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Improving the Mongolian glass returning method based on the German experience

Bachelor Thesis

by

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Statutory Declaration

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I hereby affirm in lieu of an oath that I provided the submitted bachelor thesis

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Acknowledgment

First and foremost, I thank my university – the German Mongolian Institute for Resources and Technology. All supervisors, professors, and lecturers involved in this process gave me the knowledge during the past years.

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In the end, I would like to say thank you to my family and friends for enabling me to be here and supporting me through everything, and being there with me. Without them, I would never know where I could have been.

Abstract

Countries and companies worldwide strive to reuse their raw materials. At the same time, developed countries like Germany have achieved good results with glass bottle collection from the consumers. To learn from German experience, this paper provides a literature analysis of the development and success of German's glass bottle return rate. Mongolian situation analysis is done based on the APU JSC, which collects their shipped glass bottles of the products from market. APU's reverse vending machine implementation feasibility study is calculated using Net Present Value analysis and payback period method. In addition, using a comparison of glass bottle collection flow diagrams of Germany and Mongolia, and "WasteAware benchmark indicators", missing gaps and essential areas to improve in Ulaanbaatar are identified. With the help of German's experience and practices, suggestions are recommended to APU company.

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1. Introduction

1.1 Problem Statement

Worldwide we use packaging material, including glass material, in our everyday lives. 45.9 million tons of household waste were produced in Germany in 2015, and 2.5% is glass(1). In 2019 solid waste generation in Mongolia was around 2.6 million tons, and 7.4% was glass waste. The amount of solid waste is increasing by 176.8 thousand tons per year because of Mongolian urbanization, population growth, and industrialization (2).

Using natural resources efficiently, reducing their environmental impact, and saving costs are crucial goals in every company and country. Reusing glass bottles is economically and environmentally beneficial. The demand for reusing glass bottles will be increasing as the glass packaging market size increases. In 2019 the global glass packaging market size was $60.32 billion; this number tends to increase up to $81 billion in 2027(3). In Mongolia, the production of beer, alcohol, and soft drinks increased from 91.8 l to 110 l per capita from 2011 to 2014(2). So, we will face more demand to be eco-friendly and reuse glass bottles in our production process in the future.

All glass packaging used for production is imported from another country to Mongolia. Unfortunately, the reusage of glass bottles is relatively low in Mongolia. So, lots of money are being wasted without reusing returnable glass packaging. When a customer has empty glass bottles, it usually directly goes to the not separated waste in Mongolia. One of the reasons behind this is that there is no developed system, strategy, or policy on collecting glass bottles back from the customers in Mongolia. There is a limited number of glass collecting points, and the requirement for collected glass to reuse is high.

Nonetheless, developed countries like Germany lead the recycling and reusing rate globally, and the achievement of urban household solid waste management practice is pretty good. The implementation and the idea of reusing glass bottles have existed in Germany since the 18th century(4). They have a long-time experience, so just duplicating the current system of Germany is not suitable in the Mongolian situation. Especially from the Mongolian companies' perspective, collecting and reusing method should be cost-beneficial, so we should see the past and current development of Germany's reusing technique. Finding the appropriate glass bottle collecting method and steps to improve the rate of the returning rate is crucial in the first place.

1.2 Research questions / The aim of the study

This thesis study aims to suggest possible improvements in the glass collection method to increase the return rate of APU and do a financial analysis of the proposed method. The method will be suggested based on the German recycling development experience.

European countries, especially Germany, are leading the world's recycling rate. In 1991, the glass packaging recycling rate was 53.7% in Germany. However, in 6 years, it is increased to 83.5%. The integrated system of Germany showed very positive results. Within the context, "**What method and policy did Germany use to increase their glass packaging rate?"** The main 3 pillars of the German UHSWM system will be investigated. To illustrate how the process flow diagram of the ON and OFF channel glass waste process will be illustrated.

In order to suggest improvements in APU company, the current situation needs to be evaluated. "**What are the Mongolian specifics and current condition of APU company?"** APU is the biggest and the oldest beverage company in Mongolia. In 2020, they collected and reused 25 million glass bottles from the market(5). So important KPIs of APU will be used in this thesis paper. Also, the ways and methods of collecting glass bottles of APU will be observed and illustrated as a flow diagram too.

However, considering the uniqueness of each country and essential parameters, all the methods of Germany cannot just be copied in the Mongolian situation. So, the following research question is **"What are the suitable methods in the Mongolian case?"** There are many years of experience in Germany. People's behavior, living style or economy of those 2 countries are very different from one another. So based on the literature review, this question will be investigated.

Even though there are suitable methods that can increase the return rate of glass bottles, being financially beneficial is one of the critical factors to consider. A limited number of methods will be calculated and analyzed financially. The last research question is, **"Can it be financially beneficial?".** To analyze the "Net Present Value (NPV) method will be used based on the current glass bottle packaging cash flow of the APU company. Three scenarios will be made; the best, normal, and the worst. In the best scenario, we will assume that the return rate of the glass bottle is high and that the suggested collection method works at its total capacity. In the worst scenario, the return rate is not improved, which means the same as today. In contrast, in the normal scenario, based on the current project of APU to improve the return rate, we use reasonable and optimistic return rate values to calculate NPV.

1.3 Scope and Limitation of the thesis

This paper only focuses on the process of glass bottle collection. It excludes further processes like washing plants, recycling, and importing.

When analyzing the current situation in Mongolia, the data is mainly based on APU because there are a few beverage companies that reuse their glass bottles in Mongolia. The KPI measurements of APU cover all 21 provinces. Since Reusable Package Management is a relatively new department in APU, there are limited data from previous years. Financial analyses of the last part of the paper are done in the frame of Ulaanbaatar, the capital city of Mongolia. When analyzing the current situation in Mongolia, there are still missing gaps in waste management data and updated, relevant information.

The feasibility study of reverse vending machines is done from the perspective of the APU company, not Ulaanbaatar as a whole. It is assumed that the reverse vending machine would only collect APU's produced glass bottles because of the limitation of the data from other companies.

1.4 Definition

1.4.1 Glass

One of the oldest materials is glass, used in many areas like preservation and packaging. Glass is composed of silicates, lime, and soda. It can be defined as a hard, fragile, and usually transparent material. Those raw materials need to be melted at around 1700 °C, and certain additives can be added to change their color and properties. For example, alumina increases the hardness and durability of glass. Lead is added to make the glass clear and shiny. Other metal oxides are mainly used to alter their transparency and color. With those additional chemical products, current glass containers are lighter and stronger. The weight of the glass packaging was decreased by 25-50% over the last 50 years (6).

Among the variety of usage of glass, a wide range of foods and drinks are packed in glass containers and bottles. For example, instant coffee, beer, wine, jams, etc. However, generally, 70% of the glass container are bottles, and 30% of them are jars. In the food industry, around 85% are clear glasses, whereas other industries like pharmaceutical and cosmetics prefer to use opaque or amber glasses. To produce glass bottles, there are mainly four main stages; batch preparation, melting, molding, and annealing (Fig1). During the manufacturing process, 86 million tonnes of carbon dioxide are produced every year globally because of the high melting temperature(7).

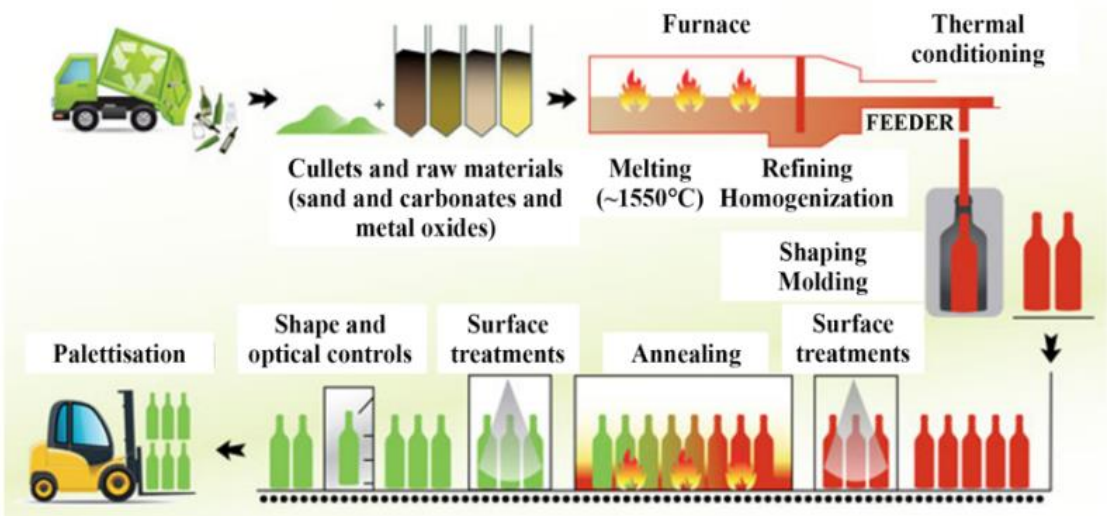

Figure 1. Glass production process.

However, glass packaging has many benefits. It is sustainable, 100% recyclable, reusable, refillable, convenient, and safe to store food and drinks. Since its melting point is so high and inert, glass components do not make chemical reactions with foods or drinks. So it means glass does not change the product's taste, smell, or composition. That is one of the reasons why the glass represents a quality image to the customers.

The result of a survey from the European countries showed that 74% of them prefer to use glass containers rather than other packaging formats(8).

However, as time goes by, glass corrosion can occur in 3 ways(6).

- If the glass is exposed to alkaline compounds, it gradually destroys the silica bonds and forms other bonds. For instance, detergents in dishwashers affect the whitening of the glass surface.
- Leaching can occur from the acid attack on the glass. Acid's hydrogen ions are exchanged with the alkalis or other positive ions.
- Weathering corresponds to very extended storage conditions inducing surface blooming. It makes a milky, hazy, or crystalline residue on the surface of the glass.

1.4.2 Waste

August 1993, wastes are portable objects that the owner has abandoned. In most human activities, waste can not be avoided. There are several types of waste. Municipal solid waste is the waste that is produced from households, offices, hotels, schools, or other institutions. The significant components are paper and paperboard, food, and plastics(9). The waste needs to be disposed of safely for public health and the environment.

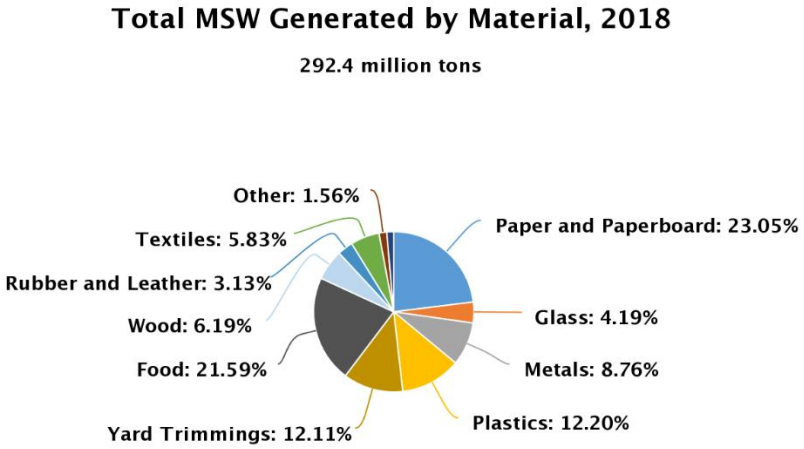

Figure 2.Total MSW generated by material, 2018

1.4.3 Reverse vending machine

A reverse vending machine (RVM) is an automatic machine that accepts recyclable and reusable materials in exchange for a reward. A person can insert an empty glass bottle, plastic bottle, aluminum can, or crate. Then the container is scanned, and the machine identifies the barcode using advanced technology. RVM prints and returns valuable things like coupons, discounts, or charitable donations. Elmer M Jones and Sue Walker

Vance submitted the first patent for an 'Empty Container Return and Handling Machine,' including a coin return mechanism, on September 13, 1920, in America. Then Aage Tveitan designed an advanced ‘Automatic Bottle Return Machine’ in 1962(10). The use of RVM is increasing day by day as waste generation is increasing and there are need to manage waste efficiently in many countries. Customers consume almost 1.4 trillion beverage containers every year, amounting to a massive volume of packaging that can be collected and reused or recycled(11). To address this problem, a reverse vending machine (RVM) concept was used to create an automated recycle bin that has been deployed in several nations on subways, malls, and other public places. Employee work is reduced, saving time and energy while also motivating people. It is also cost-effective (12). In 2018 there were around 40.000 RVM in Germany(13).

There is a variety of RVM depending on its different manufacturers and needs. In general, there are 2 fundamental types of RVMs. "Front-end" type is usually smaller and has limited backroom container handling and storage. Another type is "Backroom" which is a much larger and completely integrated and sophisticated "backroom" capability with compacting(14).

Figure 3. Reverse vending machine and its receipt in Kaufland(Germany)

2 Methodology

This study comprises four steps with a logical sequence that links qualitative and quantitative data to answer research questions. The first step is based on a literature analysis and a document analysis, which are secondary data collections. Other research papers are analyzed to investigate and understand the accomplishments of Germany's glass bottle collection rate. Improvement of glass collection Chanel It is quantitative data.

In the second step, both quantitative and qualitative data are used. To understand the current situation in Mongolia, some relevant companies are interviewed shortly about their collection method. All interviews covered the return rate of their glass bottles, collecting locations, and the amount of money they give back to the consumer bringing back their used bottles. As there is a lack of integrated information from those companies, interviewing increases the study validity. Also, one company's internal data is used for literature analysis. Using this company's monthly quantitative data, the average return rate is determined and becomes the main comparison KPI with Germany. Also, to identify the company's obstacles, the information gained during working in the company is used. Personal experience living in the social environment helped to make a clear picture of consumer behavior towards the glass bottle collection. In order to increase the validity of that information, a literature analysis about the current Mongolian situation of waste management is done.

In the third step, primary data is used to do NPV analysis. Relevant data is sorted and analyzed. Those data were from the last 3 years. Due to the pandemics in 2021, the shipping amount from the companies in some months was much lower than in normal years. Thus data from 2021 is excluded; only shipment and returned number of glass bottles in 2019 and 2022 are included. Based on those data, future cash inflows and outflows are calculated to do Net Present Value. The net present value (NPV) is a calculation used in capital budgeting and investment planning to determine the profitability of a proposed investment or project. The NPV is the outcome of calculations performed to determine the current value of a future stream of payments(15). The payback period analysis is also investigated to reveal the characteristics of different investment scenarios. The payback period is the amount of time it takes to repay an investment's cost or reach the breakeven point for an investor.

$$NPV = -C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + ... + \frac{C_T}{(1+r)^T}$$

$-\ C_0 = Initial\ Investment$
$C = Cash\ Flow$
$r = Discount\ Rate$
$T = Time$

Figure 4.Net Present Value formula(15)

The last step is applying the "WasteAware" benchmark indicators for 2 capital cities of Mongolia and Germany. This approach is an effective tool for communicating problems and informing stakeholders about chances for improvement. The literature analysis method is used in this step. Quantitative indicators include public health collection, environmental controlled disposal, and resource management – reuse, reduce, and recycle (in percentages). In contrast, qualitative indicators include user and provider inclusivity, financial sustainability, and the national policy framework and local institutions. The key benefit is that these indicators have already been used in more than 50 case studies worldwide, making this a valuable model for comparison(16). Finally, the feasibility of German's glass bottle collection method in the Mongolian context is discussed.

3 State of the art

3.1 Introduction to the waste management

The world is meeting many unprecedented challenges due to increasing urbanization and economic growth. The volume of the waste is expected to increase to 2.2 billion tons in 2025, especially in lower-income countries(17). In order to minimize the consequences of waste, waste management is essential in every country. The waste management concept became popular between 1850-1890 because the researchers stated that "The spread of the disease could be controlled by the presence or absence of public health measures(9). If there is a lack of waste management infrastructure, people and waste might mix. It is dangerous not only to the environment but also to human life. For good management, municipal solid waste disposal demands proper environmental monitoring along the waste treatment chain, from garbage collection to final disposal, as well as regular site inspections(18). Improving MSW is one of the most effective methods to improve overall municipal management, and it is often a requirement for other, more complicated municipal services. After the enormous economic growth in Germany around 1970, the first "Waste disposal Act" went through the government. Waste management is not only about law and legislation. The public is the main component of waste management, so public education and bringing the habit among them is crucial in long-term development.

Solid waste management practices are different depending on the country's income level. For instance, the cost of collection accounts for 80 to 90% of the municipal solid waste management budget in low-income countries, and a small proportion of the budget is spent on disposal. In contrast, 50% to 80% in middle-income countries and less than 10% of the municipal solid waste management budget are allocated towards collection in high-income countries.

	Low Income Countries	Lower Mid Inc Countries	Upper Mid Inc Countries	High Income Countries
Income (GNI/capita)	<$876	$876-3,465	$3,466-10,725	>$10,725
Waste Generation (tonnes/capita/yr)	0.22	0.29	0.42	0.78
Collection Efficiency (percent collected)	43%	68%	85%	98%
Cost of Collection and Disposal (US$/tonne)				
Collection[2]	20-50	30-75	40-90	85-250
Sanitary Landfill	10-30	15-40	25-65	40-100
Open Dumping	2-8	3-10	NA	NA
Composting[3]	5-30	10-40	20-75	35-90
Waste -to-Energy Incineration[4]	NA	40-100	60-150	70-200
Anaerobic Digestion[5]	NA	20-80	50-100	65-150

Table 1.Estimated Solid Waste Management Costs(17)

Country Income Group	2010 Cost[6]	2025 Cost
Low Income Countries[7]	$1.5 billion	$7.7 billion
Lower Middle Income Countries[8]	$20.1 billion	$84.1 billion
Upper Middle Income Countries[9]	$24.5 billion	$63.5 billion
High Income Countries[10]	$159.3 billion	$220.2 billion
Total Global Cost (US$)	**$205.4 billion**	**$375 billion**

Table 2.Estimated Solid Waste Management Costs 2010 and 2025(17)

3.1.1 Glass waste management

3R approach includes reduce, reuse and recycle. Integrated solid waste management and 3R approaches have become inseparable concepts. It seeks to reduce the amount of waste that needs to be disposed of while maximizing material and energy recovery from waste. The 3Rs suggest ecological options for dealing with increased waste output and its impact on human health, the economy, and the natural ecology.

Figure 5.The 3Rs logo from Voice of Youth(19)

Thus, the 3R approach should be considered in glass waste management. Glass is one of the most accessible materials to reuse and recycle. Reusing is the second most preferred way to deal with waste (Fig 6). We can reduce the impact of greenhouse emissions by reducing waste in certain ways. If we reuse, there will be a reduction of waste, a decrease in necessary production volume, and a reduction of waste for landfills. However, is it really have less impact on the environment than non-fillable bottles?

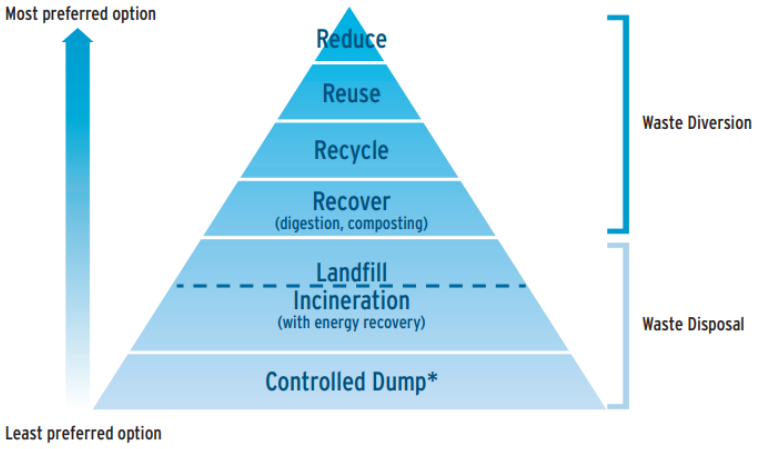

Figure 6. Waste Hierarchy(17)

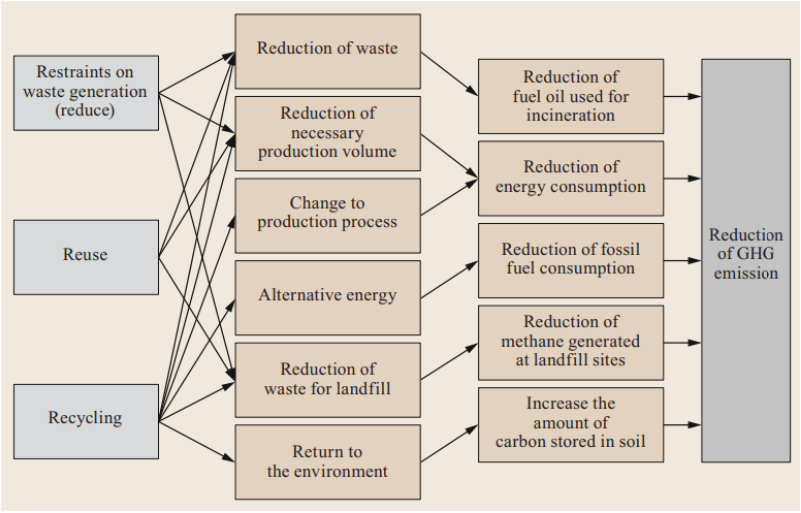

Figure 7. The 3Rs approach and its impact on greenhouse gas emissions (19)

In various industries, refillable bottles can be a viable and sustainable alternative to single-use products. Germany's study in 2010 suggests that reusable glass bottles show good environmental results in the case of local markets within a 100km distance and for at least 25 rotations (20). The study in Portugal did research based on returnable and non-returnable glass bottles. Parameters of the bottle producers are similar, and the study evaluates the impact on the environment of returnable and non-returnable glass bottles. The study shows that returnable bottles might go through an average of six cycles each year before being recycled. As a result, the environmental impacts of bottle manufacturing are lower for returnable bottles after the second reuse. Then as the cycle number increases, the impact of non-returnable bottles is much more than returnable bottles (Fig 8). Thus, in environmental and economical ways, preferable glass waste management is reusing the glass bottles rather than recycling.

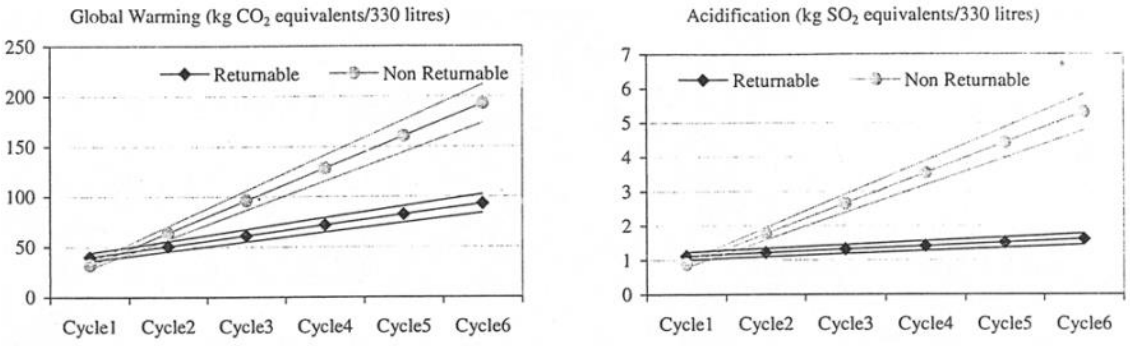

Figure 8. Critical volumes for returnable and non-returnable bottles considering 50% reuse

3.1.2 Waste collection

According to the German Waste Act, all waste disposal should include the treatment, storage, collection, transport, and disposal plan. The waste collection process starts with the filling of containers and finishes with the loading of the collecting vehicles. To do that,

waste must be collectible at the source(9). The amount of material that can be recycled and the quality of secondary materials that can be supplied are both affected by the degree of source separation(17). As stated before, in low-income countries, collection cost is so high that it accounts for around 80% of the total cost of waste disposal. Thus, any improvement in collection implementation and organization is considered as possible saving cost of waste disposal. In addition, the container's type, size, and collection frequency can influence the quality and the amount of separable waste. The following factors should be considered when planning efficient and ideal implementation and organization of waste collection:

- Collection area size
- Economic structure of the area
- Lifestyles of residents
- Zoning laws and ordinance
- User demand
- Choice of appropriate collection system (9)

Also, income level affects the waste collection rate (Fig 9). Low-income countries have low collection rates of roughly 41%, on the other hand, high-income countries have greater collection rates of 98 percent on average. Figure 10 illustrates the efficiency of MSW collection by region. Low collection rates are common in regions with low-income countries. With 65 percent and 46 percent, South Asia and Africa had the lowest rates. OECD countries, predictably, have the highest collecting efficiency, at 98 percent.

Figure 9.Waste Collection Rates by Income(17)

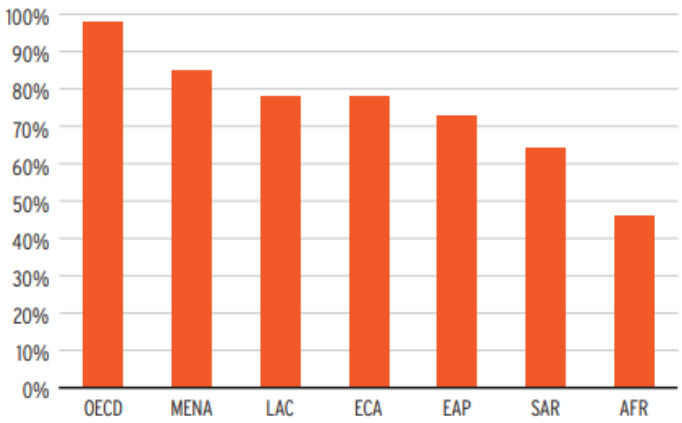

Figure 10.Waste Collection Rates by Region(17)

3.1.3 Collection systems

A waste collection system is a part of the pillar of waste management(21). A collection system is a combination of technology and human labor, specifically:

- Collection method
- Container system
- Vehicle
- Personnel(9)

It is impossible to collect garbage with only one method in a region with a mix of residential, commercial, and industrial development. The collection systems are different in countries(21).

3.1.4 Collection method

1. House-to-house method. Waste collectors go from house to house collecting garbage. This service is usually paid for by the user(17). A dedicated container system makes it easier for the collection people, especially explicitly designed and sized containers for the mechanized top-loaders. Depending on the volume and pick-up location of the waste, different kinds of containers can be used(22).
2. Community bins method. Users deposit their trash in community bins located across a neighborhood or community. MSW is collected on a regular schedule by the municipality or its designate(17).
3. Curbside Pick-Up method. Each household and user is responsible for placing their waste container at the curb on the collection days and returning the emptied container to its storage places. In implementing this process, citizens' behavior and attitude towards the method are essential. Also, the provision of the correct collection scheme design is necessary to make a higher return(17).

4. Drop-off method. Waste generators drop their waste directly to allocated drop points. It can also be considered a self-delivered method. There are 2 kinds of categories; drop-off centers and drop-off sites. Drop-off site means residents bring their separated wastes to containers in the neighborhood. In drop-off centers, people bring their wastes to containers at recycling centers. In this method, the ease of accessibility and convenience is an influencing factors to encourage the public to bring their waste. Also, the manufacturers should ensure the aspects of sustainability before implementing the drop-off method(17).
5. Contracted or Delegated service method. Municipalities often license private operators, and collecting regions may be designated to enhance collection efficiency(17).

In some countries, the curbside pick-up method shows better results than the drop-off method. In contrast, the drop-off method shows better financial and environmental results than other methods. However, a combination of the collection methods shows better achievements than using one method.

3.2 Germany

The beginning of the German's experience of collecting back their glass bottle was started in the 18th century. Consequently, they have an abundance of experience and history. Before introducing the well-defined law and legislation, there was a voluntary glass bottle giving back and collecting back operation system in Germany. Nowadays, sorting their waste and bringing reusable packages have become part of their culture(23).

Customers give their glass bottles in 2 different ways, which are thrown in the glass bottle bins and brought to the return machine. Glass is usually separated into three different bins, which are white, green, and brown. Those bins are for non-returnable glass bottles. After that, broken glasses go to the recycling center and are recycled. Whereas returnable glasses should be returned to the return machines. Both of those collections are passive. Residents must bring their trash to central collection points in the passive option.

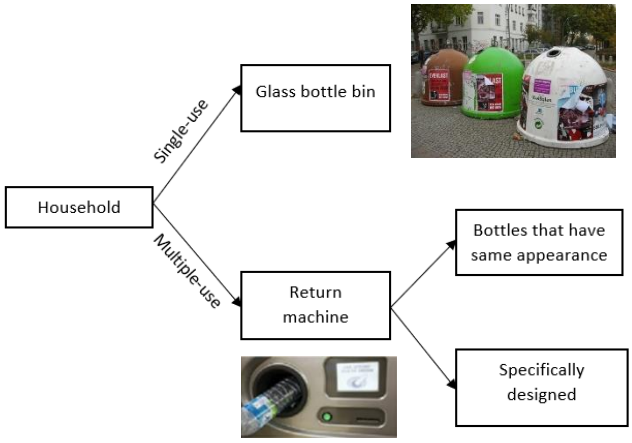

Figure 11.Glass bottle returning scheme in Germany

Mainly there are two types of refillable bottles. One is the bottles that have been made in the same type, shape, and size. It is the more convenient design from an economic and environmental point of view. This is because, when different companies use the same packing design without distinctions, collected glass bottles go to the nearest manufacturing plants. The second type is the bottles that have been specifically designed. They have to return to the specific production site. The transportation cost of those glass bottles is higher, and it is also difficult for the distributor to ensure a reasonable distance between the vending machine and the production site(23).

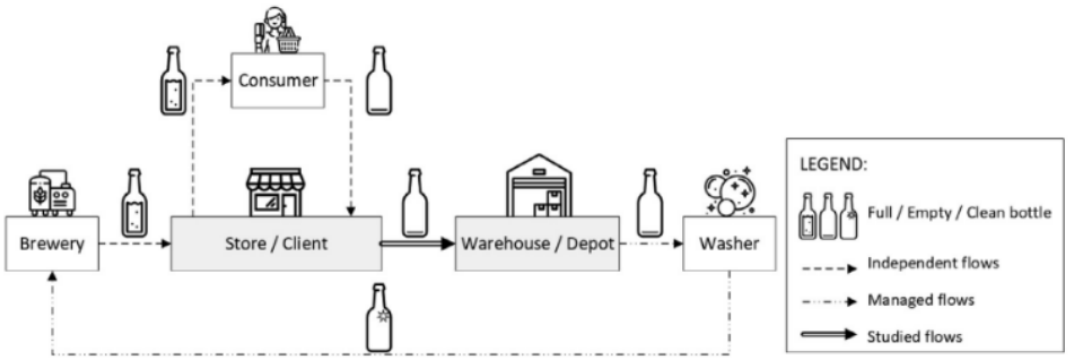

Figure 12. Simplified logistic network for reusable glass bottles(24)

3.2.1 Deposit return system

To encourage a circular economy[1], deposit return system was legislated in Germany first in 2003(23). This system is known as the "Pfand system" in Germany. When you buy a specific product like a beer or juice, you automatically pay the original product's price and deposit. Then after you drink the product, you can bring them to the vending machine and take back your deposits.

[1] The circular economy keeps resources like products, materials, and energy in the economic system for as long as possible and at the “highest value” possible.

However, the origin of returning reusable packaging started in the 1700s in Germany and Europe. In Germany, it started with mineral water, and consumption of glass bottle packing increased even during the second world war(25). In 1799, A & R Thwaites & Co advertised "Two shillings per dozen allowed for returned bottles," and just after, Schweppes introduced their returnable deposit without any legislation. Eventually, the glass packaging design evolved over time to become smaller, lighter, and standardized based on public opinions(26). Thus, the habit of returning the package is not just because of the sudden law and legislation but more like the process of long-term improvement. As Institute for Waste, Wastewater, and Infrastructure Management GmbH states, there are three pillars in developing a sustainable solid system.

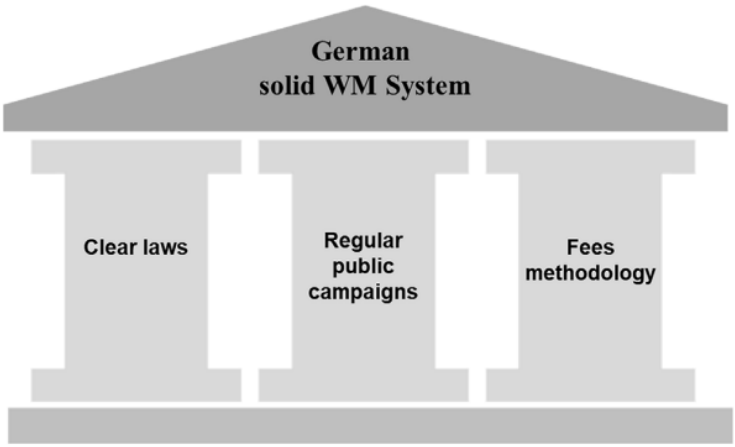

Figure 13.Pillars of the German UHSWM system(27)

In 1991, the German Packaging Ordinance, which was the first prevention and recycling of packaging waste regulation, was approved by the German parliament. It aims to reduce and avoid the environmental impacts of waste arising from packaging. It states that manufacturers are responsible for their packaging and integrate disposal costs into the product price. This led to the “The Green Dot” (Der Grüne Punkt). It was an opportunity to decrease manufacturers burden of recovering their own packaging. This is a nation-wide system for the collection and recycling. The new system has a specific logo and companies who joined them should the logo. The basic idea of Green Dot system is when consumer see the product with the logo, they know that they should separate the product to the household waste or in the containers in public places and the manufacturers should pay a license fee which varies depending on the weight, type and the volume.

In 1990, Duales System Deutschland(DSD) GmbH was founded as a non-profit organization. The recycling system is entirely supported by industry. The selective

collection and sorting of packaging waste is not financed with public funds. Until 2004, DSD coordinated package waste collection with local governments around the country and was in charge of all sales packaging sorting and recovery. DSD has been engaging private and municipal solid waste management companies to carry out this task. DSD was privatized in 2004 after the market was liberalized. In 2007, DSD used to issue customers with 74 euro per ton for glass packaging. All expenses and responsibilities for packaging waste management were passed to industry in Germany(28).

In 1997, reusable packaging quota didn't meet the legally determined percentage which was 72% and it continued to decrease(29). In 2003, a mandatory deposit was imposed on disposable drinking packages. But the legislation excluded those types of non-fillable packages such as carton packaging, polyethylene bags and stand-up bags.

To prevent fraud, companies should to apply first. Manufacturers, importers and their product need to be clearly identified. They should get an identification for themselves and their products. Once they are registered, they have access to all other system partners like RVM manufacturers, sorting plants, user special ink and clearing service providers. Packages should be labeled clearly and securely using special safety ink. That ink only be used in certain selected printing places so that RVM can read. Then using specific bar code and identification number of each manufacturer and importer, retailers requests the deposit invoice from the first distributer. Once the first distributer checks and confirms, they send the deposit amount to the refund claimant(30).

3.2.2 Conflicts of legislation

After the German Packaging Ordinance, most of the companies participated in the "The Green Dot" system, but some of the companies refused to purchase the logo. At that time, there were no controlling and monitoring to those companies and they were decreasing the rate of the return". Thus in 2003, it became mandatory to companies to participate in the "The Green Dot system". Not just Germany, the system achieved great success and 20 countries have implemented the system and more than 95000 licensees use the trade logo which is widely known in Europe now(31).

At the beginning of the legislation of 2003, people were asked to bring their bottle to the store they bought from. It was not appreciated by the customers(23). Then from May 1, 2006, the new "third ordinance to amend the packaging ordinance" was approved. The new ordinance required shops to take every bottle even though they don't sell. However, this was unfair to other small stores, because they have to give the deposit money from themselves to the customer and pay disposal and transport cost. So, there is $200m^2$ rule. The shops, which have less than $200m^2$ of retail space, don't take back reusable bottles.

That's why small beverage retailers like Aldi or Lidl in Germany only take back disposable bottles(32).

3.2.3 Steps and campaigns to encourage the public

One of the German's important pillar of the good waste management system is regular public campaigns. After and before the legislation, there were many programs to give educational knowledge about the reusable bottles and campaigns to boost the public to give back their used glass bottles.

After disposable packaging deposit system, some people had a struggle to differentiate the characteristic of the one-way and reusable bottles. So, a campaign to clarify the difference between those two types of glass bottles was needed at that time. Using the standardized and official labels on the bottles were the main tool differentiate. In addition, the government of Germany encourages people to use reusable glass bottles rather than disposable bottle. It was claimed that, if people know the benefit of the glass bottle and can separate the glass bottles easily, the public tend to buy reusable glass bottles(4). Also, in order to enhance the reusable bottles quota, the deposit amount of the bottles are different. Reusable glass bottles have lower deposit amount than one-way packages. It creates a change in buying behavior among the costumers and helped to make habit.

Figure 14.Reusable glass bottle label

Figure 15. One-way bottle label

Bottle	Deposit amount
Reusable glass beer bottle	8 cents
Reusable beer bottle with swing top	15 cents
Reusable mineral water bottle	15 cents
Some 1.0 liter wine bottles	2 or 3 cents
All disposable bottles and cans	25 cents

Table 3.Deposit amount in Germany

There is "Deposit Belongs Next to it" (PFAND GEHÖRT DANEBEN) campaign to encourage people to leave the bottles close to the bins. In Germany, it is common to see people drinking a beer in the street and also the people who are collecting the bottles. People who are drinking in the street usually throw away their bottles inside the bins and glass broke down easily. Since it is hard to know what is inside the bins, glass collecting people might hurt their hands, and it increases the probability of the glass to be refilled again. Using the campaign, people get the feeling that it is bad to just throw the bottle away in the bins in many ways and spread the information which is "Returnable bottles do not belong in public garbage cans, but next to them!" This campaign had numerous partners like Fritz-kola and other soft drink companies in Germany(33).

Another successful campaign was “Give the Deposit” (Pfandgeben). Firstly, it was developed by the students in 2011, and it expanded to nationwide platform. The principle is very simple. There are some private individuals and companies who don't want to return the glass bottles to vending machines or have willing to donate their deposits. Using an application or a telephone, they connected those people with glass collecting people. People just give the information about the location and time and people go there and pick them up. It is beneficial to both sides(34).

There is “Donate Your Deposit” (Spende dein Pfand) nation-wide campaign in Germany. It was initiated in 2014. There are small boxes next to the return vending machine, and people who have deposit receipts can donate in the boxes. Then the cumulated deposits are donated to the different projects, companies or charities for educational, environmental, or youth initiative activities. Its primary purpose is to show that anyone can easily do good in society(35).

Freiburg

Freiburg city in Germany is one example showing that waste sorting and waste management were already developed well in Germany before implementation well-regulated laws. Data from 1997 provides that Freiburg citizens first sort based on their compositions and then categorize them into 7 containers, including glass packaging. Glass bottle is 10.40% of household waste in Freiburg, and they successfully give back all the bottles. As the paper stated, local government care and regulations pushed to

become an environmentally friendly city. Even though Freiburg has only 200.000 citizens, 383 bring-sites were placed to collect glass bottles which means 1 collecting point for 522 residents. Also, in their educational programs in schools, a program about waste management and sorting waste was included(36).

3.2.4 Consumer behavior

Waste has to be separated was well developed in Germany. It made it easier to collect reusable glass bottles from the consumers after the implementation of the deposit return system because of the habits they had. Drop-off site collection method is the main method to collect glass bottles in Germany. However, to that, glass bottle waste needs to be separated. Participation of consumers is the main factor of the method since consumers sort the waste manually and bring it to the collection points(37).

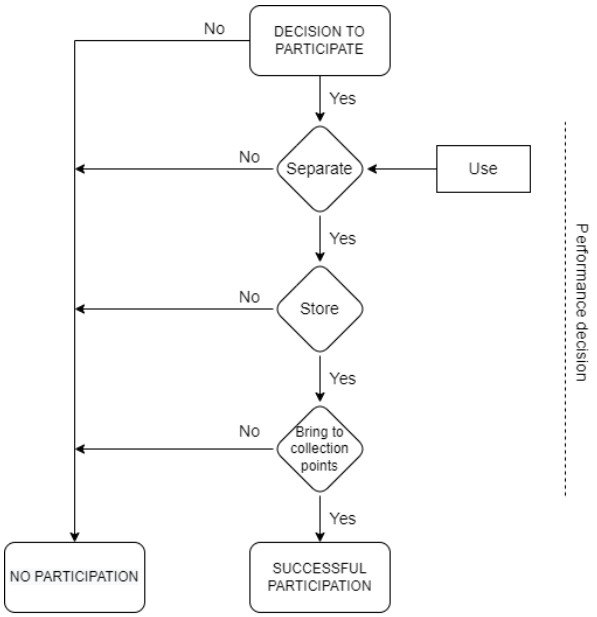

Figure 16. The consumer task in a glass bottle collection

According to the Reasoned action model, if there is enough willingness and intention to do certain tasks, consumers perform(38). There are 2 phases to change behavior; goal setting and goal striving(Fig 17). The necessity of achieving the goal is important during the goal-setting process. Consumers shift to the goal-striving phase after setting a goal, where the achieving the goal and the difficulty of completing the task at hand become increasingly relevant.

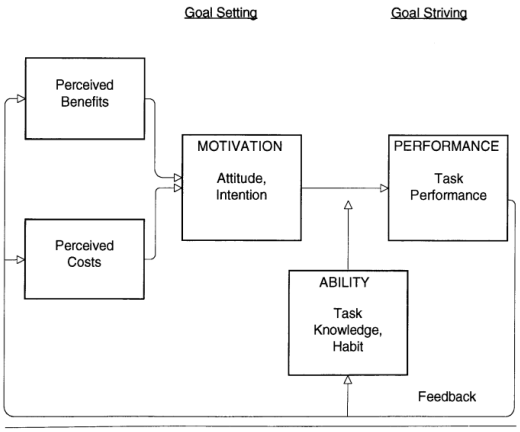

Figure 17. Factors Determining Task Performance in Waste Separation(37)

As described in Fig 17, task knowledge and habit are important ability factors. A person who wants to engage in a waste separation program but doesn't know how or has a poor understanding of the rules will not be able to do so successfully. When the new method of collecting is introduced, the force of old habits is strong and may fall back into the old patterns. The study shows that future behavior was influenced by the trash separation program based on the new habit of the residents(37). Costs mean how much money, time, and physical and mental effort consumers are showing to complete the task. Benefits refer to expected or experienced good consequences by doing the tasks. The benefit of collecting glass bottles, eventually arise society as a whole.

In Germany, citizen's motivation to participate in a waste separation program at the beginning was very high. A survey from Göttingen and Heidelberg in 1986 shows that 84% and 92% of the consumers in the survey liked the waste separation program before it started. On the other hand, some cities in the Netherlands, the motivation of the separation program was low because the cost of bringing several kinds of waste to the neighborhood contains was too high for some people. Also, when consumers assumed and were informed that separating waste was not treated efficiently and environmentally, the consumers discontinued to participate.

But, despite an overall good incentive to engage, 22% of customers in Göttingen, Germany, thought that the extra task of rubbish separation was 'sometimes' or 'always' unpleasant. The storage system, in particular, may have an impact on the expenses of participation. Prior to the launch of the program in Gottingen, 25% of customers anticipated that they would have difficulty obtaining space for the containers. Following the start of the program, 22% is lowered to 13% once they actually experienced. In Alzey-Worms, 24% of customers struggled to find space for the two containers(37).

For the successful sorted and collected waste management, waste removal procedure was important in Germany too. Because of the odor, weight and space, frequency of

waste transportation was important factors in Göttingen and Heidelberg. During the time Germans were also made containers more convenient for everybody (Fig 18).

Figure 18. Advertisement of lighter container bin(39)

Another factor that makes sorting and collecting more inefficient is separating and drop-off waste incorrectly due to the lack of knowledge. Consumers in Groningen were asked if they knew how to separate their garbage before and after the start of the waste separation program. Before the experiment, 76 percent of consumers (N=283) said they did not know how to separate all or most rubbish products. Only 13% of participants had such a lack of understanding a few weeks after the program began. Other cities had the same results too(37). High motivation does not lead to high-quality performance when actual task knowledge is significantly lower than perceived task knowledge.

After the initial phase, advertising and promotional strategies could be utilized to maintain the right performance. The goal is to maintain satisfactory performance based on a good motivation (attitude). Information feedback and inducements will be effective, especially in the early stages of the program. Participants in Amersfoort and Woerden got fliers on a regular basis detailing how much waste had already been separated and which specific waste items they should pay special attention to(37).

Consumer research before and throughout a waste separation program gives information regarding the motivation, ability, and actual performance of consumers when the program represents a significant change from existing garbage disposal habits. This type of data reveals the program's success and areas for improvement. Political debates and publicity surrounding have increased the public awareness (40).

3.3 Current situation in Mongolia

3.3.1 Market of glass bottled products

Mongolian population is around 3.360.000 and almost half of them live in the capital city Ulaanbaatar. In 2020, the market of the vodka was 24 million liter, beer's market size was 94 million liter, and wine's market was 2 million liter (41). Most of those product use glass bottles. But not all production companies reuse their glass bottles, because they don't have washing plants. Even though some companies collect their bottles from the customers to reuse their glass bottles, the collection points are limited, and people lack valid information about their collection points. Some companies:

Company	Deposit refund/₮	Collecting points	Glass product type
Ulemj Organic Co. Ltd	100-400	Total 36 shops in Ulaanbaatar	Yoghurt and dairy products
Gazar shim	70-350	2 collecting points	Preserved salad, compote and pickle
Gem International	100-200	2 collecting points	Vodka, beer, water
Arvain Undes	100-600	1 collecting points	Vodka
APU JSC	100-400	Small shops	Vodka and beer

In addition to the companies' collection points, there are several secondary raw material collection centers. They buy glass bottles from the customer and sell them back to the companies with additional fees. Among those companies, APU JSC is the oldest and the biggest beverage company in Mongolia.

3.3.2 APU JSC

APU was established in early 1924. APU Group consists of 6 companies such as APU JSC, APU TRADING, MBC AP LLC, SBB TRADE LLC, SBB LLC, and APU DAIRY LLC. Now APU produces 76.3% of the total vodka consumption of Mongolia. They produced 303 types of products (SKU), including dairy, soft drink, vodka, beer, wine, and other imported products in 2020. 23 of them are reusable glass bottles and in 2020 they collected 25 million glass bottles from the market all over the countries using around 3000 collection centers (5). 8 of the SKUs are beer bottles and the rest 15 are vodka bottle. Size of the beers are 0.33 l, 0.45 l, and 0.5 l. The vodka's bottle sizes are 0.2

l,0.35 l, 0.5 l, 0.75 l and 1 l. Mainly APU distribute their products by 2 channels; On-trade and off-trade channels. On-trade channel means distributing the product to places with direct consumption like bars, restaurants, or hotels. Off-trade channel includes all retail outlets like supermarkets, mini markets, and convenience store. Also, they distribute their products to the regional channel.

Figure 19. APU beer data of 2020

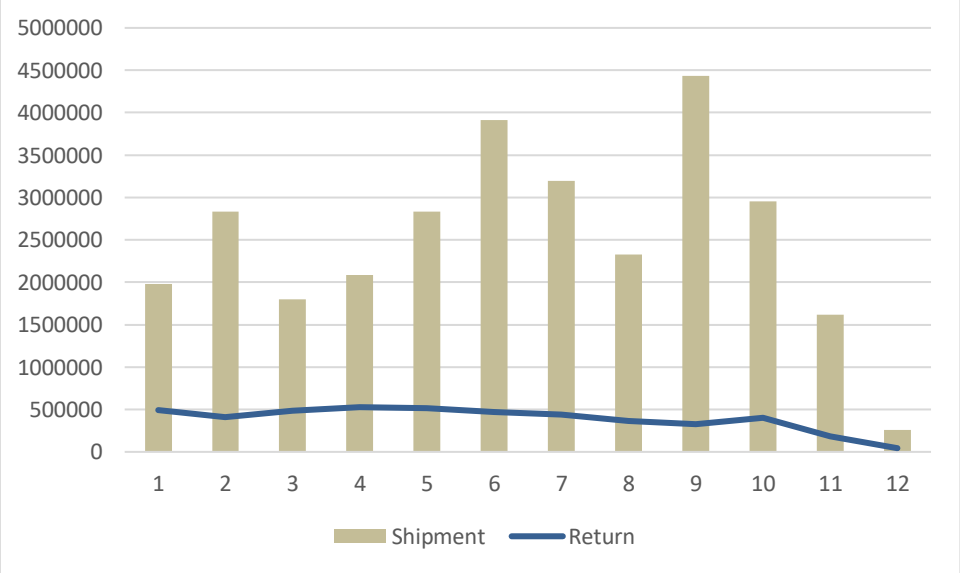

Figure 20. APU vodka data of 2020

As you can see from the graphs return rate of the beer bottle is much higher than vodka return rate. You can see the relationship between shipment and returned glass bottle numbers on beer data. As the number of shipments increases, the returned number increases too. However, there is almost no change in vodka bottle return in all months.

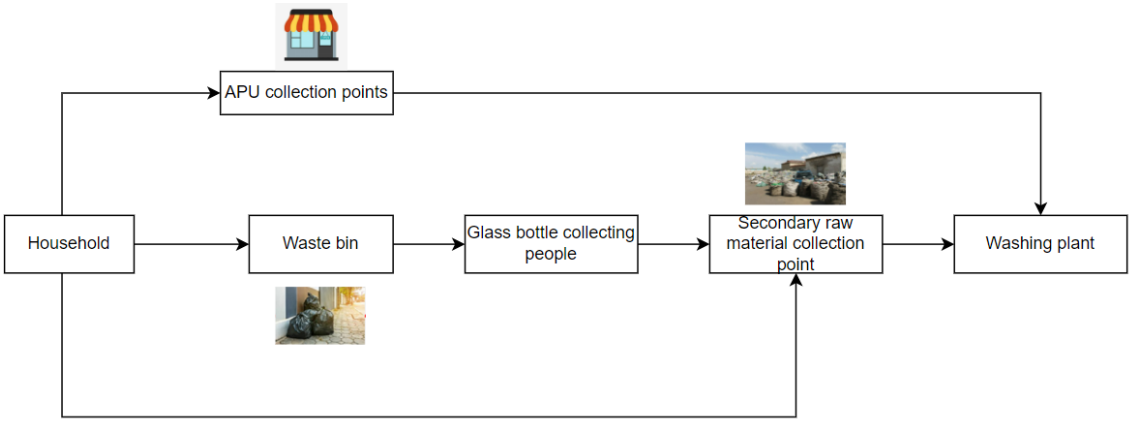

Figure 21. APU glass bottle collection channel flow chart

Consumers in Mongolia have 3 possible ways to dispose of their used glass bottles. Certain small stores have a contract with APU and buy glass bottles from the consumers. Then APU workers come and get the cumulated amount of glass bottles. Some people in Mongolia collect their glass bottles and deliver them by themselves to the secondary raw material collection points. Depending on the number of glass bottles, the buying price is different. Also, households dispose of not separated waste with their used glass bottles. In some cases, people who collect plastics or glass bottles collect from their wastes and bring it to the secondary raw material collection points.

To know the costumer's behavior towards the reusable glass bottle and its collection, the survey was conducted by the APU project team. The result shows that 64% of the participates direct throw away their used glass bottles. 40.3% of the participates don't receive sufficient knowledge and information about reusing and recycling and 38.3% of them are informed by social media. However, as age increases, information access is limited. The main reasons why they don't bring their used glass bottles to the collection points:

- Collection points are far from the home. It is not easy to carry collected glass bottle due to its glass weight and volume. Also consumers think it is time consuming to bring their bottles.
- Fee is not high enough.
- Secondary raw material collection points are dirty and smelly.
- There are no room for collecting glass bottles and it is smelly because they contain residual alcohols.
- People don't know where to bring their glass bottles. They don't get enough information about reusing and collecting.

4 Analysis and Result

4.1 NPV calculation

Based on the collection methods in Germany, the drop-off method is the main tool, and using a reverse vending machine; the return rate is increased rapidly. So in this section, to make the investment profitable to APU company, the optimal return rate is calculated using Net Present Value in 5 year period. 3 kinds of return rate scenarios are concerned in this analysis. The scenario only includes the area of Ulaanbaatar city.

4.1.1 Initial investment

In total, there are 156 sub-districts (khoroo) in Ulaanbaatar's 6 districts, excluding the remote 3 districts(42). At first, I consider placing 100 reverse vending machines (RVM) in 100 sub-districts because some sub-districts are too far from the washing plant of APU and challenging to collect. INCOM-TOMRA company's H-11 product was suitable for our application (Appendix A). This company is located in China, so the transportation cost is much lower than other countries' transportation to Mongolia. Also, TOMRA is well known Norwegian RVM manufacturing company(43). The main reason to choose the H-11 is that this model has a soft-drop system for glass bottles and is easy to install.

Initial Investment

1	Total cost of RVM	$	475,000
	Number of RVM		100
	Cost of RVM	$	4,750
2	Shipment cost	$	18,000
3	Total installation cost	$	7,200
4	Unpredictable expense	$	50,020
5	Advertisement	$	166,667
6	Customs tax	$	23,750
7	Value added tax	$	47,500
	TOTAL	**$**	**788,137**

Table 4. Initial investment

Shipment cost

Shipment cost is calculated as one 20FT container costs $1500 to Mongolia from Shenzhen where is the manufacturing location of TOMRA(44). Then approximately 12 containers are needed to transport 100 RVM.

Installation cost

Installation cost includes salary, transportation, hotel and food expenses of workers who will install the machines in Ulaanbaatar. To install 100 RVMs, approximately 4 workers are needed from the TOMRA company.

Costs	Days	Price	Number of workers	Total
Hotel	7	80	4	2240
Food	7	20	4	560
Air ticket	2	200	4	1600
Wage	7	100	4	2800

Table 5. Workers' installation expense

Unpredictable expense

The cost is for anticipating the unexpected costs that might occur to prevent a business downfall. The unpredictable cost covers 10% of total CAPEX. For instance, breakdowns are a common problem for many firms. The unpredictable cost will cover maintaining the quality of the operations or replacing old equipment.

Advertisement

In the first phase of this investment, it is important to spread the information about those machines. Encouraging people to bring the bottles and informing the locations of the machines should be done immediately because it is new technology and method to collect bottles from the public in Mongolia. Initially, this cost would be around 500 million tugrik which is 166.7 thousand in dollars.

Taxes

When importing machines from China, there are 2 kinds of taxes should be paid. VAT at the rate of 10% is imposed on the supply of goods, services, and works imported, exported, and sold in Mongolia(45). Also the customs duty tariff of electrical machinery is 5%(46).

4.1.2 Cash inflow

In the calculation, cash inflow is saving by implementing RMV. Importing new bottles costs higher than reusing the glass bottles again (Appendix B). By improving the beer and vodka glass bottle's return rate, the company's income can increase. 3 scenarios are considered:

1. The worst-case scenario: No increase in both beer and vodka glass bottle return rate.
2. The normal case scenario: both beer and vodka glass bottle return rate are increased by 3-5% from the current situation.
3. The best-case scenario: both beer and vodka glass bottle return rate are increased by 8-15% from the current situation. This amount is almost the maximum capacity of the total 100 RVM collected in a year. In a day, one RVM can collect and store 320 glass bottles.

The worst-case scenario

There will be no cash inflow if there is no increase in the return rate. So, in this case cash inflow is equal to zero.

Normal case scenario

Cash Inflow		
Beer bottle saving	$	90,744
Beer bottle cash outflow after	$	3,257,653
Beer bottle cash outflow before	$	3,348,398
Vodka bottle saving	$	159,454
vodka bottle cash outflow after	$	6,243,587
vodka bottle cash outflow before	$	6,403,041
TOTAL	**$**	**250,198**

Table 6. Cash inflow in normal case scenario

The best-case scenario

Cash Inflow		
Beer bottle saving	$	241,985
Beer bottle cash outflow after	$	3,106,413
Beer bottle cash outflow before	$	3,348,398
Vodka bottle saving	$	239,181
vodka bottle cash outflow after	$	6,163,860
vodka bottle cash outflow before	$	6,403,041
TOTAL	**$**	**481,166**

Table 7. Cash inflow in best-case scenario

Beer and vodka bottle cash outflow is the current price that APU company pays for glass bottles in a year. It includes both collected bottles and imported bottles. Beer and vodka bottle cash outflow after is the price that the company would pay when there is a certain

increase in return rates. So, if the return rate increases, the amount of importing glass bottles decreases.

4.1.3 Cash outflow

Additional cost to operate RVM is considered as a cash outflow in this analysis. All current workers will work in the future. This assumption is made to calculate the additional cost.

Cash Outflow		
Operating cashflow	$	128,417
Additional labor cost	$	20,000
Transporation cost	$	30,417
Maintenance expense	$	38,000
Rent	$	40,000
Tax	$	-
TOTAL	**$**	**128,417**

Table 8. Cash outflow in worst-case scenario

Cash Outflow		
Operating cashflow	$	153,436
Additional labor cost	$	20,000
Transporation cost	$	30,417
Maintenance expense	$	38,000
Rent	$	40,000
Tax	$	25,020
TOTAL	**$**	**153,436**

Table 9. Cash outflow in normal case scenario

Cash Outflow		
Operating cashflow	$	176,533
Additional labor cost	$	20,000
Transporation cost	$	30,417
Maintenance expense	$	38,000
Rent	$	40,000
Tax	$	48,117
TOTAL	**$**	**176,533**

Table 10. Cash outflow in best-case scenario

Additional labor cost

Container size of RVM is about 1m:1m:1m and the normal truck size to collect the collected glass bottles from RVM is 6m:2,4m:2,4m. 24 containers are able to fit in one truck. So, 5 trucks and 5 additional workers are needed to pick up all 100 containers in one day. I assumed that each driver's salary is 1million tugrik in a month.

Transportation cost

In this cost, each 5 truck's fuel cost is considered. Some RVM's location is far from the APU's washing plant, so fuel cost needs are added, which is 50,000 tugrik for each truck in a day.

Maintenance cost

Any cost made by an individual or corporation to keep their assets in excellent operating order is referred to as a maintenance expense. RVM needs maintenance too, because this machine makes direct contact with the consumers and the container inside it. As the machine manufacturer said, it costs $380 a year for one machine.

Rent

The RVM needs to be placed inside, not outside. So, it is convenient to make a contract with supermarkets and pay the rent. Hence the size of the machine is not so spacious, renting can be easily negotiated with supermarkets. Including the electrical cost, the rent is approximately 150,000 tugrik each month.

Tax

Value-added tax should be examined in this analysis. Value-added tax is a consumption tax on goods and services levied at each stage of the supply chain where value is added, from initial production to the point of sale. Current tax on glass bottles will be changed if the number of purchasing bottles changes. In Mongolia, VAT is 10%. In each scenario, 10% of the reduced price of glass bottles is added to the total tax payment of the company.

4.1.4 Discount rate

The discount rate can reflect the minimum rate of return to justify undertaking the project. Thus, Mongolian banks' interest rates, inflation (CPI period average), and bond interests were concerned. Saving in the banks is the least risky way, and interest rate is 9%. Other bonds' interest rate is approximately 15-17% per year. Mongolian inflation rate 2022(March) is 14.4%. According to the world bank's 2022 April report, Mongolian inflation rate in 2022 would be 10.5% and it is predicted to decrease to 6.8% in 2024(47).

If we assume the company would invest in a safe alternative venture which is bonds in this case, the rate of return would be 15% in minimum.

4.1.5 NPV result

The worst-case scenario

If there is no improvement in return rate, the investment is not profitable. Even though the time period increases, the result of NPV calculation is decreasing. So, if there is no expectation in increasing return rate, this investment is not profitable.

Period	Cash flow	NPV
0	$ (788,136.67)	$ (788,136.67)
1	$ (128,416.67)	$ (899,803.33)
2	$ (128,416.67)	$ (996,904.78)
3	$ (128,416.67)	$ (1,081,340.83)
4	$ (128,416.67)	$ (1,154,763.47)
5	$ (128,416.67)	$ (1,218,609.25)

Table 11. NPV in the worst-case scenario

Normal case scenario

If the return rate is increased by 3-5%, investment in RVM is not profitable in 5 years. Cash flow will be increased to $96,762, however, NPV is less than zero after 5 years. Thus, the payback period is calculated based on this scenario in the next calculation.

Period	Cash flow	NPV
0	$ (788,136.67)	$(788,136.67)
1	$ 96,762	$(703,996.05)
2	$ 96,762	$(630,830.29)
3	$ 96,762	$(567,207.89)
4	$ 96,762	$(511,884.07)
5	$ 96,762	$(463,776.39)

Table 12. NPV in normal case scenario

The best-case scenario

In the best-case scenario, the investment is profitable because NPV is more than zero. Between 3rd and 4th year, NPV starts to give positive value.

Period	Cash flow	NPV
0	$ (788,136.67)	$ (788,136.67)
1	$ 304,632	$ (523,238.96)
2	$ 304,632	$ (292,893.12)
3	$ 304,632	$ (92,592.39)
4	$ 304,632	$ 81,582.15
5	$ 304,632	$ 233,038.28

Table 13. NPV in the worst-case scenario

4.2 Payback period in normal case scenario

Even though cash flow is below zero, the investment is nonprofitable in 5 years. Thus further calculation is done to know how long it takes for the company to recoup an investment. It takes 8.14 years which is 8 years and 2 months.

Year	0	1	2	3	4	5
Net income	$(788,136.67)	$(691,374.95)	$(594,613.24)	$(497,851.52)	$(401,089.81)	$(304,328.09)
	Year	6	7	8	9	10
	Net income	$(207,566.38)	$(110,804.66)	$ (14,042.95)	$ 82,718.76	$ 179,480.48

Table 14. Payback period calculation

4.3 City comparison

To have a clearer understanding of the differences between Germany and Mongolian current situation on waste management performance, the “WasteAware” benchmark indicator tool is used. Both German’s and Mongolia’s capital cities are compared (Table 15). Berlin and Ulaanbaatar's production waste per capita is similar. In contrast, there are gaps in the main benchmark indicators. In Berlin’s case, almost all indicators are high.

Ulaanbaatar’s results for benchmark indicators show that (1.1) Waste collection coverage and (2) Controlled treatment and disposal are the highest performing indicators. However, the “quality” indicators for Public health (1C) and Environmental control (2E) indicate that there is a need for improvement. All the governance factor indicators reveal medium quality. The lowest scoring indicators are (3) Recycling rate and (3R) Quality of 3Rs provision. Especially the recycling rate is so low, which is less than 5.5%.

№	Category	Indicator	Berlin			Ulaanbaatar		
B1	Country income level	World Bank income category	high			lower-middle		
		GNI per capita	$ 46,990			$ 3,670		
B2	Population	Total population of the city	3,769,495			1,615,000		
B3	Waste generation	Total household SW generation (tonnes/year)	1,341,515			522,000		
Key Waste-related data		**Data**	**Result**			**Result**		
W1	Waste per capita	MSW/capita (kg/year)	394.5			408		
		MSW/capita (kg/day)	1.08			1.12		
W2	Waste composition	Summary composition of MSW for 3 key fractions - all as % wt. of total waste generated						
W2.1	Organics	Organics	24%			33.7%		
W2.2	Paper	Paper	17%			7.7%		
W2.3	Plastics	Plastics	7%			14%		
W2.4	Glass	Glass	14%			29%		
Physical Components		**Benchmark Indicator**			**Code**			**Code**
1	Public health-Waste collection	1.1 Waste collection coverage	100% (H)			92.5% (M/H)		
		1.2 Waste captured by the system	100% (H)			85% (M)		
1C		Quality of waste collection service	100% (H)			50% (M)		
2	Environmental control – waste treatment and disposal	Controlled treatment and disposal	100% (H)			100% (H)		
2E		Quality of environmental protection in waste treatment and disposal	100% (H)			50% (M)		
3	Resource Value – 3Rs: Reduce, Reuse, Recycle	Recycling rate	85% (M)			>5.5% (L)		
3R		Quality of 3Rs—Reduce, reuse, recycle— provision	96%(H)			21% (L/M)		
Governance Factor		**Benchmark Indicator**			**Code**			**Code**
4U	Inclusivity	User inclusivity	95% (H)			54% (M)		
4P		Provider inclusivity	100% (H)			55% (M)		
5F	Financial sustainability	Financial sustainability	N/A			46% (M)		
6N	Sound institutions, proactive policies	Adequacy of national SWM framework	95% (H)			46% (M)		
6L		Local institutional policies	100% (H)			58% (M)		

Key for abbreviations:

- B- Background information
- W – Waste Information
- 1 C– Public Health.
- 2 E– Environmental Control
- 3 R– Resource Mgmt.
- 4U- User inclusivity
- 4P – Provider inclusivity
- 5F – Financial sustainability
- 6N – National Framework
- 6L – Local institutions.

Table 15. "WasteAware" benchmark indicators for Berlin and Ulaanbaatar(48),(27),(49)

5 Discussion

NPV analysis shows that to implement the deposit return system and locate Reverse Vending Machines in Ulaanbaatar, the return rate should be increased to generate profit in 5 years. In a normal case scenario, I assumed that APU's return rate for a beer bottle is increased by 3%, and the vodka bottle return rate is increased by 10% based on the current situation data. However, this improved rate is not enough to make a profit. From 8 years and 2 months since its first investment, the company's investment becomes profitable in this scenario. Hence, the following scenario is considered. If the rate of a beer bottle increases by 8% and the vodka bottle return rate increases by 15%, APU can decrease the cost of their glass bottles significantly. By decreasing the number of glass bottles' cash outflow, they are able to increase their net profit from selling. Based on the experience in Germany, drop-off collection method using a RVM is the successful influencing factor in increasing the glass bottle return rate in Germany. However, the problem is that there is no guarantee that there would be 8-15% return rate increase by applying the new collection system in Mongolia. There is a lack of research and experience in waste management in Mongolia.

"WasteAware" benchmark indicators reveal certain gaps between Germany and Mongolia. Germany is a highly developed and high-income country, as well as some benchmark indicators, are much higher than Mongolian indicators. From the analysis, 1.12kg per capita per day (W1) is categorized as a "higher waste generating" city(16). This means waste generation needs to be reduced with the help of reusing the waste. The glass bottle production (W2.4) is significantly higher, but the recycling rate is very low. So, if there are certain improvements in the glass collection system, there is a sufficient glass bottle that can be reused. Quality service provision (1C) should be extended, mainly in ger district areas, waste collection quality and system are poor. User inclusivity (4U) is an essential aspect of the system, and programs aimed at changing behavior and boosting awareness should be developed. Regarding provider inclusivity (4P), the balance of both the public and private sectors' participation should be identified clearly in the legal framework. At last, the sound of institutions and proactive policies (6N, 6L) is limited due to the government's lack of knowledge and active actions about reusable glass bottles.

Due to the lack of systematic policies and methods for collecting glass bottles, the overall glass bottle return rate is not high enough. There should be some improvements in certain areas. Based on some experiences and practices in Germany, some changes,

works, and improvements can be recommended to APU in the short and long terms. Short-term recommendations:

- Officials must be aware of the issues at hand and recognize the areas with the most desirable impacts and significant systemic effects.
- Realistic and sufficient research and data must be done. It would help them to prioritize their goals and reach their goals on a consistent basis effectively. Stakeholder roles and duties should be clarified, and all stakeholders should be involved in the decision-making process.
- Constant campaigns and encouragement among the public are necessary, even if it would take a long. Investigated research and data should be open to the public. Especially, facing environmental and economic dependency problems and advantages of reusing glass bottles need to be informed openly to the public.
- To raise the public awareness, labels on reusable glass bottles can be printed next to the product's bar code. In this way, if consumers recognize and distinguish the reusable glass bottles easier, they would have more motivation to bring their used bottles.
- Since desired return rate can't be achieved in the short-term when implementing RVMs, firstly they can start with fewer RVM near to their washing plants. This can give public knowledge about RVM and advertise the new possible channel to bring the bottles.
- For the future plan of RVM, preparations should be done from now. For example, a survey about if people support deposit return system integration in Mongolia is essential in future works of APU.
- Continue to increase the official collection points in Ulaanbaatar. However, collection points need to be distinguished and labeled clearly that every consumer understands, which would help practice the drop-off method.
- The public is less motivated and less likely to respond to new policies and programs if they are unaware of the consequences of their actions. As a result, providing the public with educational programs that represent the current state of waste in a comprehensive manner can support in the adoption of new behaviors.

Long-term recommendations:

- APU can initiate the collaboration of the companies that reuse their glass bottles in Mongolia. With help from other companies, an integrated and complex collection system can be completed. Consequently, RVM implementation would cover a bigger area.

- Knowledge about waste management and its separation should be systematically added to education programs from kindergarten to high-schools.
- Clear law and regulation need to be stated in future. This need to be based on all participates interests which includes companies, local authorities and consumers.

6 Conclusion

The current state of glass collection rate is high in developed countries, especially in Germany. Waste separation and glass bottle drop-off methods have become part of their habit and culture. The history of glass bottle collection started very early. During this period, many policies, regulations, and campaigns took actions that led to today's socio-economic and cultural distinctions. Especially before legal frameworks went through the government, public awareness and support were essential. There were constant awareness-raising campaigns and changes to make the glass bottle collection system convenient for all participants. Currently, the main channel of collection method is consumers bringing their bottles to the reverse vending machine due to the deposit return system.

However, to implement the reverse vending machines in Ulaanbaatar, the expected return rate needs to be higher than today. Waste separation habits and bringing their used bottles are not common knowledge in Mongolia. Thus, feasible solutions can be based on the three pillars of the German solid WM system. By directing the public with clear and tangible actions, behavioral change and raising awareness must go hand in hand with the aims set for sustainable and green development goals. Clearly stated regulations and laws are necessary to accelerate the improvement. Also, fees for returning the bottles would be the leverage to maintain the increase in return rate continuation. This is the important motivation to make habits and attitudes among the public.

More actions and research should be done in the future. There are still the existing gaps in Mongolia that help identify its key strengths and areas for improvement.

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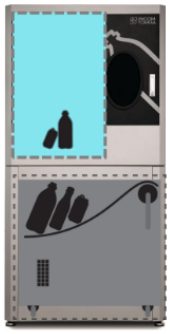
Appendices

Appendix A.

H-11 THE BASIC

- Sorting system
- Bottle shape recognition
- Full bottle detection
- Optical fraud protection
- SoftDrop safe-landing system on H-11 for glass bottles
- Robust design
- 21.5-inch touch screen
- Incom Tomra Background Operation Platform
- System integration with operator's database

H-11 RECOVERY RANGE AND BASIC FUNTIONS

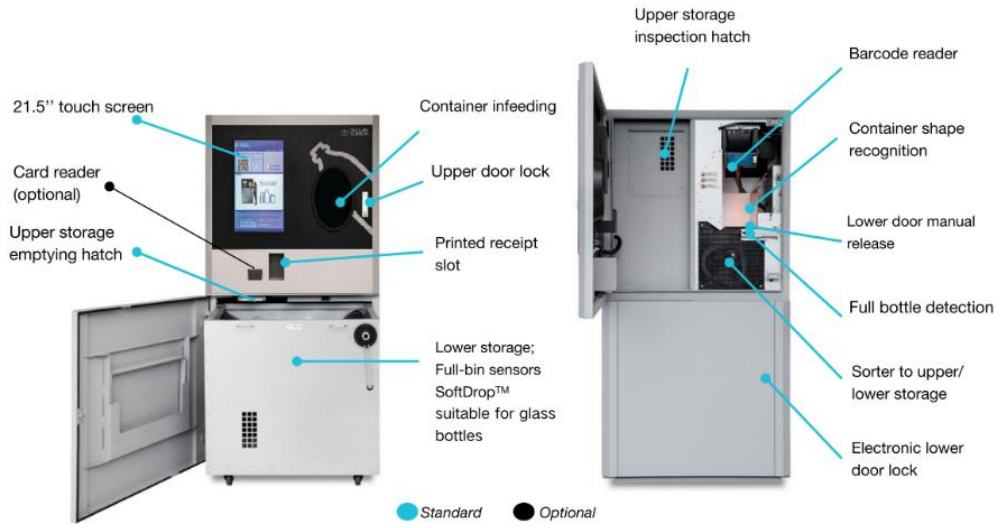


H-11: SoftDrop™ version for cans & PET (one-way) + glass (refillables)

The strategy of the sorting system
for the upper or lower bin is adjustable

Modular/Model		H11
Recognition	Barcode	√
	Shape	√
	Weight	√
	Material	N
	Metal	N
Feeding system	Conveyor	N
	Sorter pusher	√
	TranRot	N
Capacity	500ml/container	600
Recyclable item	PET,PP,PE and etc.	√
	Aluminum/mental can	√
	Glass bottle	√
Feeding rate	Piece/min	15/40
Compactor	-	N

H-11 BASIC STRUCTURE

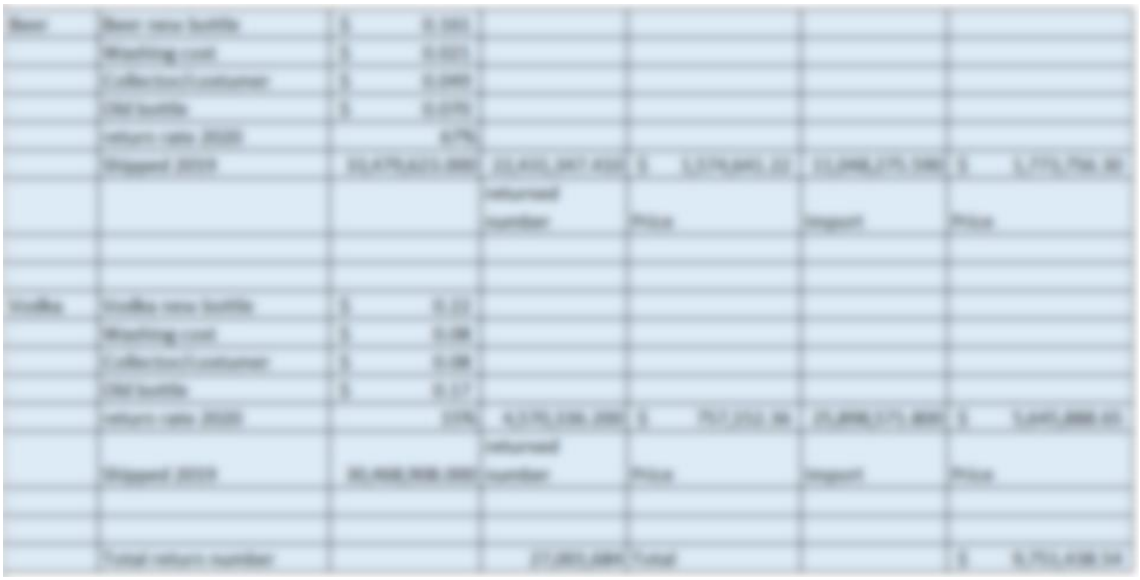


MANAGEMENT PLATFORM

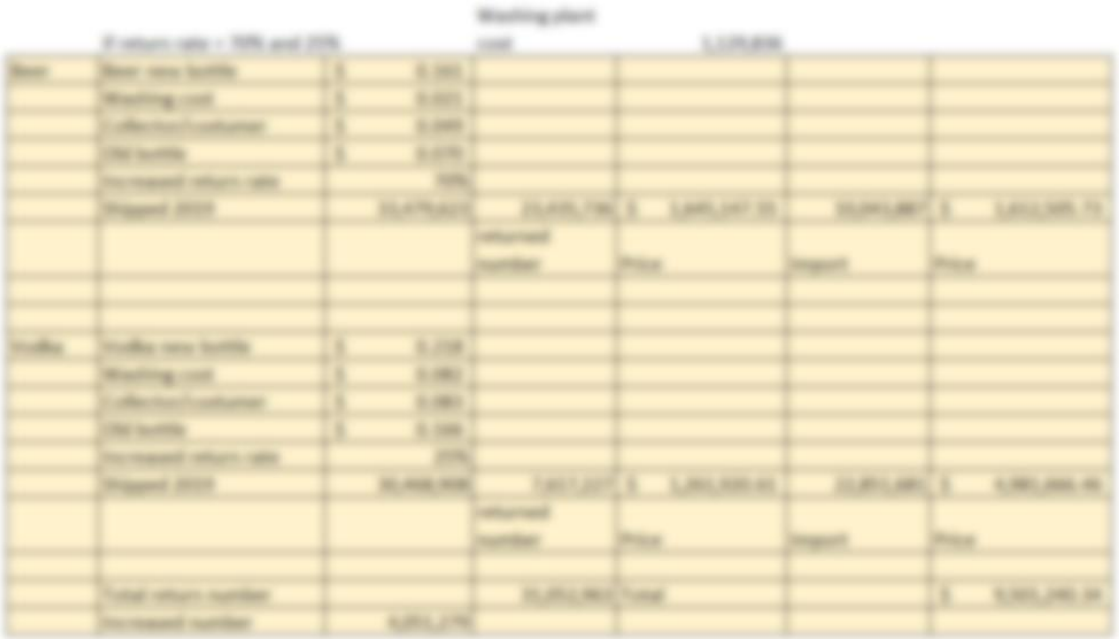
- Bottled data display and analysis syatem
- Barcode database management
- User management
- Timely notification of equipment alarm information
- Remote management RVM
- Advertisement and image production and distribution
- Coupon system production and remote distribution

Appendix B

Current glass bottle cost 1$=3000₮



Glass bottle cost in normal case scenario (Beer glass return rate = 70%, Vodka glass return rate = 25%)



Glass bottle cost in the best-case scenario (Beer glass return rate = 75%, Vodka glass return rate = 30%)