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A STUDY ON

"DEVELOPMENT OF SUPPLY CHAIN MODEL FOR BIO-DIESEL MANUFACTURING FROM USED COOKING OIL IN BENGALURU"

KSCST

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DECLARATION

We hereby declare that the entire work embodied in this project has been carried out by us under the supervision of Professor **Dr. Satish Y M**, Department of Management Studies, Ramaiah Institute of Technology, Bengaluru. This report has not been submitted in part or full for the award of any diploma or degree of any other university.

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CERTIFICATE

This is to certify that the project titled “DEVELOPMENT OF SUPPLY CHAIN MODEL FOR BIO-DIESEL MANUFACTURING FROM USED COOKING OIL IN BENGALURU” has been successfully carried out under the guidance of Professor **Dr. Y M Satish** by students **A V Thrinethra, Abhijit A Talawar, Aliptha Raveesh** and **Nagesh T B** of Department of Management Studies, Ramaiah Institute of Technology.

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ABSTRACT

This project report, presents a comprehensive investigation into establishing an efficient and sustainable supply chain for the production of bio-diesel from used cooking oil (UCO) in the urban setting of Bengaluru along with the financial model. With the mounting concerns over environmental degradation and the need for alternative energy sources, the recycling of UCO for bio-diesel production has gained considerable attention due to its potential to reduce carbon emissions and promote circular economy practices.

This research study begins by assessing the current disposal practices of UCO in Bengaluru and identifies the challenges and environmental consequences associated with its improper disposal. It explores the feasibility of transforming this waste material into a valuable resource by converting it into bio-diesel. Furthermore, this project investigates the logistics and transportation aspects of the supply chain, encompassing the collection of UCO from various sources such as households, restaurants, and food processing industries. It proposes an optimized collection route and explores the potential integration of waste management systems to ensure a steady supply of UCO for the bio-diesel manufacturing unit.

To create a sustainable and economically viable model, the report examines the policy and regulatory framework related to bio-diesel production and waste management in Bengaluru. It also considers the involvement of stakeholders such as government agencies, private enterprises, and non-governmental organizations to promote awareness and support for this environmentally friendly initiative.

In conclusion, this project offers a comprehensive roadmap to establish an environmentally sustainable supply chain for bio-diesel production. By leveraging the vast amount of UCO generated in the city, this model not only contributes to the reduction of greenhouse gas emissions but also promotes a cleaner and more circular approach to waste management. This research aims to guide policymakers, investors, and other stakeholders in taking concrete steps towards a greener and more sustainable future for Bengaluru.

INTRODUCTION

Utilising energy is a fundamental part of human society. Every nation's economic growth depends on its access to energy. The need for energy has quickly increased as a result of the population's rapid growth and rising income. The two greatest concerns facing humanity in this century are the availability of energy supplies and climate change. Due to their extensive usage of fossil fuels, the industrial and home sectors' high energy demands have led to concerns with environmental contamination. Burning fossil fuels poses a number of environmental and public health problems that could have possibly permanent effects on global warming.

Utilising leftover cooking oil to make biodiesel is a significant tool for addressing the serious issues brought on by the energy crisis and environmental pollution. Numerous uses for biodiesel exist, including mixed fuel for automobiles and heating oil for environmentally friendly urban housing. Due to its similarities to petroleum diesel fuel in terms of creating more clean energy, having lower emissions, and being environmentally benign, biodiesel fuel can be used in any blend with petroleum diesel fuel. The B-20 biodiesel blend, which contains 20% biodiesel and 80% petroleum diesel, is the most effective blend used in automobiles globally. Clean biodiesel and its diesel fuel mixes reduce emissions of hydrocarbons and carbon monoxide.

Used cooking oil (UCO) is defined as edible oil that was once used for frying in hotels and restaurants but is no longer used for that purpose. Used cooking oil is thrown in municipal drainage systems and sewers, which results in a variety of issues. When UCO is not properly disposed of, it also winds up entering the food chain or the water cycle. UCO may be converted into biodiesel, which is one of its most important uses.

Used cooking oil (UCO) is a sustainable source of non-toxic, sulphur-free, biodegradable biodiesel that can be combined with petroleum-based fuels. Through concerted effort, India has the ability to recover crores of litres of used cooking oil (UCO) for the manufacturing of biodiesel. The efficient collection and distribution of UCO is made possible by the application of the supply chain concept. When there is no simplified solution, it is essential to design an ideal and sustainable supply chain.

Disposing of cooking oil properly is crucial to prevent environmental pollution and avoid clogging of sewer systems. Pouring used cooking oil down the drain or into the trash can lead to severe consequences for both the environment and public infrastructure. Here are some recommended disposal mechanisms for cooking oil:

1. Recycling centres: Many communities have recycling centre’s or drop-off locations that accept used cooking oil. The collected oil can be recycled into biodiesel or used for other industrial purposes.

2. Contact Local Rendering Companies: In some areas, rendering companies accept used cooking oil. They process it into products like animal feed or industrial materials.

3. Consult with Local Waste Management: If you're unsure about the proper disposal method for cooking oil in your area, contact your local waste management or environmental agency for guidance. They can provide information on local regulations and available disposal options.

4. Reuse or Repurpose: If the cooking oil is still relatively clean and has not been used to cook heavily flavoured or seasoned foods, it may be possible to reuse it for cooking. However, it is essential to strain the oil to remove any food particles and store it in a sealed container in the refrigerator.

PESTLE ANALYSIS

A PESTLE analysis is a framework used to analyse the external factors that can impact a business or project. It stands for Political, Economic, Sociocultural, Technological, Legal, and Environmental factors. Let's apply the PESTLE analysis to the financial model for the manufacture of biodiesel from used cooking oil:

1. Political:

- Government regulations and policies: Assess the political environment and any regulations or policies related to the production and use of biodiesel. This includes incentives, subsidies, tax credits, and restrictions on the import/export of biodiesel or its feedstock. Political stability: Consider the stability of the political system and any potential risks or uncertainties that may affect the financial model.

2. Economic:

- Economic conditions: Evaluate the overall economic conditions, such as GDP growth, inflation rates, interest rates, and currency exchange rates. These factors can influence the financial viability of the biodiesel manufacturing project.

- Cost of feedstock: Analyse the availability and cost of used cooking oil as a feedstock for biodiesel production. Fluctuations in cooking oil prices can affect the profitability of the project.

- Market demand and pricing: Assess the demand for biodiesel and its pricing dynamics. Changes in fuel prices, consumer preferences, and government policies related to renewable energy can impact market demand and pricing.

3. Sociocultural:

- Environmental awareness: Evaluate the level of environmental consciousness and the demand for eco-friendly fuel alternatives among consumers. This can influence the market acceptance and demand for biodiesel.

- Consumer preferences: Consider societal attitudes towards sustainable and renewable energy sources. Assess if there is a growing market demand for biodiesel or if there are any cultural factors that may affect its adoption.

4. Technological:

- Technological advancements: Analyze the state of technology used in biodiesel production and its potential impact on the financial model. Assess if there are any emerging technologies or innovations that can improve the efficiency or cost-effectiveness of the manufacturing process.

- Research and development: Consider ongoing research and development efforts in the field of biodiesel production. Evaluate if there are any potential technological breakthroughs that may affect the financial model.

5. Legal:

- Environmental regulations: Evaluate the existing and potential future regulations related to environmental impact and emissions. Compliance with such regulations may require additional investments or affect the financial model.

- Intellectual property: Assess if there are any patents or intellectual property rights associated with biodiesel production that could impact the financial model.

6. Environmental:

- Sustainability and carbon footprint: Assess the environmental impact of biodiesel production compared to conventional fossil fuels. Evaluate any potential environmental benefits and risks associated with the project.

- Availability of feedstock: Consider the availability and sustainability of used cooking oil as a feedstock. Evaluate any potential constraints or risks related to the supply of feedstock.

LITERATURE REVIEW

1. (Gnanaprakasam, Shivakumar, Surendhar, Thirumarimurugan, & Kannadasan, 2013)
   Due to the high cost of the raw materials, the price of biodiesel made from virgin vegetable oil through transesterification is higher than that of fossil fuel. In the recent past, leftover cooking oil was used as feedstock to reduce the cost of biofuel. Acids, bases, and lipase are frequently utilised as catalysts in this process. There is a limited amount of lipase used in the synthesis of biodiesel since lipase catalysts are quite expensive. Waste cooking oil can be used as the primary raw material for the synthesis of biodiesel rather than virgin vegetable oil. The majority of hotels, restaurants, and other food-related businesses simply discharge used cooking oil into rivers or dump it on the ground. Despite this, leftover cooking oil can be used to produce biodiesel effectively.

2. (Kiakalaieh, Amin, & Mazaheri, 2013)
   During the Second World War in the 1920s–1930s, there were reports of the use of biofuels or vegetable oil in internal combustion engines from all over the world. Different kinds of biofuels have been tested and employed in Germany, Argentina, Japan, Belgium, Italy, France, the United Kingdom, Portugal, and China. However, the cost of producing petroleum fuel was lower than that of alternative fuels, which led to a decline in the development of biofuel infrastructure. Recent worries about environmental deterioration and the depletion of fossil fuels have once more accelerated the production of biodiesel since it appears to be the most practical solution to modern problem.

3. (Gude & Grant, 2013)
   In this study, the impact of direct sonication on the process of turning used cooking oil into biodiesel is examined. If they are not disposed of appropriately, used cooking oils can be hazardous to the environment. However, used cooking oils can be used as a cheap source of raw materials to make biodiesel. In one step, biodiesel was produced by directly converting used cooking oil using ultrasonics, an unconventional production technology. Due to enhanced mass/heat transport phenomena and specialised thermal effects at the molecular level, ultrasonic trans-esterifies used cooking oils very

effectively. As a result, the total process consumes much less energy and chemicals than traditional biodiesel production methods.

4. (Zhang, Dube, Mclean, & Kates, 2003)

   On a commercial scale, four distinct continuous process flowsheets for the synthesis of biodiesel from virgin vegetable oil or used cooking oil under alkaline or acidic conditions were created. For each process, precise operating conditions and equipment designs were obtained. These four methods underwent a technological review to determine their technical merits and limits. The alkali-catalysed method employing virgin vegetable oil as the raw material had the fewest and smallest equipment units, according to analysis, but it also had the highest raw material cost compared to the other processes. The cost of the raw materials was decreased by using used cooking oil to make biodiesel. It was found that the acid-catalysed method employing used cooking oil was more technically feasible and less difficult than the alkali-catalysed process, giving it a viable alternative to the alkali-catalysed approach's use in the manufacturing of commercial biodiesel.

5. (Gopan, Rajan, & Krishnan, 2020)

   Throughout various industries, there is a current fuel scarcity throughout the world. The price of oil and its by-products (petrol and diesel) grew due to the demand for fuel oil refinery businesses. One alternative technique to fully meet the fuel needs of engines and cars is the manufacturing of biodiesel. However, other experts asserted that the source of biodiesel manufacturing is both low-cost and expensive. Here, the process is carried out using used cooking oil, which is accessible in homes and other food-related businesses, in order to lower total manufacturing costs and generate a large quantity of bio-diesel products. The Testing model IC engine was then used to gauge the bio-diesel's performance.

6. (Papapostolou, Kondili, & Kaldellis, 2021)

   The supply chain for biofuels consists of a diverse range of tasks requiring an intricate web of variables. While the manufacture of the finished product presupposes the functioning of a conversion plant, the cultivation of the raw materials is strongly tied to the agricultural sector. The goal of the distribution network is to distribute the finished good near to where it will be consumed. The degree to which each of the aforementioned sectors is involved is a product of the strategic and operational planning of the entire supply chain and, in most cases, establishes the effectiveness of the biofuels industry. It becomes abundantly evident that the parameters in the industry are always changing when you take into consideration the attitudes that are very quickly shifting regarding the environmental behaviour of the entire biofuels supply chain. As a result, it is thought that taking into account an integrated supply chain that has been properly modelled is crucial and may lead to the specific case's most advantageous outcome from an economic and/or environmental standpoint. In this article, an integrated strategy that can consider both technical and economic elements affecting the performance of the entire value chain—the construction of a mathematical model for the optimal design and operation of the biofuels supply chain—is offered.

7. (Kristianto & Zhu, 2019)

   The future of production and sustainable manufacturing depend on a sustainable biofuel supply chain. Greener production is now being used to qualify orders on the international market. It is difficult to model biofuel supply chains that are viable from an economic, social, and environmental standpoint. In order to create a sustainable supply chain, this article creates biofuel platform planning and optimisation that combines the design of the biofuel product, production process, and networks. Consideration is given to designing supply chain networks for biofuels under different production scenarios. According to the modelling outcomes, a composition ratio between rice straws and used cooking oils that is optimal can be chosen between 0% and 50%.

8. (Wang, Ou, Liu, & Zhang, 2007)

   In this study, a two-step catalysed process was used to convert used cooking oil, with an acid value of 75.92 0.036 mgKOH/g, into biodiesel. The triglycerides (TGs) in WCO were transesterified with methanol in the second stage, while the free fatty acids of WCO were esterified with methanol in the first step, catalysed by ferric sulphate. The outcomes demonstrated that free fatty acid (FFA) esterification with methanol was catalysed by ferric sulphate with great activity, When 2 wt% of ferric sulphate was added to the reaction system comprising methanol to TG in a 10:1 (mole ratio) composition and reacted at 95 C for 4 hours, the conversion rate of FFA reached 97.22%. The methanol was vacuum evaporated, and the remaining triglycerides underwent transesterification for 1 hour at 65 C in a reaction system with 1 wt% potassium hydroxide and a 6:1 mole ratio of methanol to TG. After completing the two-step catalysed process, the final product, which contained 97.02% biodiesel, was analysed by gas chromatography.

9. (Gashaw & Teshita, 2014)

The study of alternative energy sources is becoming more popular as environmental and energy resource concerns grow. Growing interest in alternative fuels like biodiesel as a suitable diesel oil substitute for internal combustion engines has arisen as a result of the world's rising energy needs. Given that they are renewable and share many characteristics with diesel oil, biodiesels present a very viable replacement for it. Due to the anticipated shortage of conventional fuels and environmental concerns, it is a substitute for an alternative fuel that shows promise. One of the most promising alternatives to the usage of traditional fossil fuels is the utilisation of liquid fuels like biodiesel, which is created from used cooking oil through the transesterification process. However, because biodiesel is made from vegetable and animal fats, there are worries that over time, the supply of food may be threatened. As a result, current efforts have centred on using used cooking oil as one of the main feedstocks for making biodiesel.

10. (Sheinbaum, Balam, Robles, Lerrea, & Mendoza, july 2015)

This article's objective is to assess the possibility for using biodiesel made from used cooking oil in Mexico City. The study is split into two main sections: the analysis of a waste cooking oil collecting pilot project carried out in a region of food markets in Mexico City; and the exhaust emissions performance of biodiesel blends assessed in buses of the public bus transportation network (RTP) in Mexico City. The waste cooking oil collecting pilot project's findings indicate that the amount of oil discharged depends on the kind of food provided and the operational procedures in a restaurant. The disposal rate of used cooking oil from fresh oil in food markets is about 10%, however the standard deviation is relatively large. The Ride-Along-Vehicle-Emissions Measuring System was used to measure the emissions of two distinct bus types as they travelled along a regular route. According to the examination of the data by repeated measure analysis of variance, the usage of biodiesel blends reduces emissions only for buses that have exhaust gas recirculation systems.

PROBLEM STATEMENT

Used cooking oil (UCO) must be properly disposed of after three uses, as total polar materials (TPM) reach 25%, which is considered unfit for consumption. UCO use can cause health problems such as hypertension, atherosclerosis, Alzheimer's disease, liver disease and other diseases. Improper disposal of UCO and resale to street food vendors or smaller businesses will result in the re-entry of UCO into the food chain. UCO is dumped into the sewage network due to the ignorance or weak environmental awareness of food industry operators. Improper disposal of UCO can lead to contamination of water sources and soil, clogging of pipes and additional operating costs for water treatment plants. This leads, among other things, to an insufficient supply of the raw materials necessary for the production of biodiesel. The lack of a smooth UCO collection method hinders the availability of the collected UCO for biodiesel production.

OBJECTIVES

- To ascertain the availability of Waste Cooking Oil in organized establishments in North Bengaluru.
- To forecast the quantity of waste cooking oil generated from this region.
- To analyze the Organized units' perception about conversion of used cooking oil into bio-diesel.
- To determine a suitable method for collecting and distribution of used cooking oil for biodiesel production.

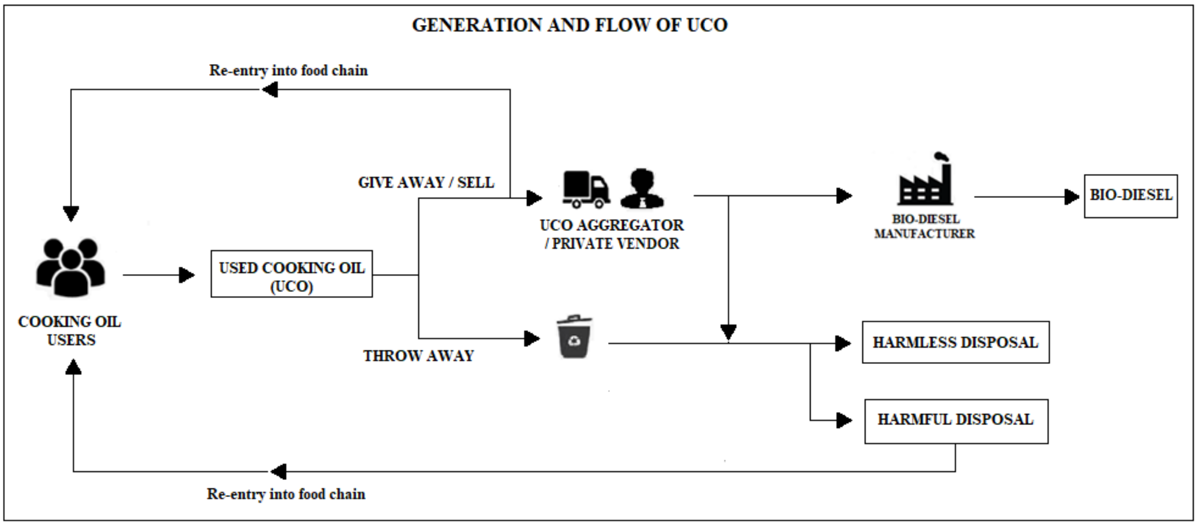
EXPERT'S SUGGESTION

- Supply chain model development for Used Cooking Oil (UCO) in Northern Bengaluru - Collection, aggregation and supply to biodiesel industry - entire value chain of biodiesel to be developed.
- Financial model for UCO operation to be developed.

PROCESS

UCO Generation and Flow

Biodiesel can be produced from various vegetable oils such as palm oil, sunflower, soybean, rapeseed, and castor oil using different types of catalysts. Biodiesel is a substitute for diesel; it is derived from the triglycerides of vegetable oils. Triglycerides in the presence of alcohol with a catalyst produce Bio-Diesel through a transesterification reaction.



Used Cooking Oils (UCOs) are oils and fats that have been used for cooking or frying in the food processing industry, restaurants, fast foods, and also at a domestic level. Once the TPM (Total Polar Materials) reading of UCO reaches 25%, it is considered unfit for human consumption and has to be disposed of.

UCO disposal is done by either give away/sell or throwing away. The UCO can be sold to either Bio-Diesel manufacturers or private vendors. The private vendors either sell the UCO to soap/grease manufacturing companies, bio-diesel manufacturers, or the street food vendors. Self-Disposal either includes burning of the UCO, mixing of the UCO with sand/sawdust, or flushing it down the drain.

Harmful disposal: Refers to disposal which is harmful to society/environment. E.g. burning in open air causes air pollution, throwing away in a drain can cause clogging of the sewage system.

Used Cooking Oil can also find its way into the water bodies when disposed of incorrectly. This lowers the water quality and consequently affects aquatic life.

The UCO can find its way back into the food cycle when it is sold to the street food vendors at a cheaper rate.

Harmless disposal: Refers to disposal in a way that is not harmful to society/environment. E.g. Providing UCO as a feedstock for Bio-Diesel generation or for producing other useful by-products.

ADVANTAGES AND DISADVANTAGES OF BIO-DIESEL

Advantages of biodiesel:

➢ Biodiesel fuel is a renewable source.

➢ Biodiesel is less polluting than petroleum diesel.

➢ The lack of Sulphur in biodiesel extends the life of catalytic converters.

➢ Biodiesel can be mixed with other energy resources and oil.

➢ Biodiesel fuel can be utilized in existing oil heating systems and diesel engines without any modifications to those systems or engines. The lubricating property of biodiesel fuel can lengthen the lifetime of engines.

➢ Biodiesel can be distributed through existing diesel fuel pumps.

➢ The use of Bio-diesel reduces the emissions of greenhouse gases and hence, reduced carbon footprint.

➢ Bio-Diesel is less combustible and therefore, safe to handle, store, and transport.

Disadvantages of biodiesel:

➢ Currently, biodiesel fuel is more expensive than petroleum diesel fuel.

➢ Biofuels are a solvent and subsequently can hurt rubber pipes in some engines.

➢ As a solvent, biodiesel cleans dirt from engines. This dirt can then get collected in fuel filters, clogging them. As a result, filters have to be changed after the first several hours of biodiesel use.

➢ Biodiesel fuel distribution infrastructure needs improvement to make biodiesel more accessible.

➢ In cold weather, pure biodiesel can thicken, making it hard to pump.

RESEARCH METHODOLOGY

A. **Title**: Supply Chain for collection and distribution of used cooking oil to the bio-diesel production unit in the east region of Bangalore city (MG Road)

B. **Problem Statement**: Edible oil when used more than thrice becomes unfit for consumption. When such oil is disposed of without proper treatment becomes a threat to the environment and also, can re-enter the food chain. By setting up an efficient collection and distribution system for moving used cooling oil from the source/supply points to a bio-diesel manufacturing plant, the Used Cooking Oil (UCO) can be converted to bio-diesel, an alternate form of energy that can replace fossil fuels and hence, can also reduce carbon footprint.

C. **Collection of Data:**

Primary Data: The data has been collected through a questionnaire from the Hotels, Cafes and Restaurants (organized sector) of North Bangalore (New BEL Road)

Secondary Data: The data has been collected from published articles, research papers, and Government publications.

D. **Sampling of Data**: The sample data has been collected from hotels, restaurants, and cafes in New BEL Road, the north region of Bangalore City.

LIMITATIONS OF THE STUDY

➢ The study was confined only to organized food establishments such as Restaurants, Hotels, and Cafes.

➢ The scope of the study was confined to only a small part of Bengaluru city due to time, budget, and unfavorable conditions.

➢ Lack of accurate data on the quantity of Used Cooking Oil (UCO) generated by Restaurants, Hotels, and Cafes.

➢ Lack of cooperation from the establishments.

QUESTIONNAIRE

Name of the Venture	Address	Type of Oil used	Edible Oil used per week	Non Edible Oil generated per week	Mode of disposal

Frequency of disposal	Awareness about Used Cooking Oil collection center (GOVT/ Private)	Awareness about Bio-diesel production from Used Cooking Oil	Awareness about ill impact of improper Used Cooking Oil disposal	Idea about Awareness programs conducted by FSSAI	Willing to give Used Cooking Oil to a collection center for Bio-Diesel Manufacturing?

- EO – Edible Oil
- NEO – Non-Edible Oil
- UCO – Used Cooking Oil

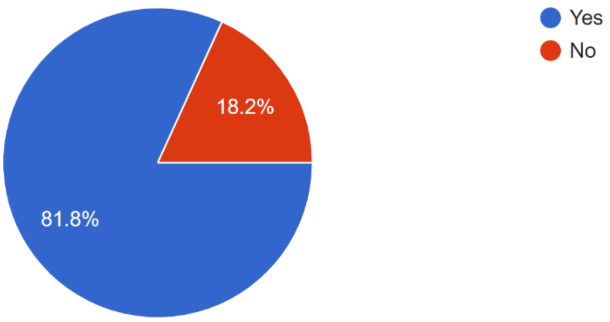
DATA ANALYSIS AND INTERPRETATION

The data as per the questionnaire answered by eateries of the Bangalore North region (New BEL Road) was gathered for the study.

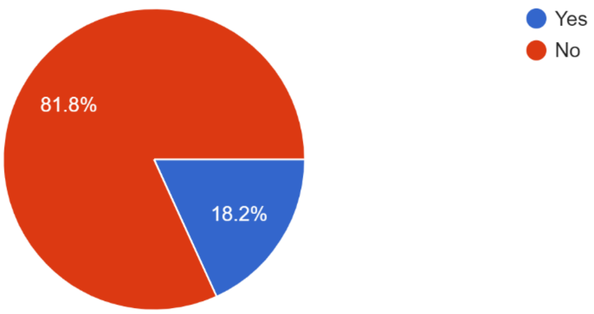
➢ The questionnaire was designed to understand the amount of Used Cooking Oil (UCO) produced by Food Business Operators (FBOs) along with the modes employed for its disposal. One of the purposes was to understand how much of UCO is unaccounted for.

➢ The questionnaire was structured to understand FBOs' willingness to adopt a new collection system, where UCO could be collected as feedstock for Bio-Diesel manufacturing along with an attempt to understand their awareness about UCO reuse and harmful effects of improper UCO disposal.

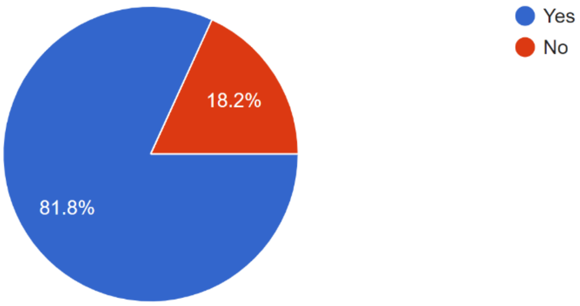
- From the survey results we understand that most of the restaurants are giving the Used Cooking Oil to their own UCO collection centres, who further sell it to soap manufacturing industries.
- Almost 80% of the respondents are aware of Used Cooking Oil collection centres



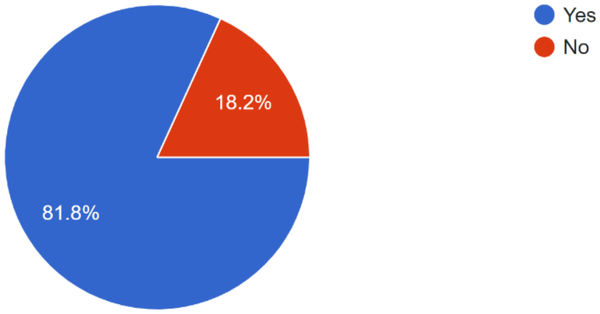
- Almost 80% of the respondents are not aware of Bio-diesel production from Used Cooking Oil



- Almost 80% of the respondents are aware of harmful effects of reusing Used Cooking Oil

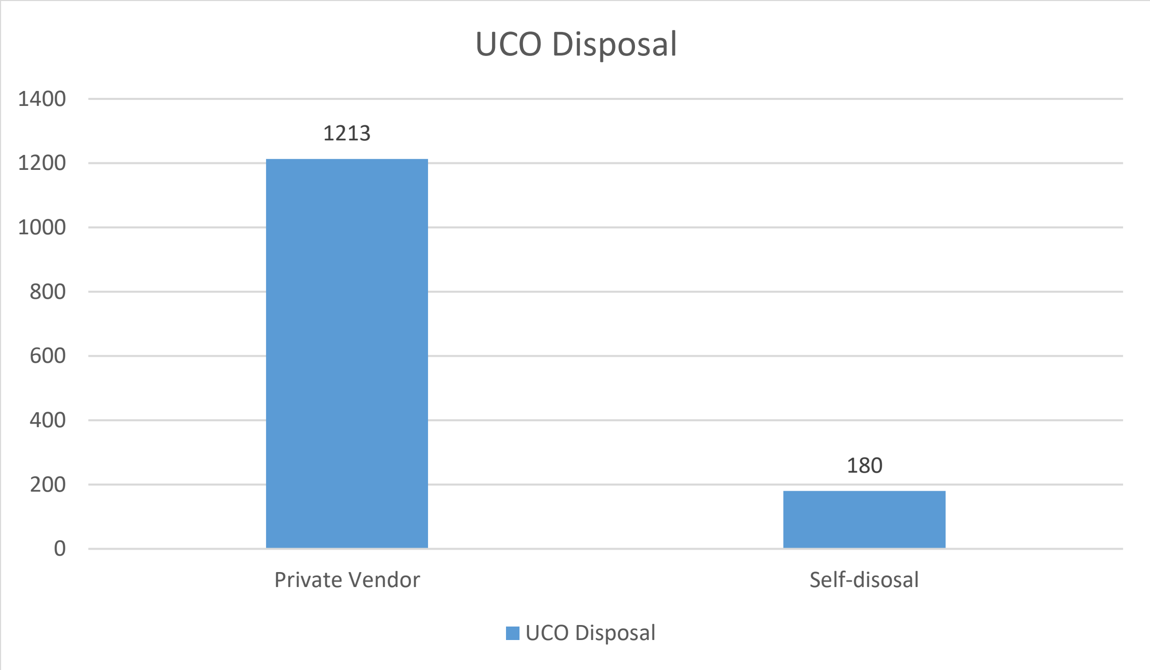


- Almost 80% of the respondents are willing to give Used Cooking Oil to a collection centre for the purpose of producing biofuel.



- The table and graph show the quantity of UCO disposed of per week in litres through different modes of disposal.

Mode of Disposal	NEO produced per week (in litres)
Private Vendor	1213
Self-Disposal	180

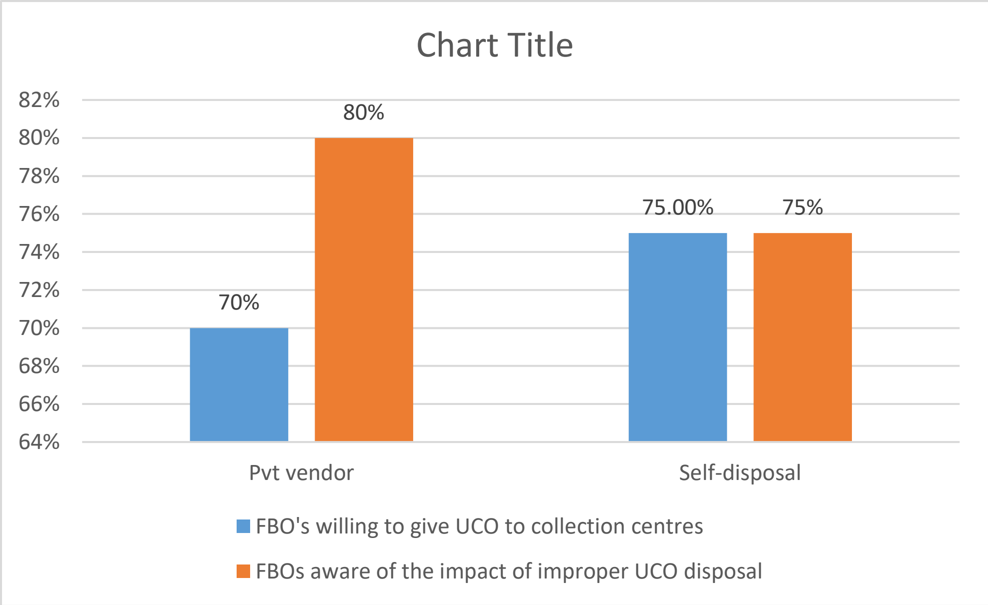


The FBOs using Private Vendor mode of disposal generate around 1213 litres of UCO per week, whereas the FBOs that do Self-Disposal generate around 180 litres per week.

The questionnaire included questions to check the willingness of the FBOs to provide their UCO to a collection center along with questions to test awareness about UCO as feedstock for Bio-Diesel production and also about the impact of improper UCO disposal.

Mode of Disposal	FBOs willing to give UCO to a collection center	FBOs aware of the impact of improper UCO disposal
Private Vendor	70%	80%
Self-Disposal	75 %	75%

- EO – Edible Oil
- NEO – Non-Edible Oil
- UCO – Used Cooking Oil
- FBO – Food Business Operators



➢ The FBOs using private vendors for UCO disposal were more unwilling to provide to a collection center. This might be due to competitive prices given by the private vendors. These FBOs are moderately aware of the use of UCO as feedstock for Bio-Diesel generation as well as ill impacts of improper UCO disposal.

➢ The FBOs choosing Self-Disposal were most willing to give UCO to a collection center. These FBOs seem to be comparatively less aware of the UCO reuse and ill effects of improper disposal of UCO.

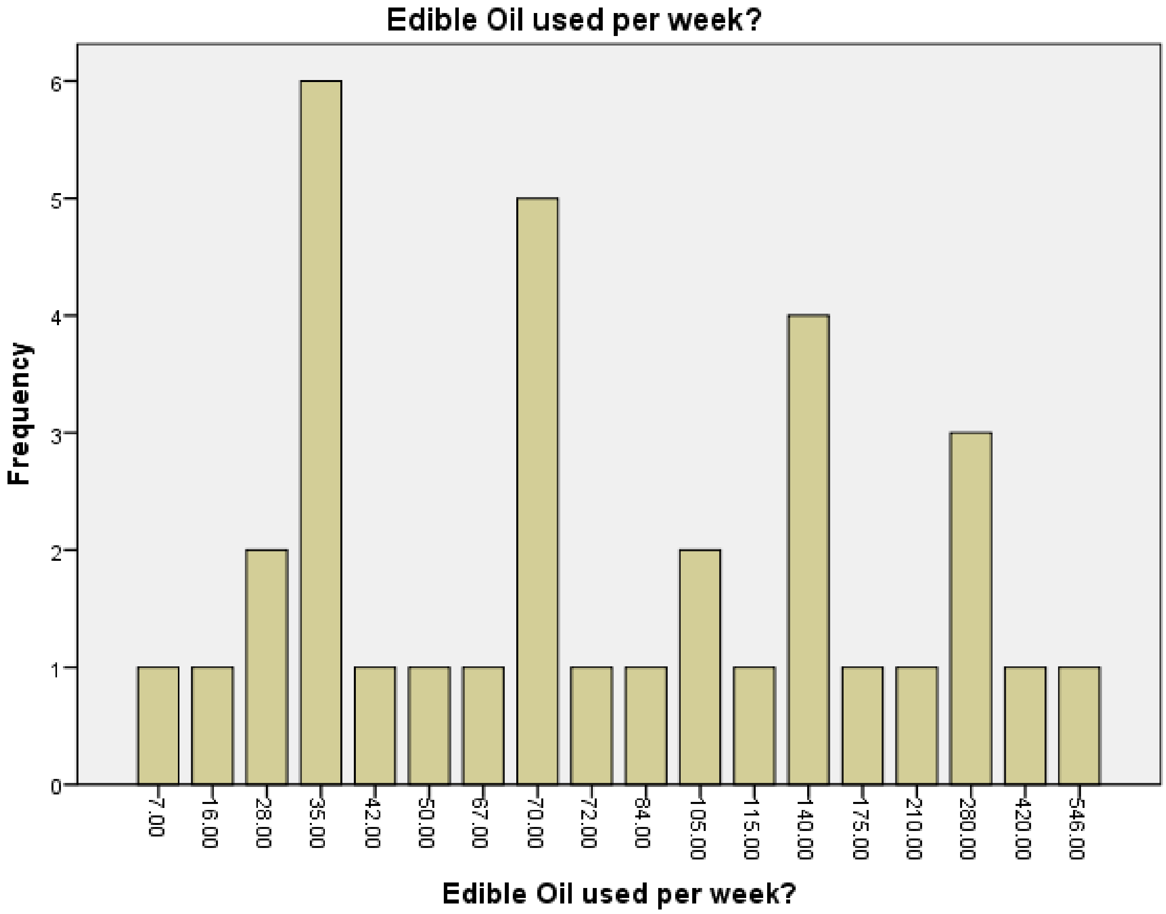
ANALYSIS USING SPSS

Edible oil used

There is prime need to understand the amount of edible oil used by the respondents, thus this is one the important of the survey. Below is the table which represents which is obtained after analysis:

Edible Oil used per week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7.00	1	2.9	2.9	2.9
	16.00	1	2.9	2.9	5.9
	28.00	2	5.9	5.9	11.8
	35.00	6	17.6	17.6	29.4
	42.00	1	2.9	2.9	32.4
	50.00	1	2.9	2.9	35.3
	67.00	1	2.9	2.9	38.2
	70.00	5	14.7	14.7	52.9
	72.00	1	2.9	2.9	55.9
	84.00	1	2.9	2.9	58.8
	105.00	2	5.9	5.9	64.7
	115.00	1	2.9	2.9	67.6
	140.00	4	11.8	11.8	79.4
	175.00	1	2.9	2.9	82.4
	210.00	1	2.9	2.9	85.3
	280.00	3	8.8	8.8	94.1
	420.00	1	2.9	2.9	97.1
	546.00	1	2.9	2.9	100.0
	Total	34	100.0	100.0	



Inference:

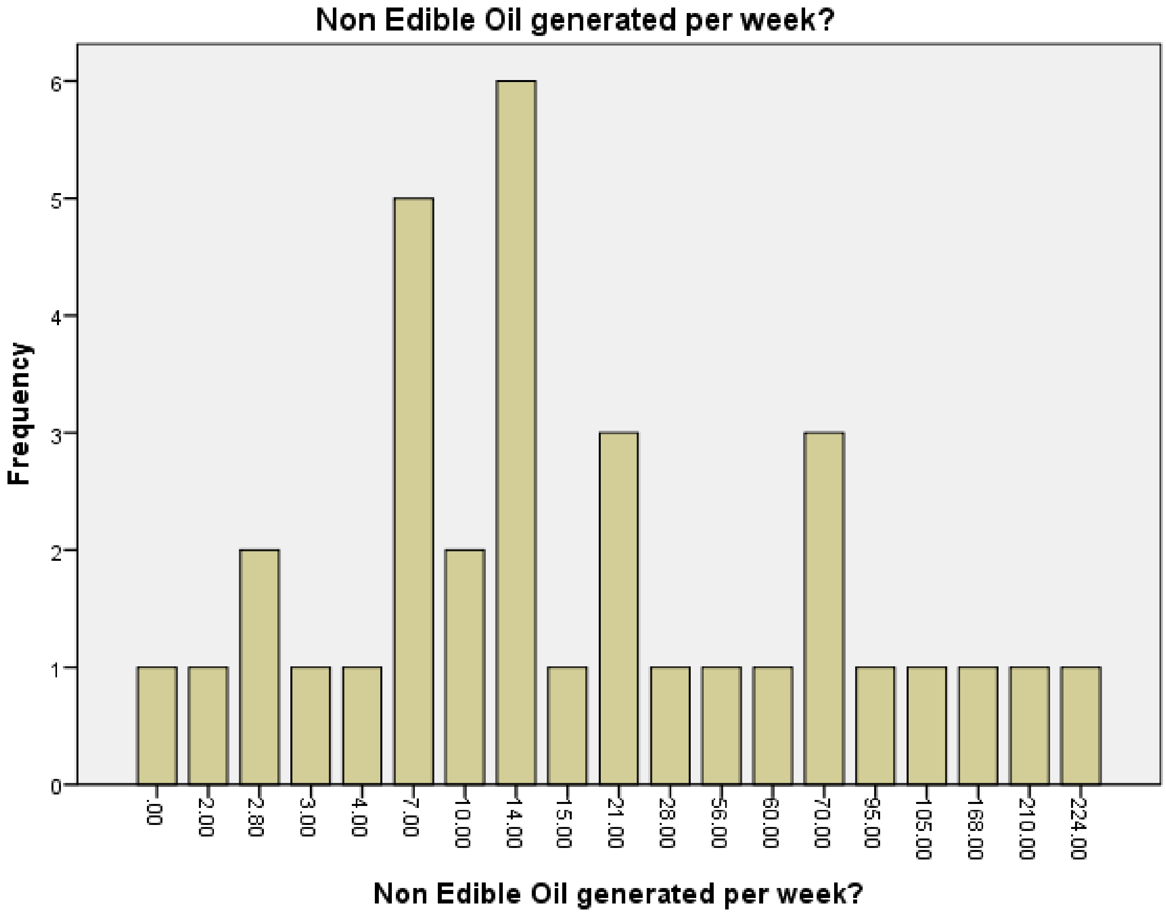
Out of 34 responses collected from the survey it can be concluded that 17.6% of the restaurants require 35L/week, 14.7% of the restaurants require 70L/week and 11.8% of the restaurants require 140l/week.

Non-edible oil generated per week

It is very necessary to understand the non-edible oil generated by the restaurants every week in order to use the results in further analysis. Below is the table which is obtained after analysis:

Non Edible Oil generated per week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	2.9	2.9	2.9
	2.00	1	2.9	2.9	5.9
	2.80	2	5.9	5.9	11.8
	3.00	1	2.9	2.9	14.7
	4.00	1	2.9	2.9	17.6
	7.00	5	14.7	14.7	32.4
	10.00	2	5.9	5.9	38.2
	14.00	6	17.6	17.6	55.9
	15.00	1	2.9	2.9	58.8
	21.00	3	8.8	8.8	67.6
	28.00	1	2.9	2.9	70.6
	56.00	1	2.9	2.9	73.5
	60.00	1	2.9	2.9	76.5
	70.00	3	8.8	8.8	85.3
	95.00	1	2.9	2.9	88.2
	105.00	1	2.9	2.9	91.2
	168.00	1	2.9	2.9	94.1
	210.00	1	2.9	2.9	97.1
	224.00	1	2.9	2.9	100.0
	Total	34	100.0	100.0	



Inference:

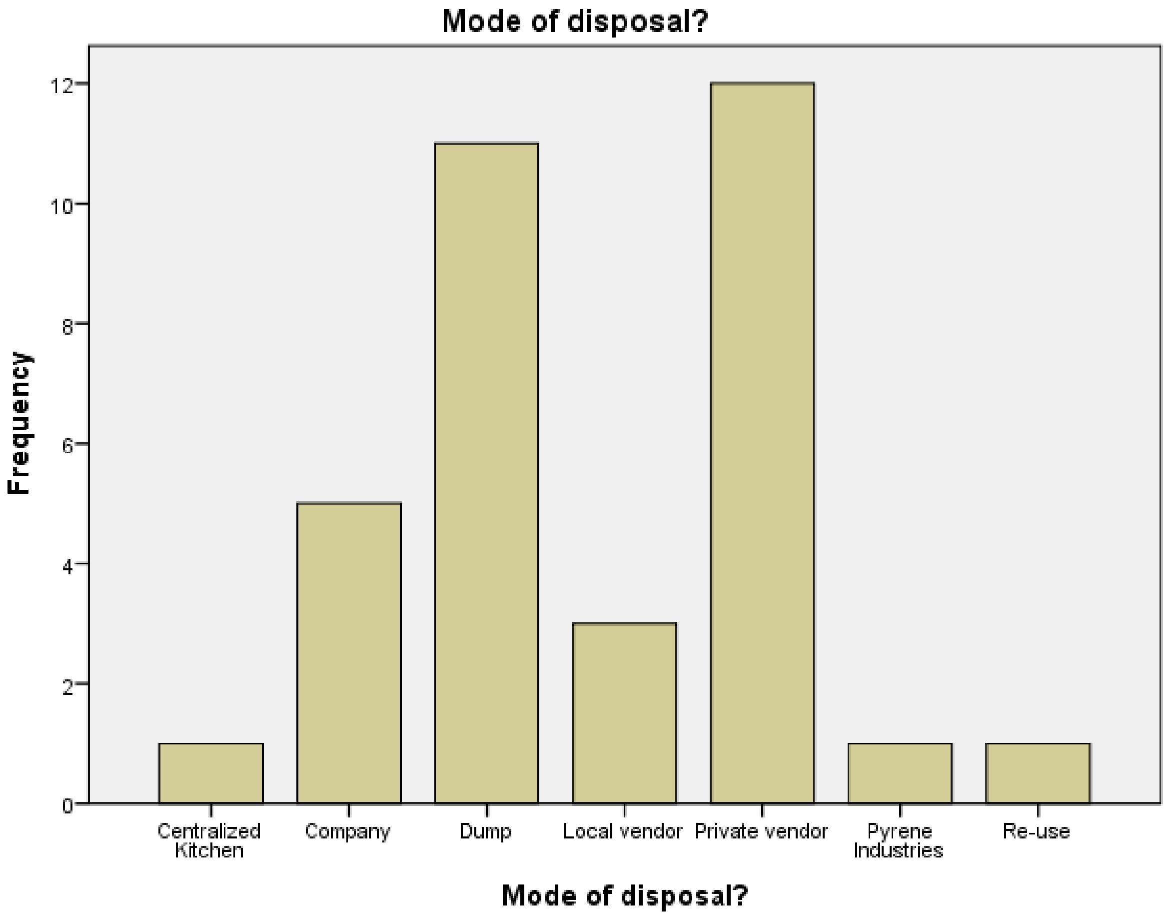
Out of 34 responses collected from the survey it can be concluded that 17.6% of restaurants generate 14L/week of non-edible oil and 14.7% generate 7L/week of non-edible oil.

Mode of disposal

It is much needed to understand the mechanisms of disposal used by the restaurants. Below is the table which is obtained after analysis:

Mode of disposal?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Centralized Kitchen	1	2.9	2.9	2.9
	Company	5	14.7	14.7	17.6
	Dump	11	32.4	32.4	50.0
	Local vendor	3	8.8	8.8	58.8
	Private vendor	12	35.3	35.3	94.1
	Pyrene Industries	1	2.9	2.9	97.1
	Re-use	1	2.9	2.9	100.0
	Total	34	100.0	100.0	



Inference:

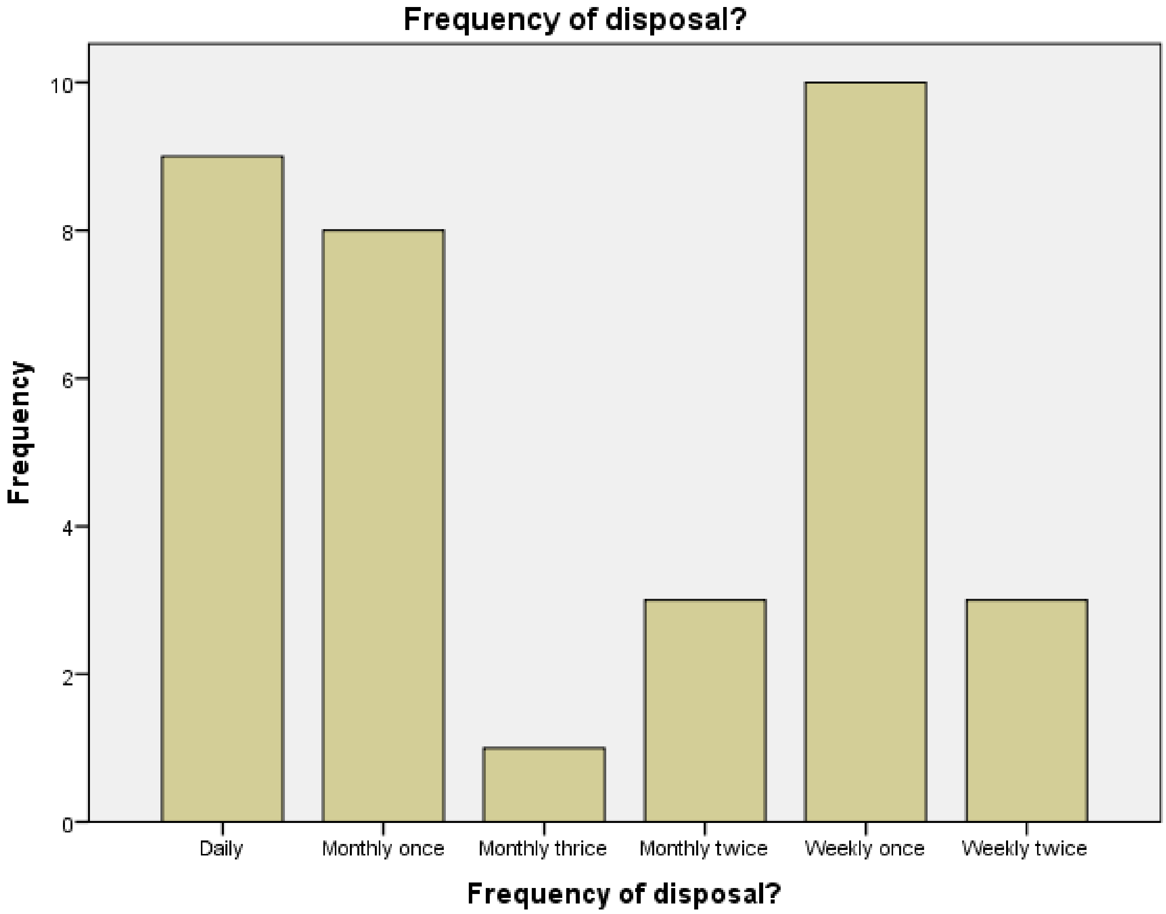
Out of 34 responses collected from the survey it can be concluded that 35.3% of the respondents give the UCO to private vendor and 32.4% of them dump it in unauthorized manner.

Frequency of disposal

It is much needed to understand on what frequency the UCO is disposed. Below is the table which is obtained after analysis:

Frequency of disposal?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	9	26.5	26.5	26.5
	Monthly once	8	23.5	23.5	50.0
	Monthly thrice	1	2.9	2.9	52.9
	Monthly twice	3	8.8	8.8	61.8
	Weekly once	10	29.4	29.4	91.2
	Weekly twice	3	8.8	8.8	100.0
	Total	34	100.0	100.0	



Inference:

Out of 34 responses collected from the survey it can be concluded that 29.4% of the restaurants dispose weekly once, 26.5% of them dispose daily and 23.5% of them dispose monthly once.

Descriptive Statistics

In this process we understand about characteristics of the responses collected. In this step the descriptives of Edible oil used per week and Non-edible oil generated per week is obtained. Below table is obtained after the analysis:

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Edible Oil used per week?	34	7.00	546.00	118.5294	119.99476	14398.742	2.051	.403	4.520	.788
Non Edible Oil generated per week?	34	.00	224.00	40.8118	58.08908	3374.342	2.104	.403	3.924	.788
Valid N (listwise)	34									

Inference:

1. The minimum and maximum amount of edible oil generated per week is 7 and 546L.
2. The average amount of edible oil generated per week is 118.52944L.
3. The minimum and maximum amount of non-edible oil generated per week is 0 and 224L.
4. The average amount of non-edible oil generated per week is 40.8118L.

Hypothesis testing (Chi-square test)

1. Null Hypothesis: There is no relationship between “Mode of disposal” and “Awareness about Used Cooking Oil collection centre (GOVT/Private)?”.

   Alternate Hypothesis: There is relationship between “Mode of disposal” and “Awareness about Used Cooking Oil collection centre (GOVT/Private)?”.

Crosstab

			Awareness about Used Cooking Oil collection center (GOVT/Private)?		Total
			No	Yes	
Mode of disposal?	Centralized Kitchen	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
	Company	Count	1	4	5
		% within Mode of disposal?	20.0%	80.0%	100.0%
	Dump	Count	7	4	11
		% within Mode of disposal?	63.6%	36.4%	100.0%
	Local vendor	Count	2	1	3
		% within Mode of disposal?	66.7%	33.3%	100.0%
	Private vendor	Count	1	11	12
		% within Mode of disposal?	8.3%	91.7%	100.0%
	Pyrene Industries	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
	Re-use	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
Total		Count	14	20	34
		% within Mode of disposal?	41.2%	58.8%	100.0%

Inference:

Out of 34 respondents 58.8% are aware about the UCO collection centre and 41.2% are unaware of the UCO collection centre.

Chi-Square Tests

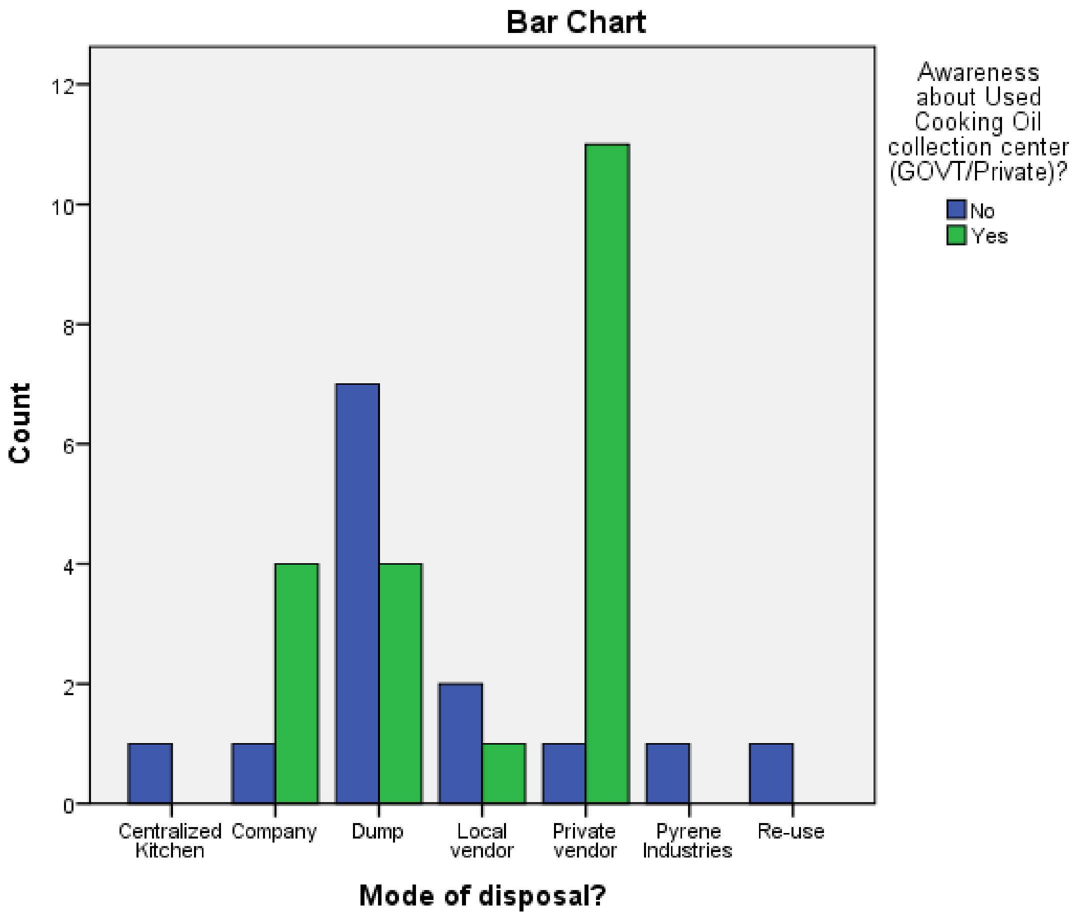
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.651[a]	6	.034
Likelihood Ratio	15.942	6	.014
N of Valid Cases	34		

a. 12 cells (85.7%) have expected count less than 5. The minimum expected count is .41.

Inference:

After testing at 5% level of significance the result says as the significance level is less than 0.05 i.e., 0.034 we reject the Null hypothesis. Thus, there is relationship between

"Mode of disposal" and "Awareness about Used Cooking Oil collection centre (GOVT/Private)?".



Inference:

Looking at the graph we can infer that most of them are aware about Private UCO collection centres.

2. Null Hypothesis: There is no relationship between "Mode of disposal" and "Awareness about Bio-diesel production from Used Cooking Oil".

   Alternate Hypothesis: There is relationship between "Mode of disposal" and "Awareness about Bio-diesel production from Used Cooking Oil".

Crosstab

			Awareness about Bio-diesel production from Used Cooking Oil?		
			No	Yes	Total
Mode of disposal?	Centralized Kitchen	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
	Company	Count	4	1	5
		% within Mode of disposal?	80.0%	20.0%	100.0%
	Dump	Count	9	2	11
		% within Mode of disposal?	81.8%	18.2%	100.0%
	Local vendor	Count	3	0	3
		% within Mode of disposal?	100.0%	0.0%	100.0%
	Private vendor	Count	11	1	12
		% within Mode of disposal?	91.7%	8.3%	100.0%
	Pyrene Industries	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
	Re-use	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
Total		Count	30	4	34
		% within Mode of disposal?	88.2%	11.8%	100.0%

Inference:

Out of 34 respondent's majority of them i.e., 88.2% of them are not aware about Biodiesel production using UCO and only 11.8% of them are aware about the same.

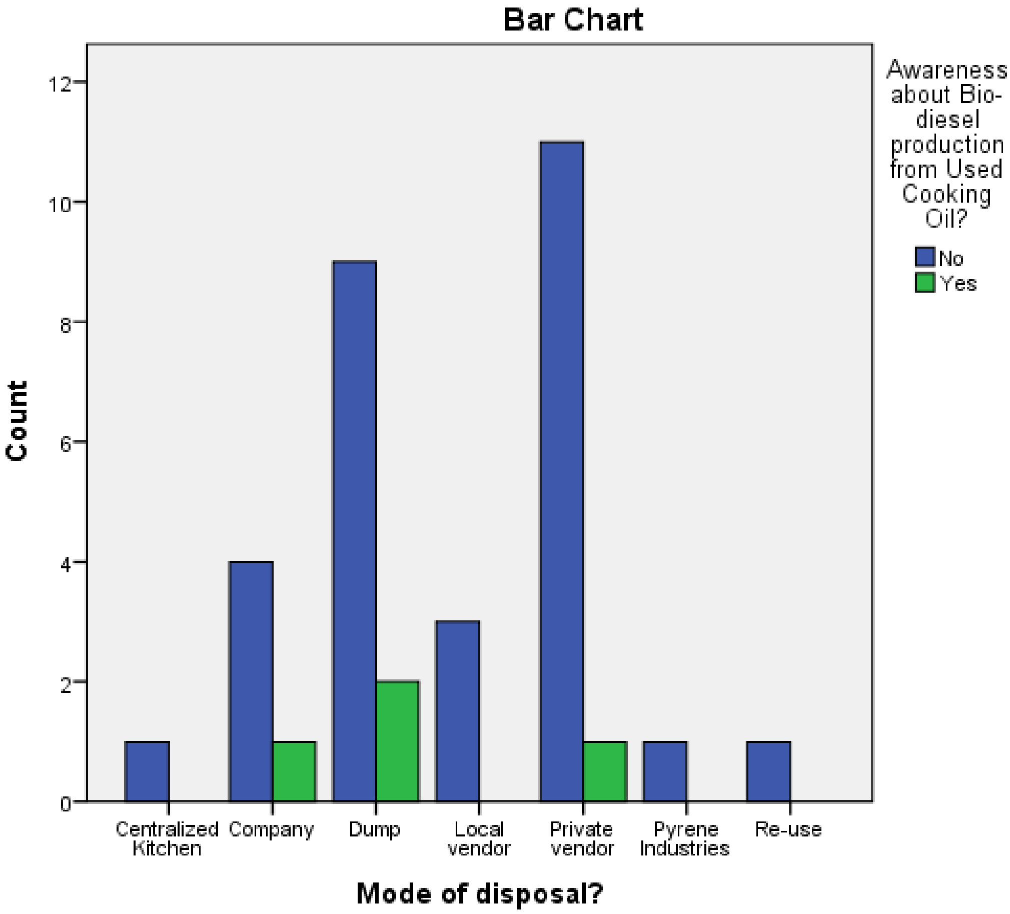
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.699[a]	6	.945
Likelihood Ratio	2.311	6	.889
N of Valid Cases	34		

a. 12 cells (85.7%) have expected count less than 5. The minimum expected count is .12.

Inference:

After testing at 5% level of significance the result says as the significance level is more than 0.05 i.e., 0.945 we accept the Null hypothesis. Thus, there is no relationship between "Mode of disposal" and "Awareness about Bio-diesel production from Used Cooking Oil".



Inference:

Looking at the graph we can infer that most of them who give the UCO to Private vendors are unaware about Biodiesel production from UCO.

3. Null Hypothesis: There is no relationship between "Mode of disposal" and "Awareness about ill impact of improper Used Cooking Oil disposal".

   Alternate Hypothesis: There is relationship between "Mode of disposal" and "Awareness about ill impact of improper Used Cooking Oil disposal".

Crosstab

			Awareness about ill impact of improper Used Cooking Oil disposal?		Total
			No	Yes	
Mode of disposal?	Centralized Kitchen	Count	0	1	1
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Company	Count	0	5	5
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Dump	Count	2	9	11
		% within Mode of disposal?	18.2%	81.8%	100.0%
	Local vendor	Count	0	3	3
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Private vendor	Count	0	12	12
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Pyrene Industries	Count	0	1	1
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Re-use	Count	0	1	1
		% within Mode of disposal?	0.0%	100.0%	100.0%
Total		Count	2	32	34
		% within Mode of disposal?	5.9%	94.1%	100.0%

Inference:

Out of 34 respondent's majority of them i.e., 94.1% of them are aware about ill impact of improper UCO disposal and 5.9% aren't aware about the same.

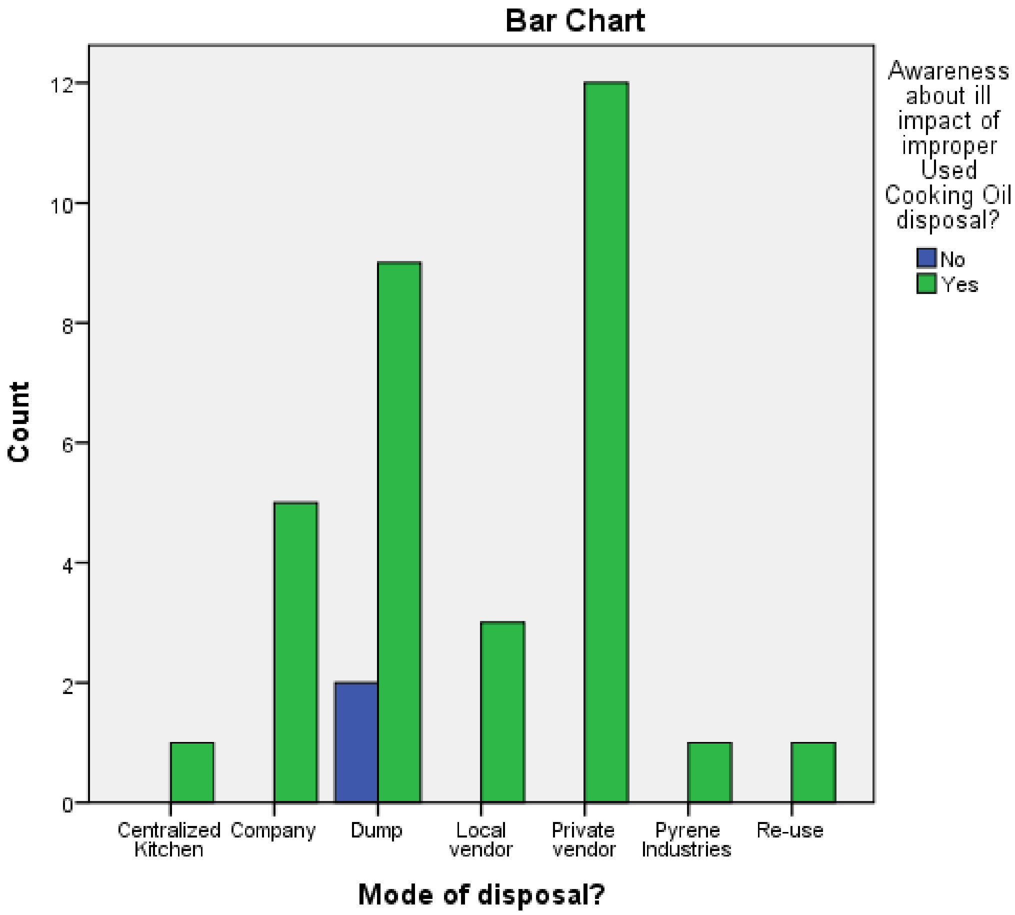
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.443[a]	6	.617
Likelihood Ratio	4.782	6	.572
N of Valid Cases	34		

a. 12 cells (85.7%) have expected count less than 5. The minimum expected count is .06.

Inference:

After testing at 5% level of significance the result says as the significance level is more than 0.05 i.e., 0.617 we accept the Null hypothesis. Thus, there is no relationship between “Mode of disposal” and “Awareness about ill impact of improper Used Cooking Oil disposal”.



Inference:

Looking at the graph we can infer that most of them who used to give UCO to Private vendor were aware about ill impact of improper UCO disposal.

4. Null Hypothesis: There is no relationship between “Mode of disposal” and “Awareness about the Health Hazards caused”.

   Alternate Hypothesis: There is relationship between “Mode of disposal” and “Awareness about the Health Hazards caused”.

Crosstab

			Awareness about the following [Health Hazards caused.]		
			Agree	Strongly Agree	Total
Mode of disposal?	Centralized Kitchen	Count	0	1	1
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Company	Count	3	2	5
		% within Mode of disposal?	60.0%	40.0%	100.0%
	Dump	Count	8	3	11
		% within Mode of disposal?	72.7%	27.3%	100.0%
	Local vendor	Count	1	2	3
		% within Mode of disposal?	33.3%	66.7%	100.0%
	Private vendor	Count	8	4	12
		% within Mode of disposal?	66.7%	33.3%	100.0%
	Pyrene Industries	Count	0	1	1
		% within Mode of disposal?	0.0%	100.0%	100.0%
	Re-use	Count	1	0	1
		% within Mode of disposal?	100.0%	0.0%	100.0%
Total		Count	21	13	34
		% within Mode of disposal?	61.8%	38.2%	100.0%

Inference:

Out of 34 respondents 38.2% strongly aware on the health hazards caused using UCO and 61.8% of them are just aware about same.

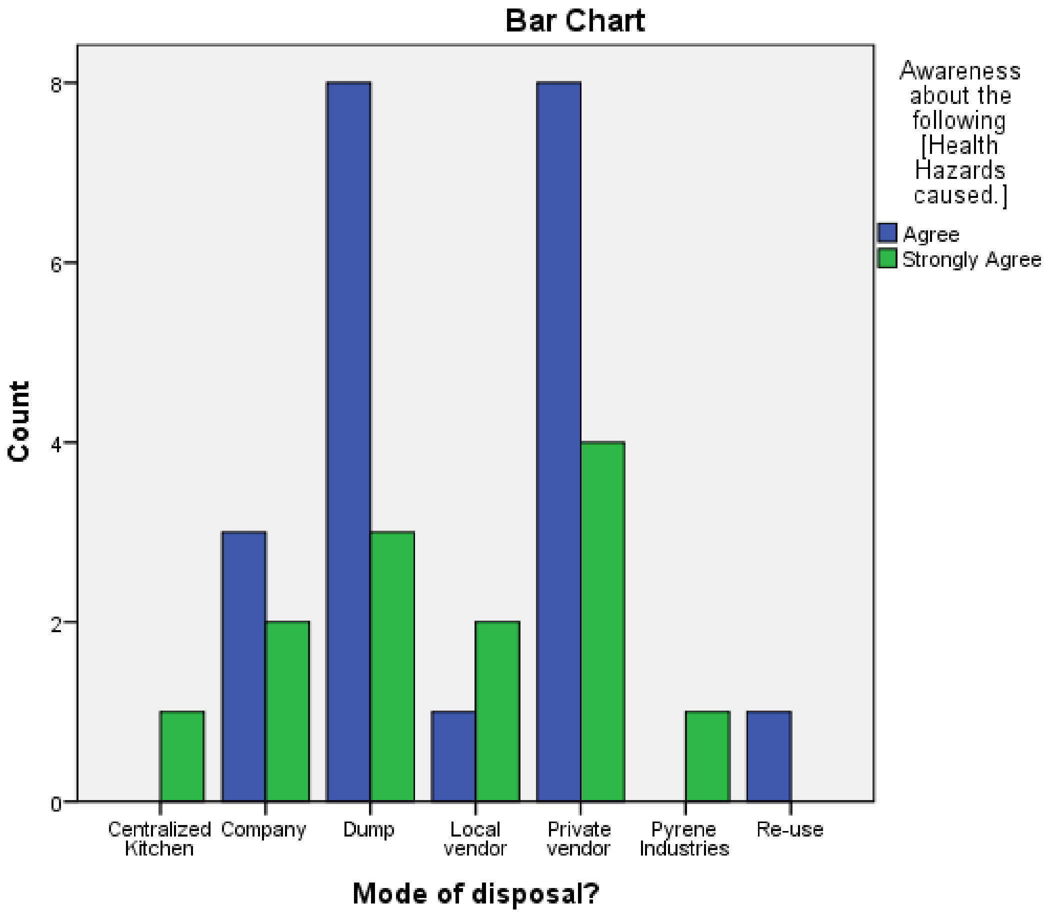
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.565[a]	6	.474
Likelihood Ratio	6.517	6	.368
N of Valid Cases	34		

a. 12 cells (85.7%) have expected count less than 5. The minimum expected count is .38.

Inference:

After testing at 5% level of significance the result says as the significance level is more than 0.05 i.e., 0.474 we accept the Null hypothesis. Thus, there is no relationship between "Mode of disposal" and "Awareness about the Health Hazards caused".



Inference:

Looking at the graph we can infer that the most them who used to give the UCO to Private vendors and Dump are just aware about the health hazards caused by usage of UCO.

5. Null Hypothesis: There is no relationship between "Mode of disposal" and "Awareness about the Problems faced to build a Sustainable Environment".

   Alternate Hypothesis: There is relationship between "Mode of disposal" and "Awareness about the Problems faced to build a Sustainable Environment".

Crosstab

			Awareness about the following [Problems faced to build a Sustainable Environment.]			
			Agree	Neutral	Strongly Agree	Total
Mode of disposal?	Centralized Kitchen	Count	0	0	1	1
		% within Mode of disposal?	0.0%	0.0%	100.0%	100.0%
	Company	Count	2	1	2	5
		% within Mode of disposal?	40.0%	20.0%	40.0%	100.0%
	Dump	Count	6	0	5	11
		% within Mode of disposal?	54.5%	0.0%	45.5%	100.0%
	Local vendor	Count	1	0	2	3
		% within Mode of disposal?	33.3%	0.0%	66.7%	100.0%
	Private vendor	Count	5	1	6	12
		% within Mode of disposal?	41.7%	8.3%	50.0%	100.0%
	Pyrene Industries	Count	0	1	0	1
		% within Mode of disposal?	0.0%	100.0%	0.0%	100.0%
	Re-use	Count	0	0	1	1
		% within Mode of disposal?	0.0%	0.0%	100.0%	100.0%
Total		Count	14	3	17	34
		% within Mode of disposal?	41.2%	8.8%	50.0%	100.0%

Inference:

Out of 34 respondents 50% of them are strongly aware, 41.2% of them are just aware and 8.8% of them don’t know about the problems faced to build a sustainable environment by the usage of UCO.

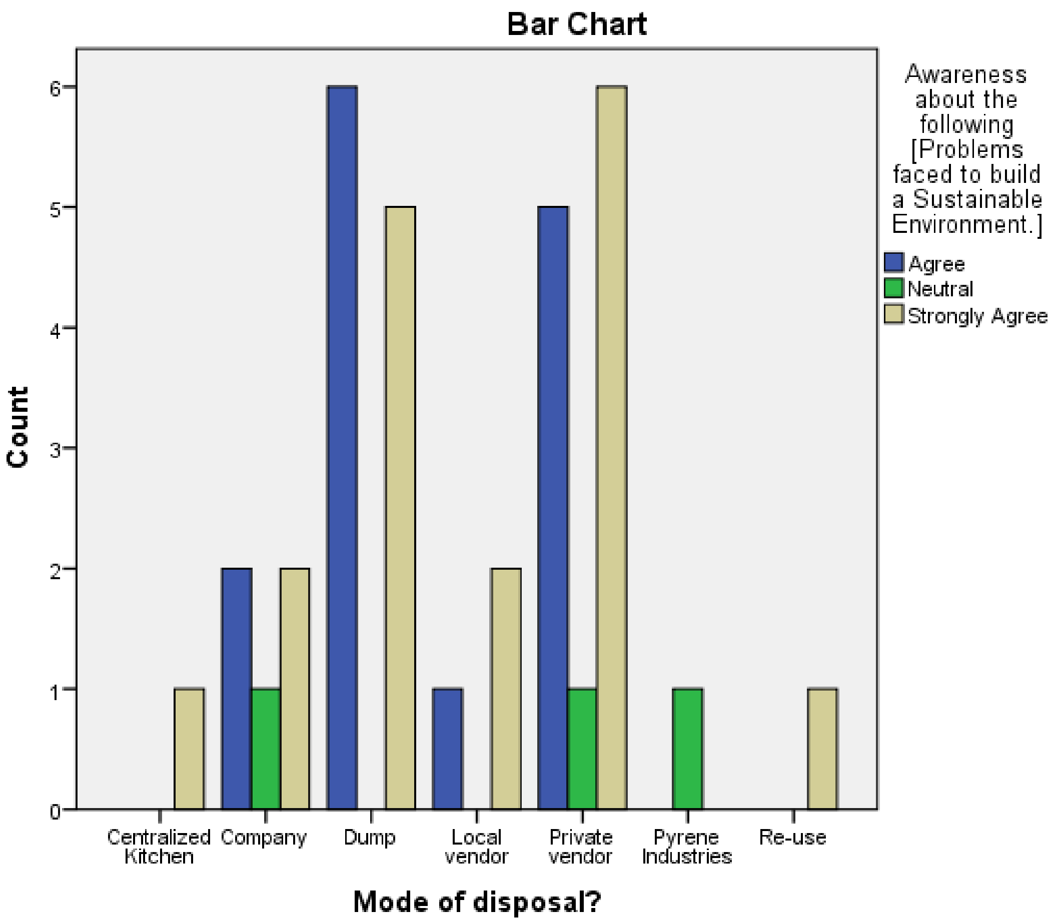
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.117[a]	12	.235
Likelihood Ratio	11.409	12	.494
N of Valid Cases	34		

a. 19 cells (90.5%) have expected count less than 5. The minimum expected count is .09.

Inference:

After testing at 5% level of significance the result says as the significance level is more than 0.05 i.e., 0.235 we accept the Null hypothesis. Thus, there is no relationship between “Mode of disposal” and “Awareness about the Problems faced to build a Sustainable Environment”.



Inference:

Looking at the graph we can infer that most them who give UCO to Private vendor and Dump are strongly aware and just aware about the problems faced to build a sustainable environment by usage of UCO.

RESULTS

➢ It was observed that the Food Business Operators (FBOs) choice of mode of disposal affects the knowledge and awareness about ways of UCO reuse and ill impacts of UCO disposal.

➢ Maximum UCO disposal by FBOs was through Private Vendors. The FBOs using Private Vendors were less open to provide UCO to collection center because Private Vendors were offering better rates for the UCO and most of the food chains had their own supply chain transporting UCO to their own centralised collection centres for different purposes.

➢ The FBOs preferring Self-Disposal were more willing to provide UCO to a collection center and also were found to be less aware of the ill impacts of improper disposal of UCO.

➢ It was observed that the FBOs do not keep proper records of UCO generated. Thus, giving way to the unaccountability of UCO.

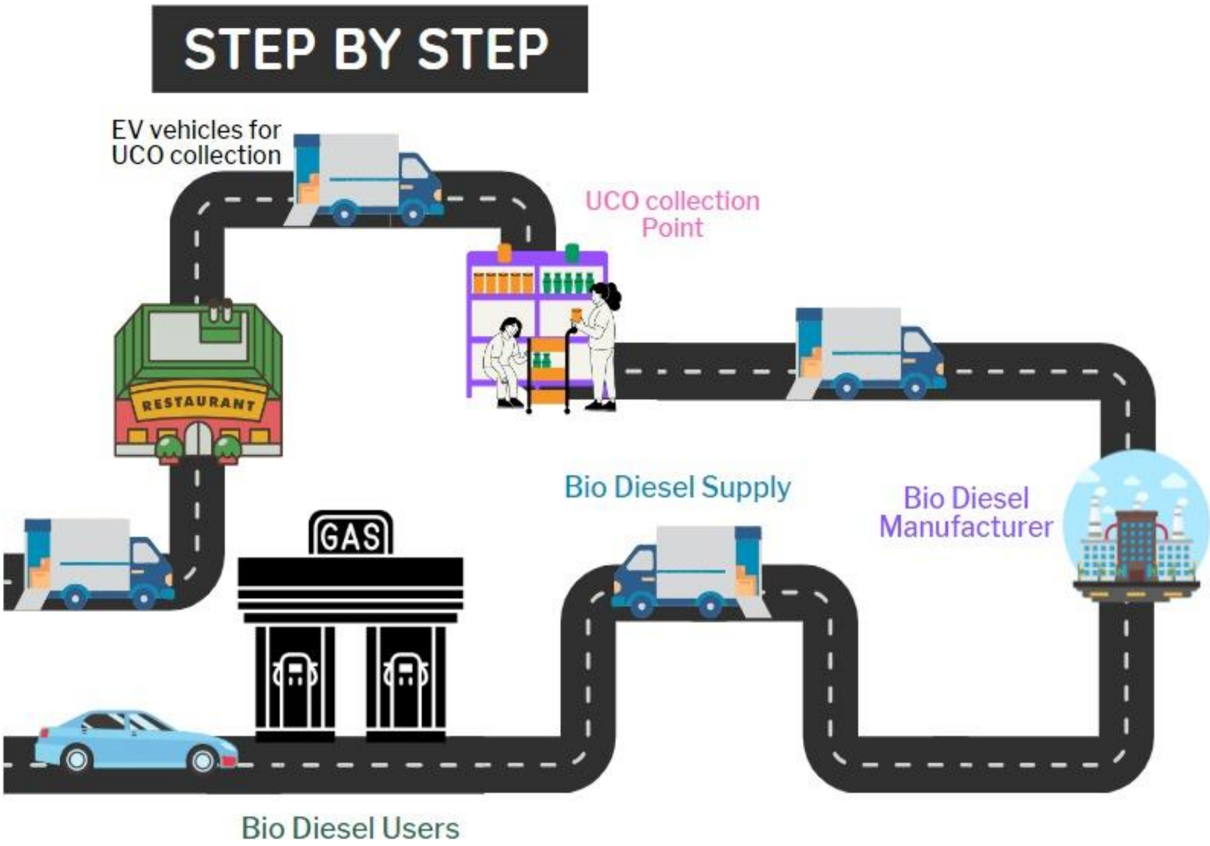
The results show that awareness plays an important role in encouraging Food Business Operators (FBOs) to provide their Used Cooking Oil (UCO) for Bio-Diesel Production. The proposed Supply Chain design aims at addressing it.

PROPOSED SUPPLY CHAIN DESIGN

A sustainable supply chain refers to a system that integrates environmentally, socially, and economically conscientious practices throughout its entire operational process. Embracing sustainability principles enables businesses to reap numerous advantages and foster positive outcomes. Here are some key uses and advantages of a sustainable supply chain:

1. Environmental conservation: Sustainable supply chains aim to minimize their environmental footprint by reducing waste, greenhouse gas emissions, and resource consumption. This can lead to a more efficient use of resources and protection of ecosystems and biodiversity.
2. Cost savings: Implementing sustainable practices often results in cost savings over the long term. By reducing waste and optimizing processes, companies can cut down on material and energy costs, thus increasing profitability.
3. Risk mitigation: Sustainable supply chains are generally more resilient to environmental and social disruptions. By diversifying suppliers and sourcing from regions less vulnerable to climate-related issues, businesses can reduce their exposure to risks such as supply shortages and regulatory changes.
4. Innovation and creativity: Sustainability challenges encourage businesses to think outside the box and develop innovative solutions to improve efficiency and reduce environmental impacts. This can lead to new technologies, products, and business models.
5. Long-term business viability: By incorporating sustainable practices, companies can ensure their long-term viability in an increasingly environmentally conscious world. Sustainable supply chains are better positioned to adapt to changing market conditions and stakeholder expectations.

SUPPLY CHAIN MODEL-1



Use of EV vehicles for collection and transportation of UCO

Procedure:

1. EV vehicles are assigned to collect the UCO from restaurants of given locations.
2. Restaurants store the UCO in respective storage containers provided by organizations.
3. EV vehicles collect the stored containers from all the restaurants given in a particular location.
4. The collected UCO is then transferred to a collection point. Collection point is a center point for all the EV vehicles to unload the collected containers.
5. The collected containers are now transported to BioDiesel Manufacturing industries.
6. Thus the manufactured Biodiesel is then transported to respective fuel stations for public use using EV vehicles.

Why EV vehicles for the Supply Chain?

Using electric vehicles (EVs) for supply chain operations offers numerous advantages, contributing to sustainability and efficiency. Here are some key benefits:

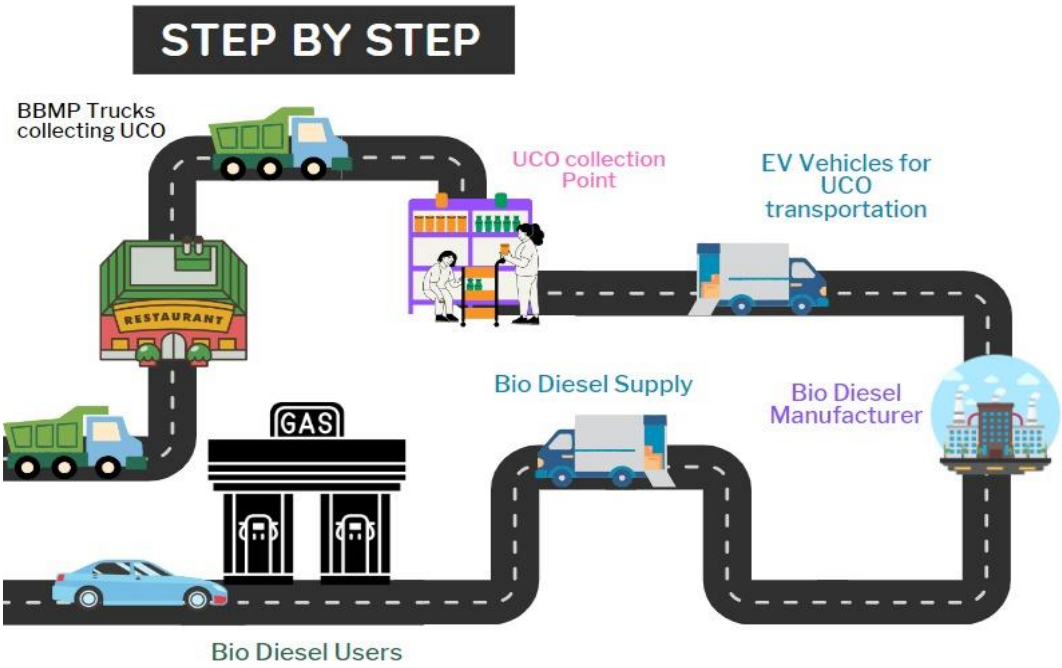
1. Environmental benefits: EVs produce zero tailpipe discharges, prompting diminished ozone harming substance emanations and air contamination contrasted with customary petroleum product fuelled vehicles. By embracing EVs, production network tasks can fundamentally add to moderating environmental change and further developing air quality.
2. Cost savings: However the forthright expense of EVs might be higher than ordinary vehicles, they for the most part have lower working and upkeep costs. EVs have less moving parts and require less successive upkeep, bringing about diminished costs over the vehicle's life expectancy.
3. Energy efficiency: Electric vehicles are more energy-proficient than gas powered motor vehicles. This proficiency means less energy utilization during transportation, decreasing in general fuel costs for the store network.
4. Noise reduction: EVs are calmer contrasted with conventional vehicles, which can be particularly helpful for store network activities in metropolitan regions. Decreased commotion contamination can prompt superior working circumstances for drivers and diminished unsettling influence for encompassing networks.
5. Potential for renewable energy integration: EVs can be charged utilizing power from sustainable power sources, for example, sunlight based or wind power. By coordinating sustainable power into the charging framework, production network tasks can additionally lessen their carbon impression and reliance on petroleum derivatives.
6. Local emissions reduction: In metropolitan regions, where store network tasks are frequently focused, EVs can assist with lessening neighbourhood emanations, adding to better general wellbeing and a cleaner residing climate for occupants.

Below is the list of EV logistic companies in India:

1. Delhivery
2. Ecom Express
3. Shadowfax

4. Wow Express
5. Rivigo
6. Gati-KWE
7. Xpressbees
8. DotZot
9. Blue Dart
10. Magenta

SUPPLY CHAIN MODEL-2



Use of BBMP and EV vehicles for collection and transportation of UCO

Procedure:

1. BBMP trucks are assigned to collect the UCO along with the collection of garbage from restaurants of a given location.
2. Restaurants store the UCO in respective storage containers provided by organizations.
3. BBMP vehicles collect the stored containers from all the restaurants given in a particular location.

4. The collected containers are transferred to collection centers. Collection centers are the points where EV vehicles (Trucks using BioDiesel can also be used as substitute for EV vehicles) collect the containers from BBMP trucks.
5. The collected containers are now transported to BioDiesel Manufacturing industries.
6. Thus the manufactured Biodiesel is then transported to respective fuel stations for public use using EV vehicles.

Why choose BBMP trucks as part of our Sustainable Supply Chain?

1. BBMP trucks are used to collect garbage from different restaurants of a given location.
2. BBMP trucks can be used to collect the UCO along with the waste collection in order to avoid assigning a separate transport for collection from restaurants. Thus this eliminates usage of any means of transport for UCO collection.

BBMP vehicles have different sections for waste collection.

(https://www.tribuneindia.com/news/chandigarh/replete-with-flaws-garbage-collection-needs-a-relook-193212)

Using biodiesel as fuel for vehicles offers several advantages, particularly in terms of environmental impact and energy sustainability. Here are some key reasons why biodiesel is used as an alternative fuel:

1. Renewable and Sustainable: Biodiesel is produced using sustainable assets like vegetable oils, creature fats, and reused cooking oil. These feedstocks can be renewed, making biodiesel a more feasible and harmless to the ecosystem choice contrasted with limited non-renewable energy sources like oil diesel.
2. Reduced Greenhouse Gas Emissions: Biodiesel has lower carbon dioxide (CO_2) emanations contrasted with traditional diesel. It can altogether lessen ozone harming substance discharges, assisting with moderating environmental change and further develop air quality.
3. Biodegradability: In the event of spills or leaks, biodiesel is less harmful to the environment as it is biodegradable and less toxic than petroleum-based diesel.
4. Compatibility with Existing Diesel Engines: Biodiesel can be utilized in most diesel motors with no adjustments. It tends to be mixed with petrol diesel to different extents, making it a practical and adaptable elective fuel choice.
5. Government Incentives: Many countries offer incentives and subsidies to promote the use of biodiesel and other biofuels, making it a financially attractive option for vehicle owners and fleet operators.
6. Diversification of Energy Sources: Utilizing biodiesel broadens the energy sources utilized for transportation, decreasing reliance on petroleum products and improving energy security.

FINANCIAL MODEL OF UCO SUPPLY CHAIN

SCOPE OF THE FINANCIAL MODEL

Financial Projections:

- Develop comprehensive financial projections for the biodiesel manufacturing project. This includes income statements, balance sheets, and cash flow statements.
- Estimate the capital investment required for the project, including the costs of equipment, facilities, feedstock procurement, and operational expenses.
- Calculate the revenue streams based on projected sales volume and pricing, considering factors such as market demand, competition, and regulatory incentives.
- Assess the profitability and return on investment (ROI) metrics, such as net present value (NPV), internal rate of return (IRR), and payback period.

Cost Analysis:

- Perform a detailed cost analysis to identify and quantify the various costs involved in biodiesel production. This includes feedstock costs, processing costs, labor costs, transportation costs, and overhead expenses.
- Analyse the cost drivers and potential cost-saving opportunities, such as process optimization, economies of scale, or sourcing strategies.
- Conduct sensitivity analysis to evaluate the impact of cost fluctuations and market variability on the financial model.

Risk Assessment:

- Identify and assess the key risks and uncertainties associated with the biodiesel manufacturing project. This includes market risks, regulatory risks, operational risks, and financial risks.
- Develop risk mitigation strategies and contingency plans to address potential challenges and uncertainties.

- Perform sensitivity analysis to understand the project's sensitivity to changes in key variables, such as feedstock prices, market demand, or regulatory policies.

Sensitivity Analysis:

- Conduct sensitivity analysis to evaluate the impact of changes in key variables on the financial model. This includes assessing the project's sensitivity to variations in feedstock prices, production costs, market demand, and regulatory incentives.
- Identify the critical variables and determine their potential effects on the project's financial performance and viability.
- Assess different scenarios and analyze their implications on the financial projections.

Questionnaire for financial data survey

How much cost is incurred for setting up a biodiesel plant?

Your answer

Does government provide subsidy for equipment's?

Your answer

How economical could bio fuel be for commercialization?

Your answer

What is the transportation cost of feedstock?

Your answer

What is the total power cost during one full production process?

Your answer

What is the total Manpower cost of Production?

Your answer

What is the annual capacity of the plant?

Your answer

How many litres of water is used for producing 1Itr of Biodiesel?

Your answer

How is biodiesel different from normal diesel?

Your answer

What is the standard procedure of biodiesel production?

Your answer

What is the variable and fixed overhead charges?

Your answer

What is the bi-product of biodiesel?

Your answer

Who are involved in the collection activities of the waste cooking oil in Bangalore?

Your answer

Current market price of used cooking oil.

Your answer

Total output produced in one cycle of production

Your answer

Quantity Ethanol and Methanol used in production process

Your answer

CASH FLOW – (ANNUALLY)

PARTICULARS	AMOUNT	AMOUNT
Revenue		
Sale of Bio Diesel	(3,00,000L * ₹90)	2,70,00,000
Sale of Glycerine	(75,000L * ₹10)	7,50,000
TOTAL REVENUE		**2,77,50,000**
Cost:		
Raw Material (UCO)	(3,75,000L * ₹50)	1,87,50,000
Chemical	(650L * ₹12)	7800
Labour		20,00,000
Electricity		2,50,000
Water		10,000
TOTAL COST		**2,11,07,800**
EBDIT	***(TR – TC)***	***67,32,200***
(Less)Depreciation		9,00,000
EBIT		58,32,200
(Less) Tax @ 30%		17,49,660
EAT		40,82,540
Add Depreciation		9,00,000
:·Annual Cash Flow		**49,82,540**

Assumptions

- The plant has the capacity of producing 1000 Liters of biodiesel per day so we are assuming it can produce (1000*25 working days*12 months) 300000 litres of biodiesel excluding the by-product.
- 1000L of UCO produces 80% of Bio Diesel and 20% of Glycerine (By product).
- 2liters of Chemical (Ethanol, Sulphuric acid) is used for 1000 litters of UCO.
- 20units of electricity is used for 100L of UCO.
- For Production purpose the cost of water is considered as 10,000 rupees per year.
- The Life of the machine is assumed to be 10 years.
- Depreciation for machines is assumed as 10%.
- Assuming the machine has no salvage Value.
- Interest is not deducted as it can be used as a Tax Shield.

Important note:

Since we are experimenting, and we don't have the details of the active users of the bio-diesel we considering only 1000 litres production capacity plant that can produce 300000 litres of bio-diesel even though North Bengaluru can generate 30,00,000 litres of UCO.

BREAK EVEN ANALYSIS

FIXED COST	1,50,00,000
SELLIN PRICE	90
VARIABLE COST	70

$$BEP = \frac{\text{FIXED COST}}{\text{SALES}-\text{VARIABLE COST}}$$

$$= \frac{15000000}{90-70}$$

= 7,50,000 Liters

To attain Break Even Point, the company should produce and sell 7,50,000 litres of Bio Diesel.

BREAKEVEN PERIOD

$$BE\ period = \frac{\text{Breakeven point}}{\text{Production per year}}$$

$$= \frac{7{,}50{,}000}{3{,}00{,}000}$$

= 2.5 years

To attain breakeven it will take 2.5 years to the company

WORKING NOTE

Depreciation Calculation of Plant:

$$Dep = \frac{\text{Asset Value} - \text{Salvage Value}}{\text{Life of the Asset}}$$

$$= \frac{90{,}00.000-0}{10}$$

= 9,00,000

CALCULATION OF NET PRESENT VALUE

Year	Net Cash flows	Discounting factor @10%	Present value of cash flows
1	4982540	0.909	4529129
2	4982540	0.826	4115578
3	4982540	0.751	3741888
4	4982540	0.683	3403075
5	4982540	0.621	3094157
6	4982540	0.564	2810152
7	4982540	0.513	2556043
8	4982540	0.467	2326846
9	4982540	0.424	2112597
10	4982540	0.386	1923260
Total			30612725

Total Present Value of Cash Flow = 3,06,12,725

Initial Investment = 1,50,00,000

NPV = Total Present Value of Cash Flow – Initial Investment

= 3,06,12,725 – 1,50,00,000

= 15612725

(*Discount rate assumed at 10%)

Since the Net Present Value of this project is positive we can proceed with implementing the project.

INTERPRETATION

1. GROWTH RATE: when growth rate is above 5% NPV turns out to be positive, hence the project is feasible. Keeping discount rate 5% and subsidy on equipment to be 20% which is given by government.

2 DISCOUNT RATE: when discount rate is below 5% NPV turns out to be positive, if it exceeds 5% NPV becomes negative keeping growth rate 10% and subsidy 20% from government.

3. SUBSIDY: when subsidy is above 10% the NPV turns out to be positive and it increases. Keeping growth rate 10% and discount rate 5%.

SUGGESTIONS

1. If there is growth of biodiesel, then NPV increases. The growth rate of biodiesel should be minimum of 5% and above it.

2. The government can reduce the rate of interest on loan which makes NPV positive. It should be less than 5%.

3. The government can provide subsidy on the equipment which reduces the total cost from which NPV turns out to be positive. The more percentage of subsidy given the more NPV value increases.

CONCLUSION

Biodiesel is an efficient alternative fuel to conventional diesel and can be used directly as a diesel engine fuel without modifying the engine. It has many positive properties such as high biodegradability, reduced greenhouse gas emissions, non-sulphur emissions, non-particulate emissions, low toxicity, and excellent lubricity and is derived from renewable sources such as vegetable oils and other natural sources. Biodiesel provides energy security, because it protects the environment and also promotes the economy. Used cooking oil (UCO) is a cost-effective and promising feedstock for biodiesel production.

There is little literature on the UCO supply chain, as most existing studies focus on the technical and technological aspects of converting UCO into biofuel. The UCO supply chain may prove to be a game changer by promoting responsible UCO disposal and biodiesel awareness. The system includes reverse logistics which makes it sustainable and also ensures proactive UCO procurement. India is the third largest importer of fossil fuels after the United States and China. If implemented on a larger scale, the proposed scheme could facilitate India's target of achieving a 5% biodiesel/diesel blend by 2030.

FUTURE SCOPE

➢ The project was limited to restaurants (organized sector) in the northern part of Bangalore city (New BEL Road). By extending the scope of the study to other areas of Bangalore, the optimal utilization of used cooking oil (UCO) can be significantly improved.

➢ Further studies on the life cycle of UCO at the hands of private vendors may help to understand the extent of unaccounted disposal of UCO into the system.

➢ Further studies on UCO self-disposal can help to understand the life cycle of uncollected UCO - if and how it finds its way back into the system.

➢ The government could organize awareness campaigns and stock tankers to educate the public about UCO and its use as a feedstock for biodiesel production.

➢ Government could introduce a system similar to solid waste collection for UCO from households and all other sectors.

➢ Government can regulate the collection of UCO from private sellers to increase the accountability of UCO thereby curbing illegal practices.

➢ Improving UCO collection can make India an exporter of UCO to international markets.

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ANNEXURE

Questionnaire

Sl. No	Name of the Venture	Type of Oil used	EO used per week	NEO generated per week	Mode of disposal	Frequency of disposal	Aware about Bio-diesel production from UCO	Aware about ill impact of improper UCO disposal	Idea about Awareness programs conducted by FSSAI	Willing to give UCO to a collection center for Bio-Diesel Manufacturing?
1	Ottupura	Refined Oil	140	7	Self-disposal	Every day	No	No	Yes	Yes
2	Easy Bites	Refined Oil	546	210	Private vendor	Every week	No	Yes	Yes	Yes
3	Casino Restaurant	Refined Oil	35	2	Private vendor	Every week	No	Yes	No	Yes
4	Mc Donald's	RBD palm oil	420	168	Private Vendor	Every three days	No	Yes	No	Yes
5	BEL st	Refined oil	7	3	Private Vendor	Every month	No	Yes	Yes	Yes
6	Nandini Deluxe	Refined Oil	175	105	Private Vendor	Every three days	No	Yes	No	No
7	Tarangini	Refined Oil	28	14	Private Vendor	Every month	No	No	Yes	Yes
8	Koriken	Palm oil	280	224	Private Vendor	Every week	Yes	Yes	Yes	Yes
9	Vinny's	Refined Oil	70	21	Private Vendor	Every month	No	Yes	Yes	Yes
10	Beijing Bites	Refined Oil	140	7	Self-disposal	Every day	No	Yes	Yes	Yes
11	Taco Bell	Refined Oil	42	7	Private Vendor	Every two weeks	Yes	Yes	No	No
12	Thunga Canteen	Refined Oil	105	15	Self-disposal	Every day	No	Yes	Yes	Yes

Sl. No	Name of the Venture	Type of Oil used	EO used per week	NEO generated per week	Mode of disposal	Frequency of disposal	Aware about Bio-diesel production from UCO	Aware about ill impact of improper UCO disposal	Idea about Awareness programs conducted by FSSAI	Willing to give UCO to a collection center for Bio-Diesel Manufacturing?
13	BOSS	Refined Oil	35	10	Private Vendor	Every two weeks	No	Yes	Yes	Yes
14	Pulusu	Refined Oil	105	21	Self-disposal	Every day	No	Yes	Yes	Yes
15	New BEL social	Refined oil	35	21	Private Vendor	Every two weeks	No	Yes	Yes	Yes
16	Corner 54	Refined oil	70	28	Self-disposal	Every month	Yes	Yes	Yes	Yes
17	Bell Curve	Refined oil	70	56	Private Vendor	Every month	No	Yes	No	No
18	Gilly's Restobar	Refined oil	70	14	Private Vendor	Every month	No	Yes	Yes	Yes
19	Chinese Wok	Refined oil	16	10	Private Vendor	Every week	No	Yes	No	No
20	A1 Rich bowl	Refined oil	28	0.5	Self-disposal	Every day	No	Yes	Yes	Yes
21	Leon Grill	Refined oil	210	14	Private Vendor	Every week	No	Yes	No	No
22	ITC master chef	Refined oil	35	14	Private Vendor	Every week	No	Yes	No	No
23	Smoky Docky	Refined oil	280	70	Private Vendor	Every day	No	Yes	Yes	Yes

Sl. No	Name of the Venture	Type of Oil used	EO used per week	NEO generated per week	Mode of disposal	Frequency of disposal	Aware about Bio-diesel production from UCO	Aware about ill impact of improper UCO disposal	Idea about Awareness programs conducted by FSSAI	Willing to give UCO to a collection center for Bio-Diesel Manufacturing?
24	IDC	Refined oil	140	70	Private Vendor	Every week	No	Yes	No	No
25	Truffles	Refined oil	280	70	Private Vendor	Every week	No	Yes	Yes	Yes
26	Bangalore adda	Refined oil	50	7	Self-disposal	Every three days	No	Yes	No	Yes
27	Shanthi Sagar	Refined oil	70	0	Re-use	NA	No	Yes	No	No
28	M grill	Refined oil	35	7	Private Vendor	Every day	No	Yes	No	Yes
29	Chandrappa Hotel	Refined oil	70	14	Self-disposal	Every day	Yes	Yes	No	Yes
30	Prashanth Naati corner	Refined oil	35	4	Private Vendor	Every week	No	Yes	No	Yes
31	Athulya	Refined oil	140	14	Private Vendor	Every month	No	Yes	No	Yes
32	Popeye's	Vanaspathi	67	60	Private Vendor	Every week	No	Yes	Yes	Yes
33	KFC	Refined oil	115	95	Private Vendor	Every two weeks	No	Yes	Yes	Yes
34	Brothers	Refined oil	84	0.5	Self-disposal	Every day	No	Yes	No	No