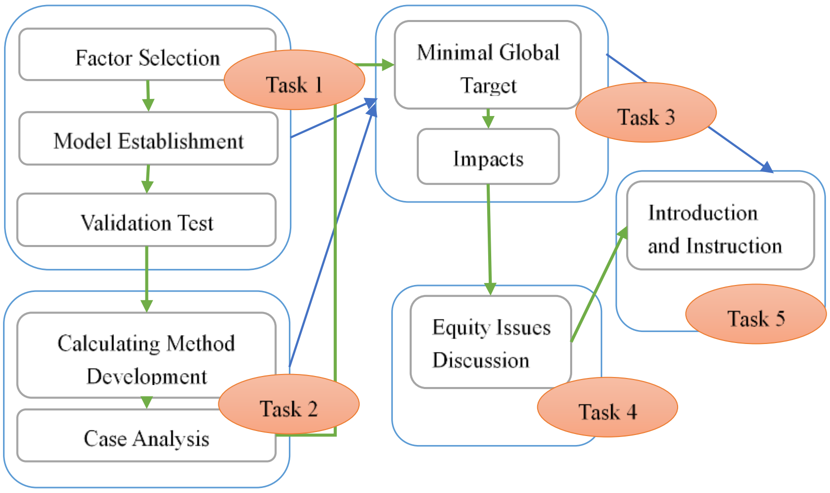

Fig.1 The Flow Chart In This Report

2 Assumption and Symbol Explanation

2.1 Assumption

- The government policy will not change in the short term.
- The statistics about plastic waste are essentially unchanged in the short term.
- A simple, wide ranging, and robust model is preferred over a detail-oriented model that requires city specific data.
- The data source is actual and reliable.

2.2 Symbol Explanation

Tab. 1 The Symbols of Definition and Description

Symbol	Meaning
SDP	Single-use or disposable plastic product waste
TRR	Theoretical recovery rate
TRR_1	The TRR generated in task 1
TRR_2	The TRR generated in task 2
MET	The model to estimate the maximum levels of TRR in task 1
CMT	The specific calculating method to estimate TRR in task 2
MAL	The minimal achievable level of global waste of single-use or disposable plastic products
ECPW	Environmental cost of plastic waste

3 Task 1

In this task, we develop a weighted combination model named MET (model to estimate the maximum levels of SDP that can safely be mitigated without further environmental damage) which outputs a theoretical recovery rate (TRR) to measure the levels of single-use or disposable plastic product waste (SDP) that can be safely mitigated.

The model is defined as below:

$$TRR_1 = \sum_{j=1}^{k} w_j x_j + c$$

Here k means the total number of factors and in this model the total is 9. j is the order of the factor. w_j is the weight of the j th factor. x_j is the value of the j th factor. c is a constant.

The output TRR ranged from 0 to 1. And the higher the TRR is, the more SDP can be reused in the total amount of plastic waste. This model takes nine factors as input. Those factors reflect the situation in an area and have an effect on the plastic recycling rate. They are described in the table below.

Tab. 2 The Definition and Description of Factors

Symbol	Meaning
x_1	Education level
x_2	Population density
x_3	Total amount of plastic waste
x_4	Plastic waste generation per person
x_5	The share of plastic waste that is not adequately treated in the region
x_6	The share of global total mismanaged plastic waste
x_7	GDP per capita
x_8	Urbanization level
x_9	Technological innovation level

3.1 The Input Information

The distinguishing mark of this model is that it combines population, resources and development, which is shown in the factor selection. We consider from these three perspectives and choose nine factors that may influence a region's recycling rate of SDP. and divide them into three categories.

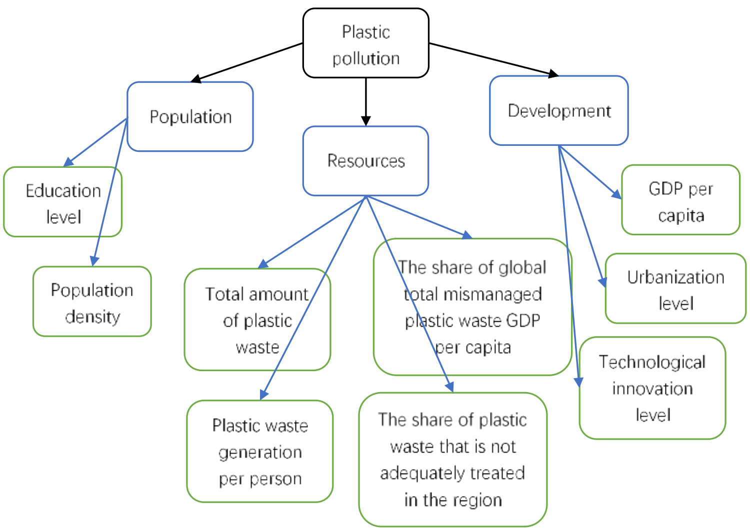

Fig. 2 The Classified Factors

3.1.1 Population

From this perspective, we focus on the influence of people and put forward two factors that is related to the TTR: **education level** and **population density**.

The education level is measured by the percentage of government spending on education. this model assumes that if the government in a region invests more in education, people are more likely to have a better understanding of the status of ecological environment, and thus have stronger environmental awareness in their daily life. Some of the government's directives, such as garbage classification, will be implemented more efficiently, which will contribute to the improvement of TRR. The education level data can be collected from the research lead by Vito Tanzi and Ludger Schuknecht[4].

The population density is the number of people living in each unit of area (such as a square mile). If the population density in a region is relatively high, as SDP are mainly generated by people, this region tends to have higher plastic waste production, and thus lower the TRR. The population density data can be collected from the World Bank[5].

3.1.2 Resources

From this perspective, we mainly analyzed the situation of SDP itself in a region, including the **total amount of plastic waste**, **plastic waste generation per person**, the **share of plastic waste that is not adequately treated** in the region, and the **share of global total mismanaged plastic waste** where the region belongs to.

The total amount of plastic waste represents the amount of plastic waste that an area currently needs to dispose of, and in original data it is measured in tons. We mainly consider the plastic waste generated in a specific year and if the data is missing, we use the mean of the accumulative waste for long-term period.

Plastic waste generation per person is the amount of waste produced per person per day, and in original data it is measured in kilograms. The larger this number is, the greater the pressure of managing SDP tends to be. The original data is collected from the research by Jambeck et al[6].

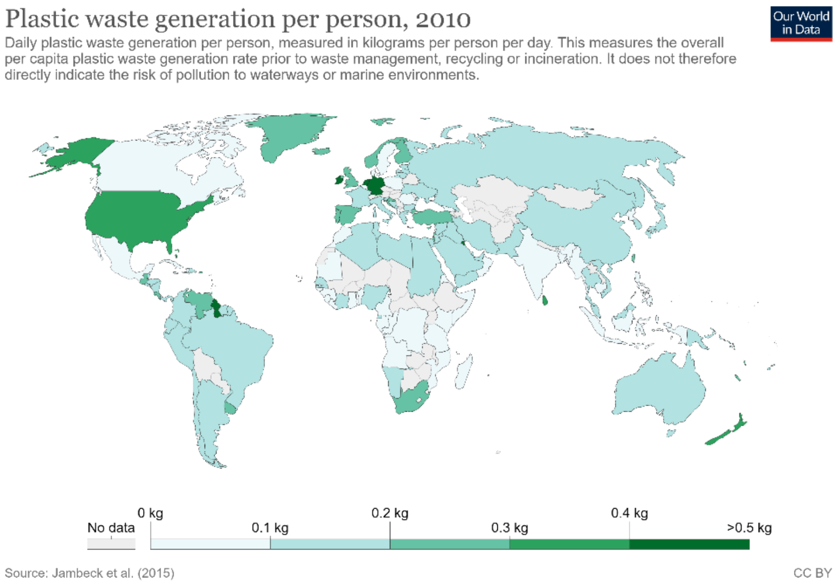

Fig. 3 Plastic Waste Generation Per Person[19]

The share of plastic waste that is not adequately treated in the region shows the current level of garbage disposal. Inadequately disposed waste is defined as the waste that can be managed through waste collection or storage sites, but is ultimately not formally or sufficiently managed. These situations can be disposal in dumps, open or uncontrolled landfills. The material is not fully recovered and can be lost in the surrounding environment. The original data is collected from the research by Jambeck et al[6].

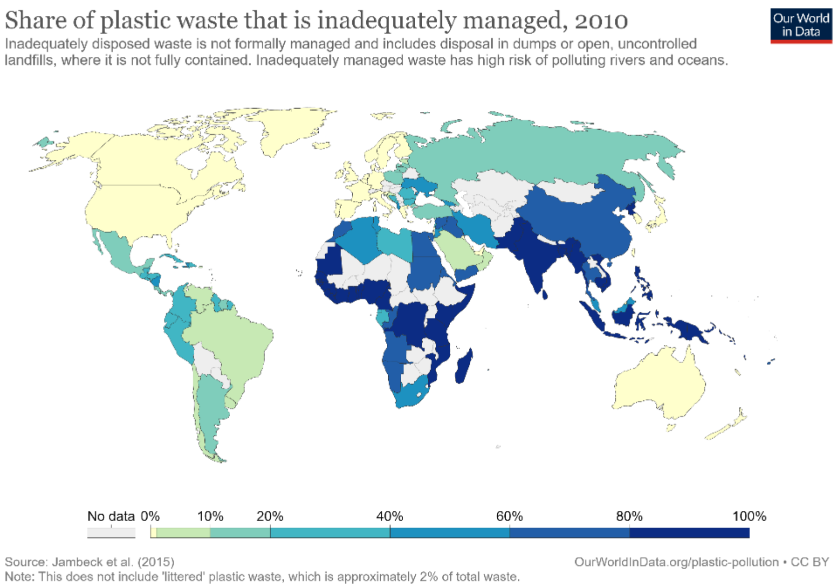

Fig. 4 Share of Plastic Waste That Is Inadequately Managed[19]

The share of global total mismanaged plastic waste focuses on the waste that threaten the ocean ecological system. Due to this main concern, the original data used quantified plastic waste generated by coastal populations (those within 50 kilometers of a coastline) and the sum of inadequately managed waste (formally managed such as disposal in dumps or open, uncontrolled landfills which could leak to the surrounding environment) and littered waste. The original data is collected from the research by Jambeck et al[6].

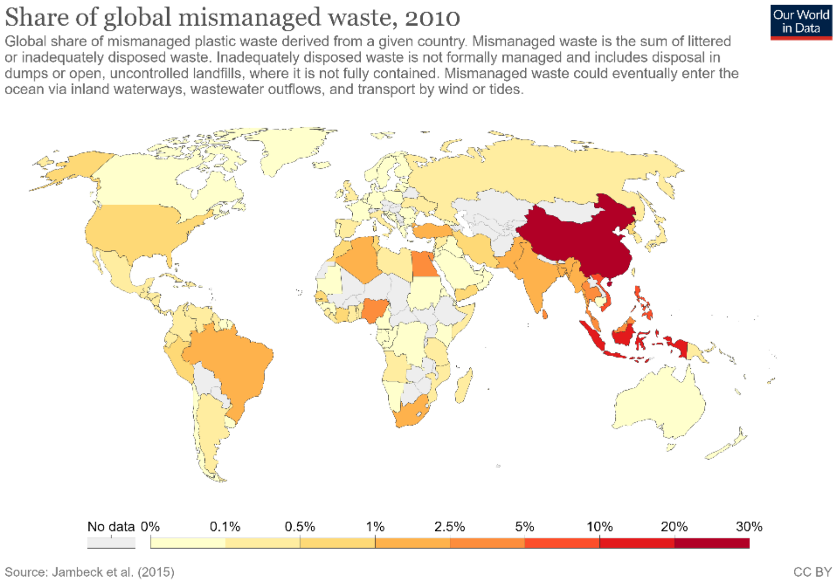

Fig. 5 Share of Global Mismanaged Waste[19]

3.1.3 Development

From this perspective, as environmental problem has great concern with economic development, we put forward three indicators: **GDP per capita**, **urbanization level** and **technological innovation level**.

GDP per capita measures of a country’s economic output that accounts for its number of people. It divides the country's gross domestic product by its total population, which makes it a good measurement of a country's economic strength. In view of Fig.3, Fig.4, Fig.5, we found countries with high GDP per capita tend to have more effective waste management systems. As for this phenomenon, we figure that high GDP per capita indicates that individuals have stronger concern over environmental problems and the government will give more attention to the environmental protection, which would facilitate plastic recycling. The original data is collected from International Monetary Fund[7].

Urbanization level is measured by the percentage of the total population living in urban areas. It has the similar impact on plastic recycling as GDP per capita. It is assumed that region with high urbanization level tend to have more effective environment-protecting methods, and consequently this factor has a positive impact on waste recovery. The original data is collected from Central Intelligence Agency[8].

Technological innovation level is listed here considering the probability that advanced technology may help solve environmental problems. It is quantified by International Innovation Index which looked at both the business outcomes of innovation and government’s ability to encourage and support innovation through public policy. High innovation level indicates the strong potential to develop new methods dealing with plastic waste and thus, to increase recovery rate. This original data is collected from World Intellectual Property Organization[9].

3.2 Model Establishment

We looked through the waste management condition by country and selected 6 countries - Norway, Sweden, Belgium, Germany, Denmark and Ireland – as our reference countries. With the intention of setting standard for maximum level of recovery rate, We chose these countries because their plastic recovery rates rank top in the world[10], which means at this time, the upper limit of realizable waste recovery level without further environmental damage can be can be designated on the basis of their achievements. By analyzing the relationship between their national conditions which are measured by the nine factors mentioned above and their actual plastic recovery rate, we can establish a model which generates the maximum level of TRR for other countries accordingly.

Because the correlation between the nine factors mentioned above and the final maximum TRR is uncertain, and these correlations are interacting with each other internally, it's difficult to analyze their influences on TRR if consider approaches which take perfect information as input. **Multiple Linear Regression** (MLR) is a statistical technique that uses several explanatory variables to predict the outcome of a response variable. By applying MLR, we can determine the weight of each factor.

The 6 countries' data is collected and displayed as follows:

Tab. 3 The Data of The Six Selected Countries

Country	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9
Norway	8	14	499682	0.28	0	0.0264	70553.11	1.4	1.14
Sweden	7.7	24	164305	0.048	0	0.0068	51124.76	1.05	1.64
Belgium	6.5	374	318151	0.08	0	0.0086	41247.86	0.62	0.86
Germany	4.8	235	14476561	0.485	0	0.0981	42176.85	0.27	1.12
Denmark	7.6	136	95171	0.047	0	0.0056	53744.64	0.74	1.6
Ireland	3.7	69	715716	0.43	0	0.0368	64782.3	1.14	1.88

After calculation, the weight of each factor are shown in table:

Tab. 4 The Weight of Each Factor

Symbol	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	c
Value	2.789	-0.028	-0.007	4.215	0.001	0.001	-0.415	0.002	0.001	39.273

The final model to calculate TRR_1 is:

$$TRR_1 = \sum_{j=1}^{9} w_j x_j + c$$

Here w_j and c can be obtained by referring to the table above.

3.3 Model Validation

The data sources for our verification are the same as the top 6 countries' data. After the collection of test data, we obtain a data set of America and China with all factors mentioned previously to verify our model. We consider this data set sufficient for our verification, but more complete data is required if we want to calculate the TRR with better accuracy.

Here is the dataset of America and China:

Tab. 5 The Data of America and China

Country	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9
America	5	35	0.335	37825550	0	0.8649	57607.61	0.95	1.8
China	4	146	0.121	59079741	74	27.6966	8123.26	2.5	0.73

Using the MEM model, the final TRR for America is 17.3%, and for China, 8.9%.

The actual recovery rate of America is about 9%, but for China the accurate data is missing. The TRR indicates the maximum recycling ability in America's case. In view of its population, resources and development level, America can achieve the highest recycling rate as about 17%, which is twice the actual value. We consider this result acceptable.

4 Task 2

In this task, we design a calculation method named CMT to judge the improvement space of the recycling rate based on existing policies and measures that can be taken to improve the TRR for the part of plastic waste that is not effectively recycled. Here we still use TRR to measure the reduction of plastic waste and see to what extent plastic waste can be reduced to reach an environmentally safe level. But to distinguish from the TRR in task 1, we name the TRR in this task as TRR_2. The higher the TRR_2 is, the more the reduction is.

4.1 Description of CMT

The main idea of CMT is: First, according to the generation way of plastic waste we carry on classification to plastic waste. Second, aiming at different kind of plastic waste, we discuss if take certain measure, they can reduce on what level. After that, the increased recycling rate in different kinds and the original recycling rate are added together to obtain the final result.

In most cases, the calculation is shown below.

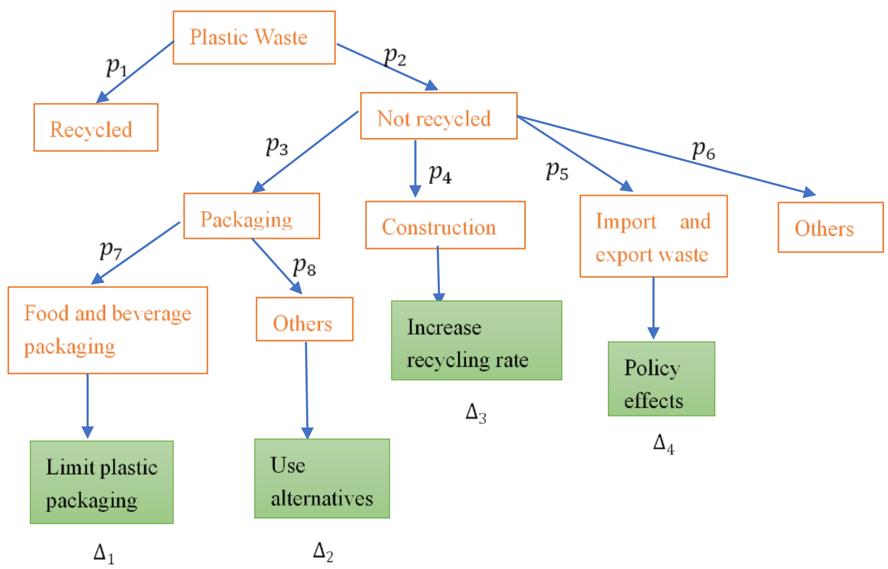

Fig. 6 Main Calculation Process Of Task 2

In this figure, $p_1, p_2, \dots, p_8$ refer to the proportion of the part at the end of the arrow in the part at the start of the arrow. $\Delta_1, \Delta_2, \dots, \Delta_4$ refer to the share of SDP that can be recycled if certain measurements are taken to reduce the plastic waste, that is, the increased part of TRR. For example, p_1 refers to the proportion of recycled waste in plastic waste, and Δ_1 refers to the increased recycling rate if some measures have been taken to reduce food packaging, such as limit using plastic bags.

The final result to judge the extent that plastic waste can be reduced for reaching an environmentally safe level is displayed in the form of TRR_2. If in the condition described in Fig. 6, the way to calculate TRR_2 is:

$$TRR_2 = p_1 + \Delta_1 + \Delta_2 + \Delta_3 + \Delta_4$$

Here is a detailed explanation of Fig. 6.

In the first level, we divide the total plastic waste into the recycled part and the part that is not recycled. The share of the first part shows the current level of managing plastic waste and the second part offers the room for improving TRR. By analyzing the effect of measurements to reduce plastic waste, we can increase the TRR from the second part.

In the second level, according to the data from American Chemistry Council[11], packaging consumes the most plastic and exports the second most in America. And in the research conducted by Geyer et al[12], packaging consumes the most plastic and construction the second most in the world. To simplify calculation, we assume that the distribution does not differ in recycled part and not-recycled part. Besides, we also suppose that in most cases, packaging, construction, imports and exports are the key parts to reduce plastic waste. As they make up large part of plastic waste, it is more efficient to improve their recycling situation.

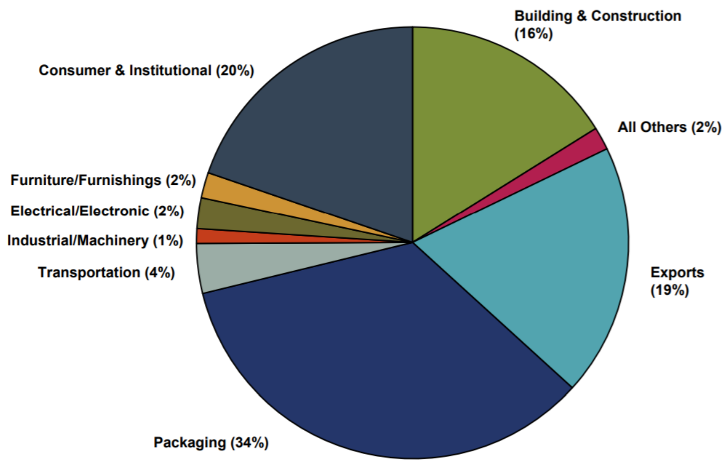

Fig. 7 Distribution for Thermoplastic Resins[11]

In the third level, we discuss the arrangements to reduce plastic waste and calculate the possible amount of waste that can be recycled. The common ways to reduce plastic pollution are setting limitations for plastic use, choosing alternatives for plastic or developing new technology to recycle plastic more efficiently. Here the availability of alternatives to plastics, the impact on the lives of citizens, or policies in accordance to the situation of the object area need to be taken into account. Then we can estimate how much plastic waste can be reduced.

In the following part of this report, we will discuss the condition of California as an example in detail.

4.2 Analysis of California

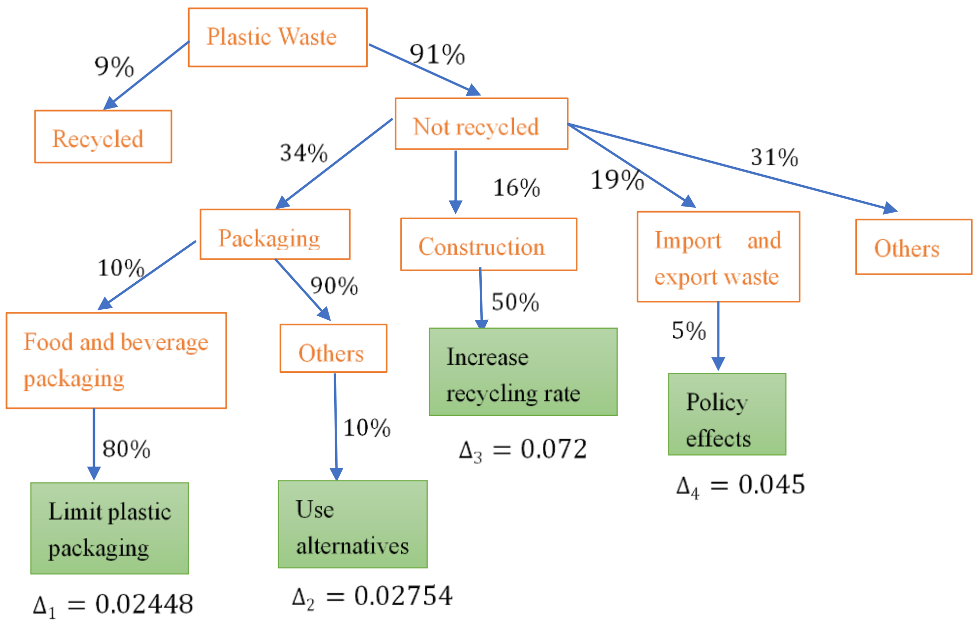

Fig. 8 Calculating Process In The Case of California

As some data about California is missing, we use the data of America instead in the analysis considering its generality. In America, the recycling rate of total plastic waste is around 9%[13], and we use this figure to represent the recycling rate in California. Thus during this calculation process, $p_1 = 9\%, p_2 = 91\%$. In the second level, we also use the plastic distribution data of America to represent California. That is, $p_3 = 34\%, p_4 = 16\%, p_5 = 19\%, p_6 = 31\%$.

California became the first state to ban single-use plastic bags since November,2016. Its law gets rid of single-use plastic bags and requires grocery stores to charge 10 cents for paper bags or for new reusable plastic bags. Those new plastic bags have to be made of partially recycled material and have to meet specific requirements.

According to the feedback from the citizens[14], we found that 80% of single-use plastic bags are reduced, which implies the effectiveness of this policy. As is mentioned by the citizens, about 6% of trash is plastic bags. Consequently, we assume that 10% of food and beverage packaging is plastic bags. By eliminate this part of plastic waste, we can generate the reduced plastic $\Delta_1 = p_2 \times p_3 \times 10\% \times 80\% = 0.02448$.

Then we look at the alternatives of plastic. Assuming in the packaging part, except the single-used plastic bags, some of the plastic left can be replaced by substitutes. Plastics are incredibly energy efficient to manufacture and because they are lighter. Two pounds of plastic can deliver 10 gallons of a beverage three pounds of aluminum, eight pounds of steel, or over 40 pounds of glass are needed to bring home the same amount of a beverage. Taking economic benefit into account, some companies chose to reduce the use of plastic step by step. For example, the Kesko company planned to reduce the amount of plastic by 20% by the end of 2025. Based on these facts, we assume the proportion of plastic that can be replaced is 10%. With all these figures, we can get $\Delta_2 = p_2 \times p_3 \times 90\% \times 10\% = 0.02754$.

After the packaging part, we are to estimate how much plastic can be reduced in construction. In Europe[15], the average recycling rate in construction is 60% while in America, that figure is 25%. Assuming California is to make related regulations or invent new materials, a recycling rate of 40% is considered reasonable. Then we can calculate $\Delta_3 = p_2 \times p_4 \times 50\% = 0.072$.

As for the imports and exports part, we mainly focus on the related policies. To reduce plastic waste, importing SDP should be limited and exporting should be encouraged. Here we lack the data of policy change in California. How much plastic waste import to and export from the state is unclear, too. By observing the situation of other countries, we choose a disturbed value as 5%, assuming that 5% more plastic can be exported. Thus $\Delta_4 = p_2 \times p_6 \times 5\% = 0.045$.

With $\Delta_1, \Delta_2, \Delta_3, \Delta_4$, we can figure out the final $TRR_2 = 0.21447$, which illustrates that California can raise its recycling rate to **21.4%**.

4.3 Environmental Cost

Considering environmentally safe level, we introduce the **environmental cost of plastic waste (ECPW)** to evaluate the cost of restoration to an area's original state after the plastic pollution. The process is shown below.

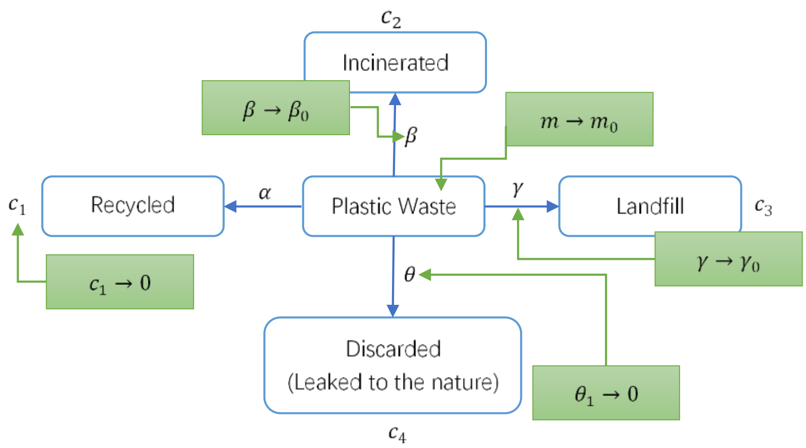

Fig. 9 Derivation of Environmental Costs

Here is an explanation of the figure above.

There are three ways to manage plastic waste: recycling, incineration and landfill. Due to various reasons such as the limited level of waste disposal, some waste would end up in the ocean ineluctably.

Assuming these statistics can be obtained: the annual plastic waste generation in the region (m), the rate of plastic waste recycling(α), incineration(β) and landfill(γ), the share of plastic that leaks to the nature(θ), the amount of pollution produced while processing the recycled plastic waste(c_1), the total amount of toxic gases and particles produced by burning every ton of plastic waste(c_2), the organic waste and toxic chemicals from landfill per ton of plastic waste(c_3), the cost to rid plastic waste of nature per ton of plastic waste(c_4), and the total economic cost of dealing with the pollution(c). The ECPW of the certain region is calculated using the following formula:

$$ECPW = \alpha \times m \times c_1 + \beta \times m \times c_2 + \gamma \times m \times c_3 + \theta \times m \times c_4$$

We can calculate the environmentally safe level of the region using the formula above. Hypothesizing that the processes of recycling plastic waste are strictly in accordance with international standard, c_1 can be approximated as 0. Considering the great harm of waste to the marine, especially the plastic waste, we stipulate that there is no plastic waste ending up in the ocean under the environmentally safe level, thus θ is set to 0. β_0 comes from the regulation about gas emission developed by United Nations Environment Program and γ_0 is transformed from environmental quality standard for soil. m_0 is the plastic waste generated under the premise of regional sustainable development without affecting citizen's lives. The environmental cost of plastic waste under the environmentally safe level is calculated as below:

$$ECPW_0 = \beta_0 \times m_0 \times c_2 + \gamma_0 \times m_0 \times c_3$$

By calculating ECPW and $ECPW_0$ and making comparison, we can judge whether the object region has reached the environmentally safe level.

5 Task 3

In this task, we combine the model in task 1 and the discussion in task 2 to figure out the target recycling rate of the global waste of SDP products and explore the possible impacts if that rate is achieved.

5.1 Target Recycling Rate

In task 1, we developed a weighted combination model to evaluate a region's maximum recycling rate regarding its inherent situation. In task 2, we discussed some possible ways to increase the recycling rate and calculated the optimal TRR if certain conditions can be improved. We use the model in task 1 to figure out the TRR_1 of global waste and apply the calculating method in task 2 to get TRR_2 for global range. We choose **the mean of TRR_1 and TRR_2** as our target recycling rate and the reasons are as follows:

The model in task 1 generates a maximum TRR and it is achievable because this model is trained using the data collected from countries with high recycling rates. This means other regions in the world are capable of achieving the generated TRR if they have similar environmental-protecting mechanism with the sample countries. The calculation in task 2 follows ways to reduce plastic waste and consequently the feasibility of final result can be evaluated in each step of calculation. These two features ensure that their mean is achievable.

Using models in task 1, we input the data of global range as:

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9
Globe	4.7	50	0.18	45833000	18%	1.0	8123.26	1.69	-0.47

The data above is collected from the same source as the sample countries in task 1. After processing these data, we get **TRR_1=23.969%**.

We follow the calculation method in task 2. The parameters and computing process are shown below.

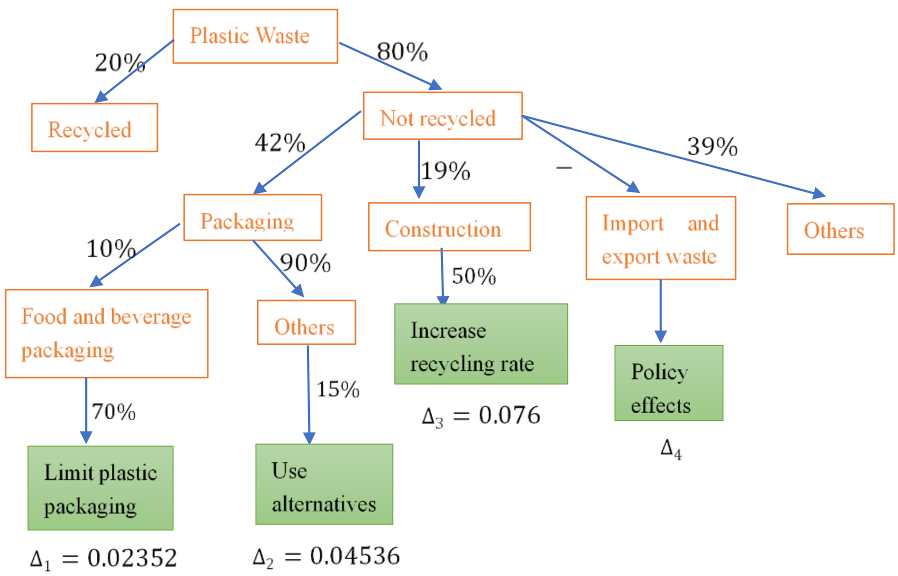

Fig. 10 Calculating Process In Task 3 Using CMT

As is shown in the figure, 80% of plastic waste of the globe is not recycled, among which 42% is packaging waste and 19% is construction waste. We assume 10% of packaging is food and beverage packaging and by limiting plastic packaging 70% of it can be reduced. By using alternatives 15% of other packaging can be reduced. As for construction, we set the target for 50% average recycling rate. We estimated the number at each step based on the available statistics and finally we can get TRR_2.

$$TRR_2 = p_1 + \Delta_1 + \Delta_2 + \Delta_3 = 34.488\%$$

The **final target recycling rate** for the globe is $\frac{TRR_1 + TRR_2}{2} = 29.229\%$

5.2 Possible Impacts

In the first place, we look at the possible measures that people can take in order to facilitate plastic recycling. Nowadays taxes, bans, and extra fees on plastic products have been catching on around the world. For instance, in March 2019, the European Union voted to ban single-use plastics by 2021[16]. In June, Prime Minister of Canada vowed not to just ban single-use plastics such as bags, straws, and cutlery, but also to hold plastics manufacturers responsible for their waste[17]. 141 countries, including China, Bangladesh, India, and 34 African countries, have implemented taxes or partial bans on plastics[18].

By looking through what can be done or has been done to achieve the target TRR, we will analyze the impacts during the course from three perspectives: people's life, environment and plastic industry.

1. People's life

To achieve the target, the most direct result is that fewer plastic bags or straws will be seen in daily life as more people take a bag with them when head out. Less plastic use will also reduce reliance on takeaways. Considering the use of unnecessary packaging, disposable cutlery and containers for single-use items are limited, people may cook at home more often. Besides, garbage classification will be spread more widely and in the end it will become a common habit.

2. Environment

When the plastic recycling rate and the management of plastic waste are being improved, less plastic will be landfilled, enter the oceans, or incinerated. As a result, some phenomena such as mountains of plastic trash in the oceans or massive "garbage patches" formed by plastics may be less likely to be seen. The nature will be closer to what it used to be.

3. Plastic industry

The plastic industry will face more strict limitations. The direct result of the restriction is that the increase of plastic generation will be slow down. Due to huge economic advantages that plastics have, it is hard to tell whether the plastic generation will decrease. But we can infer that environmental-protection policies will make it more expensive to produce plastic if there is no technological revolution. One the other hand, as people are taught to use less plastic in their daily life, in some area such as household area the plastic demand may be reduced.

The change in plastic industry will influence industries of other fields as well. For example, the fashion industry. Polyester - a type of plastic - now dominates the fashion industry. Overproduction and overconsumption of clothing have led to high volumes of clothing disposal and brought about pollution, so the development of fashion industry may face obstacles - or it turns to a new industry, changing its current producing process.

Meanwhile, new plastics industry will rise and create new plastic economy. In this economy, plastic will not become waste. Three actions are required to achieve this vision: eliminate all problematic and unnecessary plastic items, innovate to ensure that the plastics being used are reusable, recyclable, or compostable and circulate all the plastic items we use to keep them in the human society and out of nature. Plastics with these features will be a good choice of alternative and their development will be strongly encouraged.

6 Task 4

Environmental equity means that no group or community had to bear a disproportionate share of the harmful effects caused by pollution or environmental hazards due to the lack of economic or political power. And there are development support, implementation, and enforcement of environmental policies and laws to ensure this justice.

Different countries have different ability to recycle plastic. Those countries with better recycling rate tend to suffer less from the plastic pollution as the barrier effect caused is lighter. However, there are also many countries struggling with plastic pollution while developing the economy. In view of this comparison, we can see the equity issues that plastics bring about.

To explore the possible solutions to the equity issues, we divide countries and regions into two groups. Countries that have the advantage or have less restriction from environment is classified as group A, while those at a disadvantage or faced with huge pressure from environment are classified as group B. Countries in group A are mostly high-income countries with relatively sound environmental policies, while group B, the opposite. To address equity issues, measures to be taken may differ in groups.

There are some measures that apply to both A and B.

In terms of population, both groups can continue to raise people's environmental awareness and pay more attention to education so that their people will have a better understanding of the importance of good environment.

In terms of resources, both A and B can enhance their limitation on the use of plastic. For instance, within a certain range, they can gradually strengthen the use of plastic bags, plastic straws, disposable cutlery, etc. and encourage the use of reusable materials.

In terms of environment, A and B can continue to step up efforts to create an environment where people can easily recycle plastic by offering more different types of bins for collection of glass, paper, plastic and others.

In terms of development, A and B should make plans for the development of plastic industry. There must be some companies opposed to restrictions on plastic. Consequently, the government may need to help these companies adapt to the new situation.

In addition to the measures mentioned above, it is also necessary to strengthen **cooperation between A and B**.

Group A have stronger power to treat plastic efficiently and Group B face more serious environmental problems that has generated great pressure on B's development and formed a vicious circle of "development produces pollution, while pollution hinders development". Considering the differences between two groups, it is necessary for A to give a hand to B.

There are many forms of cooperation. For example, A can sell advanced facilities to B, considering that in many countries of Group B, the low recycling rate is resulted from the lack of technology to recycle plastic. By showing support, A are supposed to make this deal with a lower price. Besides, A can send their environmental protection talents to B to impart experience and give guidance. All these efforts should be encouraged by international organizations like ICM. These organizations have the responsibility to create opportunities for A and B to communicate and let both groups understand that this is for the mutual benefit of both sides.

7 Strengths And Weaknesses

7.1 Strengths

- The model allows us to make predictions and recommendations about plastic waste even without extensive data sets.
- The model is simple and robust with the data easy to measure. A reliable result can be obtained, as long as the data is accurate.
- The model combines population, resources and development, which is shown in the factor selection. With comprehensive considerations, the model is convincing and substantial.
- In the model validation, the model performs well, which indicates that our model is workable.

7.2 Weaknesses

- The accuracy of the model depends on the reliability of the statistical, so the differences in statistical criteria may result in bias conclusion.
- Although the model is designed with comprehensive consideration, the selected factors are derived from previous experience with certain subjectivity.

MEMORANDUM

To: International Council of Plastic Waste Management
From: Team 2022495
Subject: Global Target of Plastic Waste
Date: February 17, 2020

I. Global Target

Based on the assessment of the current situation of plastic waste worldwide, the final global target is to achieve the plastic waste recycling rate of 30% by the end of 2030. The specific contents of the target are as follows:

- 70% ban on plastic bags worldwide
- 15% use of alternative materials for plastic
- 50% of the recycling rate of construction waste
- Restrictions on plastic waste import and export
- New standard for plastic industry
- Improvement of urban garbage collection efficiency
- Increased awareness of environmental protection for most citizens
- Enhancement of communication between developed and developing countries on plastic waste

II. Timeline

Referring to the implementation of existing plastic restriction laws, the process to achieve this target can be divided into three periods: preparation (March 2020 to December 2021), implementation (January 2022 to December 2029) and evaluation (January 2030 to December 2030).

i. March 2020 - December 2021: Preparation

- Carry out a comprehensive investigation on the current situation of global plastic waste and a complete pollution map.
- Develop general plans and region-specific plans based on plastic waste pollution.
- Hold global conferences to discuss plans and reach a consensus with most countries.

ii. January 2022 - December 2029: Implementation

Considering the implementation period is eight years long, in order to ensure that the final target is met, ICM will conduct a preliminary evaluation (2025) of the situation of plastic waste in each country to refine the follow-up plans.

- Require each country to count and report the situation of plastic waste annually.
- Aggregate and analyze the statistics on plastic waste globally in 2025.
- Evaluate the current goal completion level.
- Combine the new experiences of the past four years to refine the current plans for each country in 2025.

iii. January 2030 - December 2030: Evaluation

- Assess the global plastic waste to see if it achieves the global target.
- Summarize the decade's efforts and experiences on dealing with plastic waste crisis and conclude into a report.

III. Possible Circumstances

i. Favorable Circumstances

During the decade, the spread of biodegradable plastics, discovery of new plastic alternatives or emergence of new recycling technologies will all promote the process of realizing global target. But to change the situation of plastic waste fundamentally, the economic cost must be taken into account. In order to transfer achievements in technology into actual decrease of plastic use, the cost of new materials or processing methods need to be quite low so that they can be accepted by industries.

ii. Unfavorable Circumstances

Global or regional public health crisis or domestic political instability will hinder the process. Because these two types of issues tend to lower the administrative efficiency and talent and capital investment are very likely to be affected, environmental protection will be hampered. False or inaccurate data of plastic waste will also have negative impacts as they may mislead estimates of the current situation and cause wrong decisions.

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Sincerely,

Team #2022495