CATRA RESEARCH INSTITUTE
ISSN 2720 - 9644 (print)
ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS Indonesia OneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

USING MENTAL MODELING TO STUDY THE MANAGEMENT OF USED COOKING OIL IN KUALA NERUS

Volume: 5
Number: 4
Page: 1209 - 1225

Siti Syazuwahanna Binti Mohd ZAMRI[1], Latifah Binti Abdul GHANI[2]
[1,2]Faculty of Business, Economics and Social Development, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.
Corresponding author: Siti Syazuwahanna Binti Mohd Zamri
E-mail: S62884@ocean.umt.edu.my

Article History:
Received: 2024-05-12
Revised: 2024-06-12
Accepted: 2024-07-16

Abstract:
This study investigates the effectiveness of integrating real options with the Net Present Value (NPV) technique in the context of the financial services sector. The study aimed to assess how this approach enhances decision-making among financial practitioners. Using a quantitative research approach, data was collected via a questionnaire from 286 financial service participants with prior experience evaluating projects and making decisions. The results concluded that incorporating real options into traditional NPV analysis significantly improves decision-making, offering decision-makers greater flexibility and efficiency. The results suggest that when faced with hypothetical projects where initial NPV turns negative with the adoption of real options, decision-makers are more likely to make rational choices that optimize the outcome. Based on the findings, adopting a combined NPV and real options strategy for practitioners in the financial services sector is recommended to make more informed and flexible investment decisions, which would ultimately benefit their organizations and stakeholders. Future research should explore the qualitative aspects of decision-making and expand the analysis to different nations and industries.

Keywords: Used Cooking Oil, Sustainability, Mental Model, Knowledge and Awareness

INTRODUCTION

Using cooking oil in cooking has become an obligation in all communities worldwide (Ahmed et al., 2020). Cooking oil is one of the most important components of daily life and is used for various cooking purposes in home kitchens and the food industry. The amount of cooking oil used in cooking varies. In Malaysia, cooking oil is widely used in most local communities, especially in food businesses (Pratama et al., 2021). However, if not properly managed, the reuse of cooking oil can lead to health and environmental issues (Khalil et al., 2023). Malaysia is no exception, with Malaysia's Environmental Performance Index (EPI) ranking 130th out of 180 countries (Utusan Malaysia, 2022). This indicates that Malaysia has been included in the list of the dirtiest countries in the world.

This study focused on the knowledge and awareness of cooking oil waste management in Kuala Nerus, Terengganu. Dealing with waste cooking oil involves multiple aspects, including proper collection, storage, and disposal. Failure to systematically collect cooking oil waste can lead to environmental pollution, especially water pollution if the oil is discharged into sewage systems or rivers. This occurs when waste oil is discharged directly into sewage systems or drains, causing blockage of the channels (Wang et al., 2018).

Recycling used cooking oil reduces environmental pollution and promotes sustainable development (Martinez & Gomez, 2021). Used cooking oil is often dumped into waterways or underground, which can cause water and soil pollution and affect ecosystems. Recycling used cooking oil provides a more environmentally friendly alternative and brings significant economic

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

benefits. Used cooking oil can be recycled to produce various useful products, such as biodiesel, soaps, and detergents (Mannu et al., 2020). For example, biodiesel is a renewable fuel cleaner than traditional diesel. It reduces emissions of greenhouse gases and other pollutants, helping combat climate change.

In this study, the researchers focused on the environmental pollution caused by the disposal of waste cooking oil by business activities. They synthesized the knowledge and awareness level of waste cooking oil recycling practices among vendors, households and other communities, students and used cooking oil wholesalers. Sungai Kim Kim's Pollution has affected residents' well-being around Pasir Gudang, Johor, and even caused residents to be admitted to the Intensive Care Unit (ICU) (Yap et al., 2019). The materialistic attitude of some people also causes problems for the environment by dumping waste cooking oil into sewage and sewer systems (Matusineca et al., 2020). It is well known that the used cooking oil residue does not dissolve and gets stuck in the sewers, causing unpleasant odors and blockages. This pollution affects human well-being and soil surface degradation (Munir et al., 2023). According to a comprehensive study, the simple practices of some traders are due to the failure of the person responsible for providing cooking oil waste collection containers (Ayob, 2023).

Used cooking oil contains carcinogens and can harm human health if reused (Sharma et al., 2021). Residual toxins accumulated in used cooking oil, such as polymers, peroxides, aldehydes, amines, or diamines, react in the human body. This can lead to cancer, hypertension, arteriosclerosis, etc. (Ronitawati et al., 2020). Therefore, this study aimed to examine the level of knowledge and awareness regarding the environmental sustainability of waste cooking oil recycling. The 3 main objectives were to:

1. To identify the themes that arise in the used cooking oil management system.
2. To study the strength of the relationship between the three variables in the used cooking oil management system.
3. To develop a mental model modeling framework for used cooking oil management systems.

Disposal of used cooking oil. This study focuses on the knowledge and awareness of waste cooking oil disposal in Kuala Neerus, Terengganu. Kuala Neerus is a rapidly developing area on the east coast of Peninsular Malaysia. This may lead to rapid growth in the residential and commercial sectors, including increased restaurants and food outlets. This growth is in line with the increase in the use of cooking oil, which poses a challenge to the disposal of waste cooking oil waste. When solid waste increases, problems related to the waste disposal of cooking oil waste arise. Waste disposal of used cooking oil is a major problem in the community, especially in urban areas. Urban areas have concentrated populations and various industrial, administrative, and educational activities, and the waste disposal problem of used cooking oil is the most serious. According to Hoque and Rahman (2020), the amount of solid waste generated is equal to the total population of an area. Therefore, the increase in population, improved socioeconomic status and lifestyle, and the subsequent increase in household, commercial and factory waste are some of the main factors that lead to the increase in solid waste. To solve this solid waste problem, the government must allocate a large budget because the cost of solid waste management from collection, collection, and transportation to waste disposal is very high (Shadzili, 2020).

Entrepreneurial activity model of edible oil processing enterprises. Food venues include cafeterias and restaurants, which are one of the major causes of river pollution (Abd Rahman et al., 2018). Large-scale open venues, especially in densely populated areas, generate large amounts of solid waste (Helelo et al., 2019). Almost all operations at food industry sites generate waste because not all raw materials are fully used for cooking, and not all products are fully used by consumers.

CATRA RESEARCH INSTITUTE
ISSN 2720 - 9644 (print)
ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS onesearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

According to Khalil et al. (2023), Malaysians produce about 37,390 tons per day, at least 1.17 (kg) per person, which is expected to double yearly. Food waste and used cooking oil are generated during food preparation and cooking and when cleaning food waste from plates and bowls (Mohammed et al., 2022). Dishwater used to clean kitchen and tableware produces a lot of grease and oil in the dishwater, which then flows into nearby drains. This was confirmed by a previous study by Orjuela Clark (2020), which found that cooking oil was the main source of lipids. Therefore, as a solution, the researchers suggested introducing a program for 10 green entrepreneurs to manage the collection of cooking oil waste by converting it into biodiesel (Tesprasit et al., 2020).

Sustainable edible oil management using the 5R conceptual approach. Used cooking oil can make other ingredients (Foo et al., 2022). This was confirmed by a study conducted in Brazil, where Belo Horizonte has been converting used cooking oil into scented soap bars for cleaning and disinfection since November 2020 (Noronha, 2022). A study by Ismail et al. (2021) reported that soap was made from excess cooking oil in an innovative way that could solve the problem of used cooking oil disposal. Converting waste cooking oil into biodiesel is a good way to address food security, energy disasters, and environmental issues (Abdullah, 2020). Previous studies also support the conversion of waste cooking oil into biodiesel as it is more profitable, easier to handle, and ensures a stable supply (Malik et al., 2021).

Recycling also means collecting old materials from old waste and converting them into a form conducive to recycling waste (Khalil et al., 2023). However, these issues can be addressed by individuals and communities to achieve a waste-free nation. Solid waste is considered a source or representative of today's society, which is less efficient in waste prevention (Sukereman; Zainol, 2021). In short, today's society is more aware of systematic waste management by supporting various waste prevention initiatives. 5R stands for Refuse, Reduce, Reuse, Recycle, and Red (Zain, 2021).

Study of mental models for the issue of used cooking oil management.

1. Study of Applied Cooking Oil Mental Models for Global Issues. Used cooking oil is categorized as domestic solid waste. Managing used cooking oil (WCO) globally requires a holistic approach that combines public awareness, collection infrastructure, processing technology, and the reuse of invaluable products such as biodiesel and lubricant (Yang et al., 2021). The mental model helps visualize the process flow from source to final product, including logistics issues and market acceptance. Effective measures involve community education, preparation of collection containers, specialized transportation, and investment in green technologies. This approach not only reduces environmental pollution but also promotes a sustainable economy. Using WCO for biodiesel can reduce greenhouse gas emissions and dependence on fossil fuels (Guo et al., 2023; Atabani et al., 2023). Cooking oil waste management is an important, widely addressed global issue. The study highlights the environmental and economic challenges posed by improper disposal of WCOs, which can lead to significant negative impacts. However, WCO can be transformed into a valuable resource, contributing to sustainable practices and circular economy initiatives. A past study has emphasized recycling WCO to produce biodiesel, lubricants, and biosurfactants (Manikandan et al., 2023).

2. Study of the Mental Model of Used Cooking Oil for Malaysian Issues. In Malaysia, the problem of managing used cooking oil is getting more and more attention. Used cooking oil is a growing solid waste in Malaysia, causing various environmental and economic challenges. Improper disposal of WCO can cause water and soil pollution and affect human health (Shamsuddin et al., 2023). Managing used cooking oil (WCO) in Malaysia requires a comprehensive approach using a mental model involving public awareness, orderly collection, processing technology, and

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

reuse as a valuable product such as biodiesel. Mental models help map the process from source to final product, identifying issues such as lack of public awareness and inadequate collection infrastructure (Broek et al., 2021). Important measures, including ongoing education on the importance of WCO management, the provision of special bins for collection, efficient transportation, and investment in green technologies, can be seen in Figure 1. This approach can reduce environmental pollution and support a sustainable economy through green products that reduce greenhouse gas emissions and dependence on fossil fuels (Lim et al. 2023 al., 2023). This study can conclude that this effort can increase public awareness and efficiency of WCO management in Malaysia.

Figure 1. Collection of Used Cooking Oil Waste in the Study Area

METHODS

This study was conducted in the Kuala Nerus district, as shown in Figure 2. Kuala Nerus is a district located in Terengganu with a longitude of 103° 06' E and a latitude of 5° 23' N at the study site (GIS, 2024 and Moslim et al., 2021). This study is a mixed method, namely quantitative and qualitative, involving 30 community respondents consisting of food traders, used cooking oil buyers, students, households and the Terengganu Department of Environment (JAST).

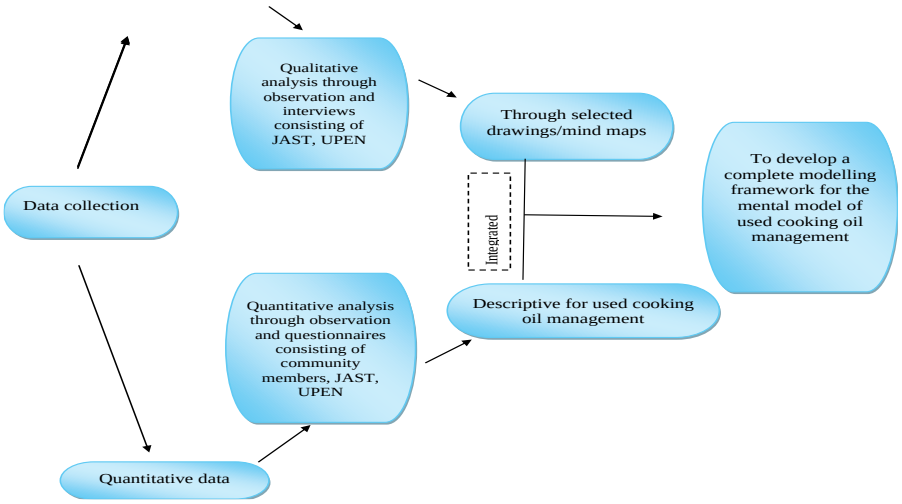
(Source: Terengganu Geospatial Information System (GIS), 2024)

Figure 2. Location of the case study area.

The study flowchart is presented in Figure 3, which discusses the framework for data collection and analysis from field observations, questionnaires, and interviews with authorities such as the Department of Environment (DOE), the National Solid Waste Management Unit (UPEN) and the local community. The data obtained in this study are divided into two, namely primary data and

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS OneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

secondary data. The primary data from this method were then analyzed using appropriate descriptive techniques to explain and elaborate the dominant relationship between domestic solid waste management systems and residents' awareness and attitude towards recycling. As a result, data is collected using Mental Model software. Data from interviews and questionnaires found that used cooking oil management results were analyzed based on 4 themes: knowledge, awareness, attitude and culture of used cooking oil waste management. The theme-based analysis is chosen so that there is no repetition of theme discussions that can be boring for study evaluators and readers (Dawson, 2022).



(Source: Terengganu Geospatial Information System (GIS), 2024)

Figure 3. Location of the case study area.

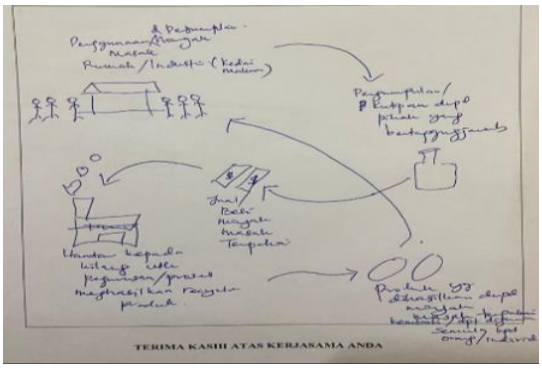
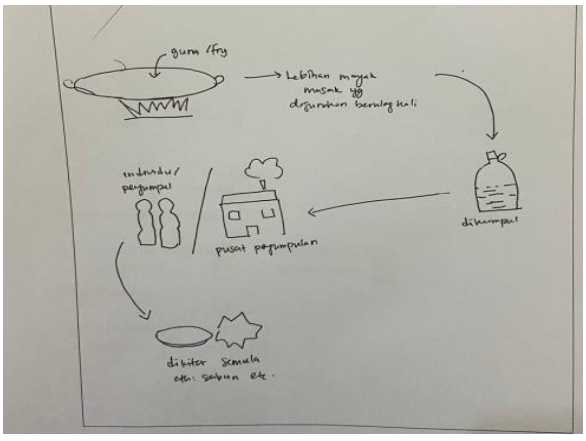
RESULT AND DISCUSSION

Qualitative analysis through sketches of selected paintings. The study's results will be presented according to the three objectives in the study's findings, which have been detailed in part one. Based on objective one has been fulfilled with social analysis carried out through selected sketches where that can help visualize the process of managing used cooking oil more clearly, i.e., the emerging themes have been identified and presented in Table 1. This sketch can also show the positive Impact of used cooking oil management on the environment and human health and the importance of providing effective inhalation programs for public awareness.

Table 1. Analysis Theme

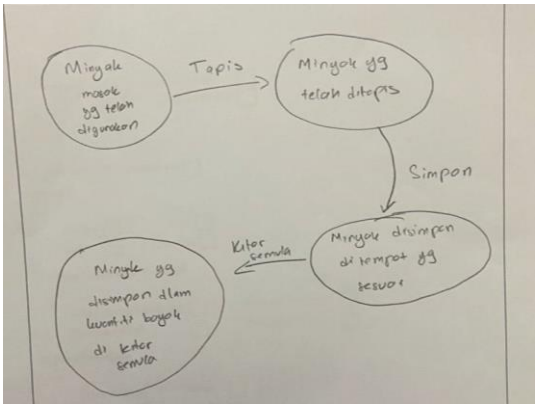
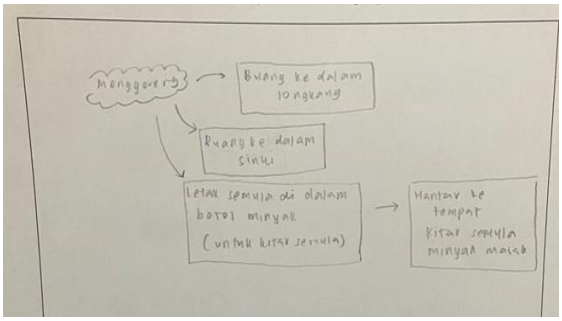
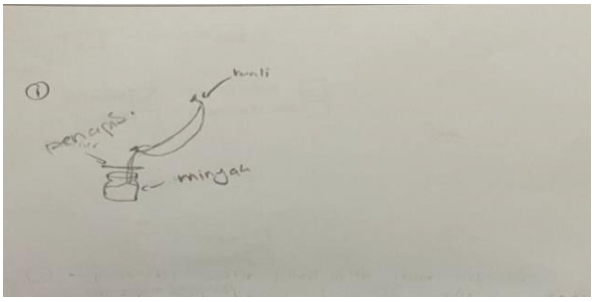
Theme	Information	Sketch/ Mind map of respondents' understanding

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Knowledge	• Knowing through the mass med • ia.Environmental Education (intermediate level). • Have existing knowledge. • Not knowing about the recycling of used oil is only a minority.		
How to dispose of	• Throw it in the trash. • Dispose of it in the sink. • Throw it on the ground. • Dispose of it in the drain. Recycling		

Sketch/Mindmap of respondents' und

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

			e r s t a n d i n g
Awareness	• Collect for recycling. • Disseminate knowledge about used oil recycling.		
Culture	• Less practiced		
Attitude	• Less aware • Slow to act		

Knowledge of Used Cooking Oil Management System. Based on the findings of the interviews, most of the respondents are already aware of oil recycling. Some respondents obtained

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

information sources on recycling cooking oil waste through the Internet and other mass media such as television, posters and newspapers. Disclosure of information on recycling used oil is limited compared to other domestic wastes such as glass, paper and cans. Such knowledge is rarely exposed to rural communities and rural areas, limiting it to the intelligent and, in turn, causing awareness of the environment to be incomplete and not include urban and rural residents. Therefore, efforts need to be further expanded, especially through media with an extensive information network, such as print and television, so that all levels of society are exposed to the knowledge of recycling cooking oil waste.

How to Dispose of Used Oil. Data from the study on the frequency of use of used cooking oil showed that 86.7% or 26 of the respondents used cooking oil more than three times before the oil was disposed of or thrown away. Some respondents admitted to using the oil repeatedly until it turned black. Using cooking oil more than twice and repeatedly can be harmful and toxic to health (Sari et al., 2022; Ghazali et al., 2023). This scenario of repeated use of cooking oil has become a habit for a few households and traders in the country, finding that although the majority of traders know that repeated use of cooking oil is not good for health, they still use it.

In this study, the cooking oil used for each activity was disposed of through various means, such as being thrown into the ground, sinks, trash cans, and drains. Only a minority, namely 3 respondents, recycled cooking oil waste by collecting oil waste, while the others disposed of it directly into the drainage.

> *"My aunt will always collect a lot of leftover cooking oil into a big barrel; later it will be full, and my aunt will call people who come to buy oil." (Respondent 15)*
> *"We usually collect this cooking oil in a big barrel; then it will take two or three weeks for oil collectors to come and buy it." (Respondent 16)*
> *"I will collect the used cooking oil in the barrel when I finish frying."(Respondent 17)*
> *"I often throw leftover cooking oil in the sink."(Respondent 18)*
> *"Previously, I only threw used oil into the sink and ran hot water afterward." (Respondent 24)*

Environmental Awareness. Exposure to the recycling of used cooking oil through the mass media and the official website of JAST has raised awareness of protecting the environment and strengthened the enthusiasm and motivation to practice recycling used cooking oil. The interviews showed that the respondents were very committed to recycling used cooking oil and would disseminate information on the recycling of used cooking oil to students, friends and family.

> *"…. if there is an allocation, we will invite Petronas, TNB or other industry parties as strategic companies to carry out sustainability programs, which we will advertise through Facebook or the official website of the Department of Environment...." (JAST).*
> *"I collect used cooking oil and put it in a special container." When there is a lot of it, I will send it to the used cooking oil collection center so that it can be recycled." "I will also remind my family members of the same thing because the cooperation of many parties will positively impact this issue ."(Respondent 24)*
> *"I will invite my family to recycle oil and tell them the danger of our actions to the environment. I will also share my knowledge on oil recycling". (Respondent 28)*

Culture and Attitude of Collecting Used Cooking Oil. These findings align with a study by Noor et al. (2023) that discusses domestic waste segregation, where only a minority of households and traders recycle used cooking oil, and the rest is disposed of in the environment. Similarly, a

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics

study conducted in Nanjing, China, showed that 90.2% of the restaurants studied disposed of used cooking oil by disposing of the cooking oil waste, and only 9.8% chose to recycle cooking oil waste (Zhang et al. 2020). The same findings are shown in the study of Khalil et al. (2023), where the level of cooking oil recycling practices in the community is still low. They prefer to throw oil waste into drains, sinks and toilets. This shows that they need to practice this cooking oil cycle in their daily lives. Among the factors is that the busyness of the respondents limits them to collecting used cooking oil, which is dumped directly into the sink, drain or soil to speed up the process of daily activities.

Descriptive analysis for used cooking oil management. Based on objective two, it is explained that related to the descriptive analysis of used cooking oil management involving factors, impacts and steps on various aspects of used cooking oil management to cultivate the practice. Effective management of used cooking oil helps reduce environmental pollution and contributes to a sustainable economy by turning waste into useful resources. This can be seen in Figure 1, Figure 2, and Figure 3, which discuss the recycling of used cooking oil.

1. Factors of Used Cooking Oil Recycling Practices.

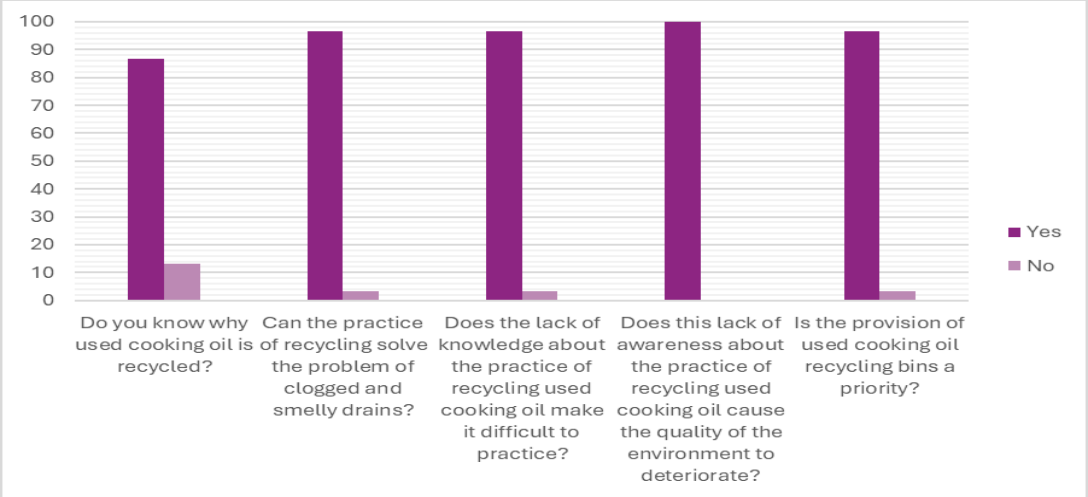


Figure 4. Used cooking oil recycling factors

The study found that all respondents knew that the lack of awareness of recycling used cooking oil would hurt the environment, equivalent to 100%. This study is in line with a previous study, which stated that more than 60% of used cooking oil from the domestic sector in Europe is disposed of in an improper way, which causes damage to the sewerage system and increases the cost of water treatment operations by up to 25% (Feo et al., 2023). Used cooking oil discharged into the sewerage can cause clogging of pipes and disruption to the filter system and oil/water separator in the wastewater treatment plant. Based on the findings of a study from the understanding of the respondents on the recycling factors of used cooking oil can be paralleled with a study from Smith and Taylor (2020) showing that the disposal of used cooking oil in landfills can produce methane gas which is a greenhouse gas that contributes to global warming. The lack of awareness and knowledge on how to recycle used cooking oil results in irresponsible disposal practices that increase the cost of cleanup and pollution management by local authorities (Martinez and Gomez, 2021). According to a study by Johnson and Williams (2019), the practice of recycling used cooking oil can significantly reduce the formation of fatbergs. This is because the recycled oil will not enter the sewerage system and reduces the risk of clogging and smell pollution.

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Then, the study found that the respondents' knowledge of the causes of used cooking oil being recycled was low, at 86.7%, equivalent to 26 respondents who knew about the matter. In a study by Universiti Kuala Lumpur (UniKL), Zaifilla Farina Zainuddin and her team developed an innovative storage container to facilitate the collection of used cooking oil at home. The study found that the community's awareness of the importance of recycling used cooking oil and the potential for generating additional income still needs to be higher. They collaborated with SWCorp and Alam Flora to raise this awareness among the population (Universiti Kuala Lumpur, 2023).

2. Impact of recycling used cooking oil.

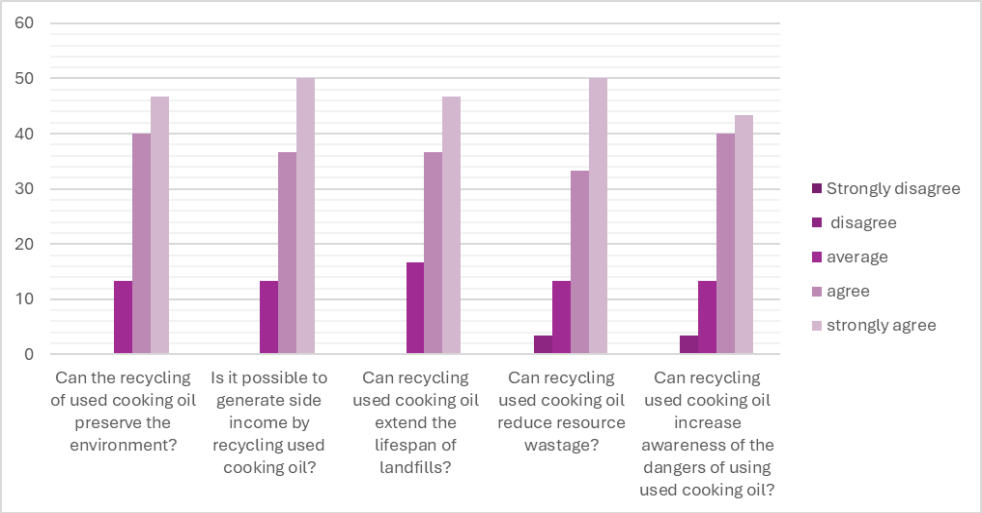


Figure 5. Impact of recycling used cooking oil

Based on the graph above, the highest number of respondents agreed with the second and fourth impact questions, which was 50% or 15 respondents. The graph above shows that the theme that arises is awareness, where cooking oil can generate side income and reduce the waste of resources. This can be reinforced by the previous article that cooking oil recycling supports a circular economy, where waste is transformed into a useful resource. By recycling used cooking oil, materials that would otherwise be discarded can be transformed into valuable products, such as biodiesel and soap, which reduces the amount of waste that goes into landfills (Martinez et al., 2019)

According to a study made by Wang et al. (2018) shows that by recycling used cooking oil, water and soil pollution can be reduced. If used cooking oil is disposed of improperly, it can contaminate water and soil and disrupt ecosystems. According to Martinez and Gomez (2021), education and awareness programs on the dangers of using cooking oil can increase public understanding of the environmental problems caused. This awareness helps motivate the community to take positive actions such as recycling used cooking oil, reducing the irresponsible disposal of such oil, and supporting more sustainable practices. Recycling used cooking oil provides economic benefits and has a huge positive impact on the environment and human health. This is a holistic approach to reducing pollution, repurposing available resources, and raising community awareness of their environmental responsibility.

3. Measures to improve the recycling practice of used cooking oil.

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

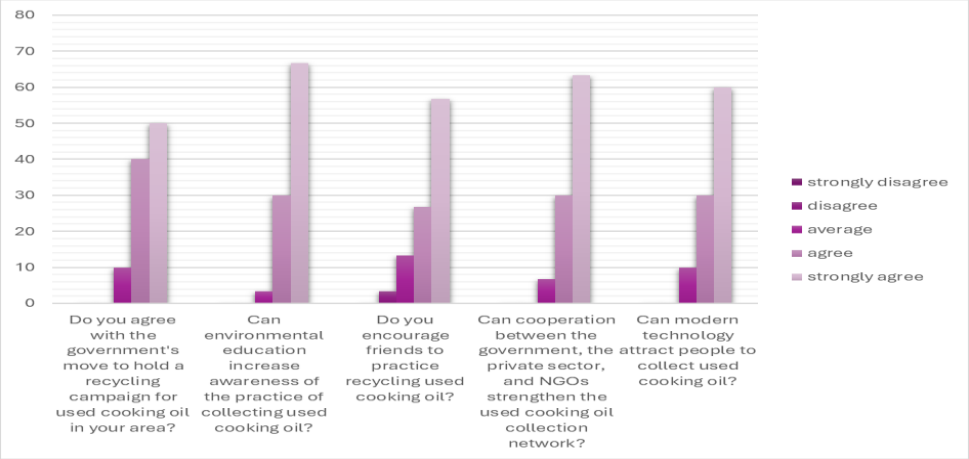


Figure 6. Measures to improve the recycling practice of used cooking oil

Referring to the graph above, in the findings of this study, the largest number of respondents was on a very agreeable scale, namely the second step question on environmental education to increase awareness, which was 20 respondents, equivalent to 66.7%. Environmental education can increase awareness of the need to collect used cooking oil. This can be proven by a study by Knickmeyer (2020), which states that awareness can influence an individual's knowledge of the expected outcome of waste segregation. Thorough knowledge of the outcome of an action or behavior can shape a person's understanding of the expected outcome (Zhang et al., 2023). Therefore, according to Johnson and Činčera (2023), environmental education aims to promote awareness and understanding of the environment and the responsibility to improve the quality of life.

Mental modeling of used cooking oil systems The study's findings were obtained based on knowledge and awareness of recycling used cooking oil. The themes and subthemes identified using the Mental Model method are shown in Figure 7. According to Wayan (2015), a mental model is a notion in a student's mind used to explain, explain, and anticipate a phenomenon. The figure above shows that the Mental Model framework has been successfully formed on the concept of used cooking oil waste management based on the knowledge and awareness of the Kuala Nerus district, Terengganu community. The figure above also explains that the blue arrow means that the community has a high level of information about the issues discussed.

In contrast, the orange arrow means that the community needs more information about the management of used cooking oil for recycling. The thicker the arrow means that most communities have a high level of information about the concept of used cooking oil management, and if thin, it is the opposite. The nature of the arrow in Figure 7 also shows the characterization aspect of the Mental Model framework of Kuala Nerus traders, Terengganu, regarding the concept of used cooking oil management.

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

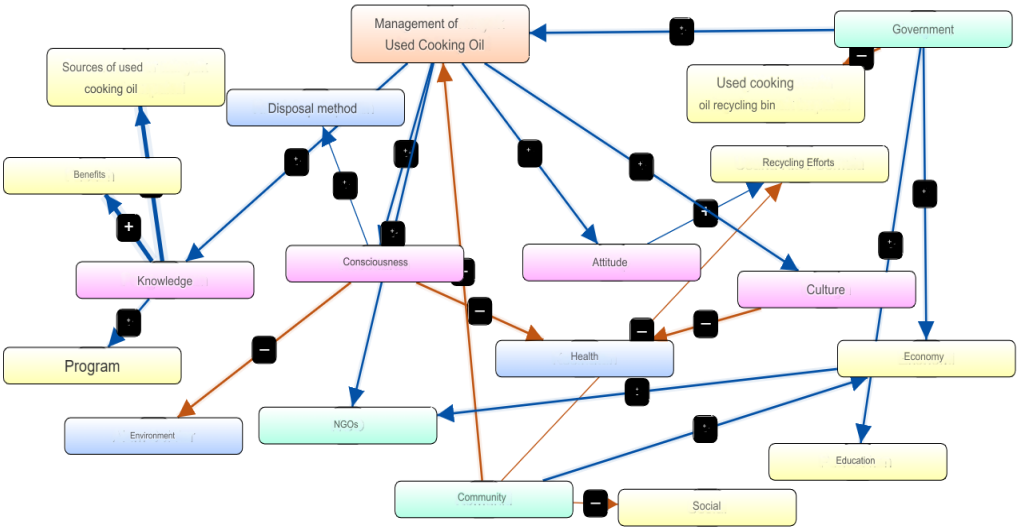


Figure 7. Conceptual Framework of the Mental Model for Waste Used Cooking Oil

Referring to Gold (1989), a modularity score based on the configuration of the edge-between algorithm has been used to analyze centrality, density and policy scenarios. Density (D) refers to the ratio of the measurement of the connectivity of the actual number of edges (E) between the nodes and the maximum number of bonds of the variable (V) present in the network (D = E /[V(V-1)] or D = E/V2) (Borgatti and Everett, 1977), Mapping of conceptual interfaces, matrices and scenarios. To assess the role of each variable in a system, variables are categorized as drivers, receivers, or regulars. Outdegree indicates the cumulative strength of the connection exiting the variable, while indegree indicates the cumulative strength of the variable entering the variable. The driver variable has a positive outer degree and a non-zero degree, the receiver variable has a positive outer degree and a zero outer degree, and the normal variable has both a non-degree and a non-zero degree. Each map's concept's centrality is calculated as the sum of the outdegree and indegree concepts. This metric serves to understand the main way a concept is viewed in the system. Once all metrics have been calculated for individual models, stakeholder groups average the metrics, and the variance is determined by profession (Table 2).

Table 2. Structural Matrix

Structure Matrix	Model Collection
Total Components	19
Total connections	22
Density	0.0643274854 (0.06)
Connections per components	1.1578947368 (1.16)
Number of driver components	2
Number of receiver components	11
Number of ordinary components	6
Complexity score	5.5

Source: Researcher

Based on Table 2, the model illustrates the structure of a used cooking oil management system that has 19 components with 22 connections. The sum of components refers to all the entities or

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

elements in this system. 22 connections represent the relationships and interactions between these components, showing how information or material flows between them. The density of the mesh is 0.0643274854 (0.06), which indicates the ratio between the number of available connections and the maximum possible connections, illustrating that not all components are directly connected. The average number of connections per component is 1.1578947368 (1.16), measuring the average number of connections per component in the system. 2 driver components play a major role in moving or influencing the network, acting as the main source or mover. Meanwhile, the 11 receiver components act as elements that receive inputs or are influenced by other components, acting as reception points in the system flow. In addition, 6 common components do not act as the main driver or receiver but are still involved in the network, perhaps as a link or supporter in the system's flow. The complexity score for this model is 5.5, which gives an idea of the system's complexity based on the number of components and the connections and interactions between them. The higher the complexity score, the more complex the network is. This explanation helps to understand the structure and function of each component in the used cooking oil management system.

1. Results of MM theme variables. Overall, the results of the mental theme variables of this model provide insight into how each component interacts in a used cooking oil management system and point to the need for improved relationships and cooperation between all parties involved to improve the system's effectiveness. MM modeling shows the results of the variable mental theme of the model in the management of used cooking oil, consisting of the strongest emerging theme from the diagram, which is the awareness of the management of used cooking oil. Awareness is important because it is the main link influencing other model components. This awareness is directly related to knowledge, attitudes, and recycling efforts, which are all important in ensuring the effective management of used cooking oil. Knowledge raises awareness about the benefits of recycling used cooking oil and proper disposal methods, while a positive attitude towards recycling encourages individuals to engage in this endeavor. High awareness also positively influences other components, such as health, culture, and the economy. For example, increased awareness can lead to more effective programs and initiatives from NGOs and governments, improving the community's environmental and health aspects. Therefore, awareness is the most powerful theme because it is the main driver connecting and influencing many important aspects of the used cooking oil management system, ensuring that each component moves harmoniously to achieve the desired purpose.

A weak theme in this mental model is the health component. Although health has some relationship with other components such as awareness, culture, and community, its influence on used cooking oil management systems is weaker. Health in this context is more influenced by other factors, such as attitudes and culture, and does not play a major role as a driver in this system. Existing negative relationships indicate the presence of influence but not on a large scale to significantly affect the overall system. This suggests that increased awareness about health can be helpful, but more is needed to be a major factor driving the use of cooking oil management systems. This is because the health component does not directly and significantly affect the used cooking oil management system. In this model, health is more influenced by consciousness, culture, and community, but it does not play a major role as a driver. Factors such as knowledge of the benefits of recycling, positive attitudes towards recycling, and policies and programs implemented by the government and NGOs are stronger in driving this system. Therefore, while health is an important aspect, in this context, it is not strong enough to be a major factor influencing the effectiveness of the overall used cooking oil management system, compared to other factors that are more direct and actively involved in the recycling process.

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Limitations of further studies and recommendations. However, some analytical constraints are associated with this used cooking oil management system. The lack of sufficient data leads to less comprehensive analysis. This is because the lack of accurate and detailed data makes it difficult for researchers to fully understand the scale of the problem and the effectiveness of the measures taken, resulting in the results based on the studies being less accurate or irrelevant to the actual situation in the field. While limited time limits the data collection and analysis process, reducing the reliability of the results. The mental model used may only be able to cover some important aspects, such as economic factors and government regulations, making it too simplistic. Additionally, the focus of research on only a few themes can lead to incomplete or biased views, which hinders a thorough understanding of possible issues and measures. These limitations should be taken into account for future study improvements.

Several recommendations could be made based on the limitations identified to improve the study of used cooking oil (WCO) management in Malaysia. First, the collaboration network between researchers, industry, and stakeholders should be expanded to improve access to more comprehensive and quality data. Second, more flexible study scheduling to allow for more comprehensive data collection and in-depth analysis. Third, more complex or integrative mental models can be used that can include a wider range of social, economic, and environmental factors. This is to investigate the strength of more accurate relationships based on quantitative analysis studies at a higher level.

In contrast, qualitative analysis can be used in various ways, such as mind maps, drawings and fuzzy cognitive modeling. Lastly, a study methodology that allows for multidisciplinary and holistic research is better used to understand the complex interactions in WCO management in Malaysia. By doing this, the study hopes to provide deeper insights and more effective solutions for overcoming WCO management challenges.

CONCLUSION

To improve the management of used cooking oil (WCO) in Malaysia, the conclusion that can be drawn is the need for reform and enforcement of relevant policies and laws to ensure industry compliance with effective practices in the collection, transportation, and processing of WCOs. For example, it should be mandatory for all restaurants and food factories to store and deliver WCO to processing centers regularly. In addition, the importance of continuous implementation of public awareness campaigns to increase public understanding of the importance of WCO management for the environment and the economy. Close cooperation with authorities such as the Department of Environment Malaysia needs to be enhanced to ensure effective monitoring and supervision of implementing best practices in the industry. Developing the right infrastructure is also important to facilitate the efficient and effective collection and processing of WCOs, such as easily accessible collection containers and well-organized transportation systems. This can help speed up the flow of WCO from source to processing more efficiently. By taking these steps, the management of WCO in Malaysia can be improved more effectively and effectively in the long term.

Using Mental Modeler software, it can identify emerging themes in the WCO management system. By applying appropriate mental models, such as those that combine technical, economic, and social aspects, we can identify weak points and opportunities to improve operational efficiency and safety. The mental model also helps in planning more effective strategies for collecting, transporting, processing, and reusing WCOs and ensuring compliance with safety regulations and standards. Using the right mental model, the management of WCO can be effectively improved, contributing to environmental sustainability and sustainable economic development.

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

REFERENCES

Abd Rahman, N. S. (2018). Pengurusan secara lestari sisa minyak masak dan sisa berminyak daripada premis makanan (Doctoral dissertation, UKM, Bangi).

Abdullah, A. Z. (2020). Produk Hiliran Oleokimia: Inovasi Kejuruteraan Tindak Balas dalam Mengharungi Kesuraman Industri Sawit (Penerbit USM). Penerbit USM.

Ahmed, R. B., & Hossain, K. (2020). Waste cooking oil as an asphalt rejuvenator: A state-of-the-art review. Construction and building materials, 230, 116985. https://doi.org/10.1016/j.conbuildmat.2019.116985

Atabani, A. E., Silitonga, A. S., Badruddin, I. A., & Mahlia, T. M. I. (2023). A comprehensive review of biodiesel as an alternative energy resource and its characteristics. Renewable and Sustainable Energy Reviews, 16(4), 2070-2093. https://doi.org/10.1016/j.rser.2012.01.003

Ayob, W. (2023). Kelestarian Aktiviti Kitar Semula Untuk Kesejahteraan Ummah Daripada Kacamata Pihak Berkuasa Tempatan Yang Terpilih Di Negeri Kedah, Malaysia. Journal of Islamic, 8(59), 114-124.

Broek, K., Luomba, J., Broek, J., & Fischer, H. (2021). Evaluating the Application of the Mental Model Mapping Tool (M-Tool). Front. Psychol., 12:761882. https://doi.org/10.3389/fpsyg.2021.761882

De Feo, G., Ferrara, C., Giordano, L., & Ossèo, L. S. (2023). Assessment of Three Recycling Pathways for Waste Cooking Oil as Feedstock in the Production of Biodiesel, Biolubricant, and Biosurfactant: A Multi-criteria Decision Analysis Approach. Recycling, 8(4), 64. https://doi.org/10.3390/recycling8040064

Foo, W.H., Koay, S.S.N., Chia, S.R., Chia, W.Y., Tang, D.Y.Y., Nomanbhay, S., Chew, K.W., 2022. Recent advances in converting waste cooking oil into value-added products: a review. Fuel 324, 124539. https://doi.org/10.1016/j.fuel.2022.124539

Guo, M., Song, W., & Buhain, J. (2023). Bioenergy and biofuels: History, status, and perspective. Renewable and Sustainable Energy Reviews, 42, 712-725. https://doi.org/10.1016/j.rser.2014.10.013

Helelo, A. B., Senbeta, A. F., & Anshebo, S. T. (2019). Assessment of solid waste management (SWM) practices in Hawassa University campuses, Ethiopia. Journal of Applied Sciences and Environmental Management, 23(6), 1081-1086. https://doi.org/10.4314/jasem.v23i6.13

Hoque, M. M., & Rahman, M. T. U. (2020). Landfill area estimation is based on solid waste collection prediction using the ANN model and final waste disposal options. Journal of Cleaner Production, 256, 120387. https://doi.org/10.1016/j.jclepro.2020.120387

Ismail, N. H., bin Rossly, M. A. I., & Dania, N. F. (2021). Casenna soap: penerimaan pengguna terhadap sabun berasaskan minyak masak terpakai dan daun gelenggang.

Johnson, A., & Williams, P. (2019). Reducing Sewer Blockages and Odor Problems through Used Cooking Oil Recycling. Journal of Water and Environment, 34(2), 102-115.

Khalil, N. A., binti Ismail, N., & binti Ariffin, A. (2023). Kajian Tahap Pengetahuan dan Amalan Kitar Semula di Kalangan Warga Politeknik Tuanku Sultanah Bahiyah. Public Health and Safety International Journal, 3(01), 21-31. https://doi.org/10.55642/phasij.v3i01.296

Lim, S., Teong, L. K., & Bhatia, S. (2023). A review of the development and challenges of biodiesel production from WCO in Malaysia. Renewable and Sustainable Energy Reviews, 142, 110833.

CATRA RESEARCH INSTITUTE
ISSN 2720 - 9644 (print)
ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS ONESEARCH ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Malik, M. S. A., Jaafar, M. N. M., Mavalavan, N., Ismail, M. S. M., Rahim, M. R., & Said, M. (2021). Prestasi Pembakaran Biodiesel Berasaskan Minyak Bunga Matahari Ke Atas Pembakar Berbahan Api Cecair: Combustion Performance Sunflower Oil Biodiesel on Liquid Fuel Burner. Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 82(2), 127-145. https://doi.org/10.37934/arfmts.82.2.127145

Manikandan, G., Kanna, P., Taler, D., & Sobota, T. (2023). Review of Waste Cooking Oil (WCO) as a Feedstock for Biofuel—Indian Perspective. Energies, 16, 1739. https://doi.org/10.3390/en16041739

Mannu, A., Garroni, S., Ibanez Porras, J., & Mele, A. (2020). Available technologies and materials for waste cooking oil recycling. Processes, 8(3), 366. https://doi.org/10.3390/pr8030366

Martinez, L., & Gomez, R. (2019). Recycling used cooking oil into biodiesel: A community approach to waste management and sustainable energy. Journal of Cleaner Production, 223, 423-429.

Martinez, L., & Gomez, R. (2021). The Impact of Awareness and Knowledge on Used Cooking Oil Recycling Practices. Journal of Environmental Education, 52(3), 237-250.

Matušinec, J., Hrabec, D., Šomplák, R., Nevrlý, V., Pecha, J., Smejkalová, V., & Redutskiy, Y. (2020). Cooking oil and fat waste management: a review of the current state. Chemical Engineering Transactions.

Mohd Ghazali, U. Z., & Sabjan, M. A. (2023). Konsep Halalan Toyyiba dalam Penggunaan Air. e-BANGI Journal, 20(3). https://doi.org/10.17576/ebangi.2023.2003.25

Mohamed, K. A., Sakawi, Z., & Hussain, M. Y. (2022). Amalan kebersihan makanan dalam kalangan pengendali makanan kantin sekolah di ampang selangor. e-BANGI Journal, 19(1).

Moslim, N., Mokhtar, N., Zubairi, Y., & Hussin, A. (2021). Understanding the Behaviour of Wind Direction in Malaysia during Monsoon Seasons using Replicated Functional Relationship in von Mises Distribution. Sains Malaysiana 50(7), 2035-2045. https://doi.org/10.17576/jsm-2021-5007-18

Munir, M. A., Hussain, A., Farooq, M., Habib, M. S., & Shahzad, M. F. (2023). Data-Driven Transformation: The Role of Ambidexterity and Analytics Capability in Building Dynamic and Sustainable Supply Chains. Sustainability, 15(14), 10896. https://doi.org/10.3390/su151410896

Noor, N. H. M., & Nordin, N. B. (2023). Undang-Undang Dan Dasar Alam Sekitar Terhadap Pengasingan Sisa Domestik: Kajian Kesan Tidak Langsung Kesedaran Masyarakat: Environmental Law And Policy On Domestic Waste Segregation: Study On The Indirect Effect Of Community Awareness. Asian Journal Of Environment, History And Heritage, 7(2).

Noronha, P.M., 2022. Transforming waste into soap. Nature. https://doi.org/10.1038/ d41586-022-01817-6

Orjuela, A., & Clark, J. (2020). Green chemicals from used cooking oils: Trends, challenges, and opportunities. Current opinion in green and sustainable chemistry, 26, 100369. https://doi.org/10.1016/j.cogsc.2020.100369

Pratama, I., & Ernah, E. (2021). Analisis proses keputusan pembelian minyak goreng sawit: studi kasus pada warga korea di kabupaten bekasi. Jurnal Ilmu Keluarga & Konsumen, 14(2), 176-188. https://doi.org/10.24156/jikk.2021.14.2.176

Ronitawati, P., Riantama, V., & Palupir, K. C. (2020). Faktor Yang Berhubungan Dengan Penggunaan Minyak Berulang Pada Pelaku Usaha Makanan. Jurnal Riset Gizi, 8(2), 116-121. https://doi.org/10.31983/jrg.v8i2.6357

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google doi Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Sari, S. P., Yuliati, E., Metty, S. D., & Shayida, H. (2022). Gambaran Pola Konsumsi Minyak Goreng Pada Rumah Tangga. In Prosiding Seminar Nasional Multidisiplin Ilmu (Vol. 4, No. 1, pp. 131-138).

Shadzili, S. B. A., & Sharuddin, P. S. B. (2020). Kajian Tahap Kesedaran Kakitangan Pengurusan Fasiliti Terhadap Kepentingan Pengurusan E-sisa.

Shamsuddin, N., & Zulkifli, N. (2023). Eco - Burning Barrels. Politeknik Sultan Salahuddin Abdul Aziz Shah.

Various waste cooking oils for biodiesel production: A comprehensive analysis of feedstock. Waste Management, 136, 219-229. https://doi.org/10.1016/j.wasman.2021.10.022

Smith, J., & Taylor, L. (2020). Environmental Benefits of Recycling Used Cooking Oil. Journal of Environmental Management, 255, 109847.

Sukereman, A. S., & Zainol, N. N. (2021). Perluas intervensi jayakan program Komuniti Sifar Sisa.

Tan, K. T., Lee, K. T., & Mohamed, A. R. (2023). Second-generation biofuel production from WCO in Malaysia: Opportunities and challenges. Energy Policy, 65, 355-362.

Tesprasit, K., Aksharanandana, P., & Kanchanavibhu, A. (2020). Building green entrepreneurship: a journey of environmental awareness to green entrepreneurs in Thailand. Journal of Information Technology Applications & Management, 27(5), 35-47.

University Kuala Lumpur (2023). Unikl Researchers Develop Innovative Container To Encourage Used Oil Recycling.

Wang, H., Yang, L., & Chen, X. (2018). Environmental impacts of used cooking oil: Mitigation strategies for cleaner production. Journal of Environmental Management, 224, 28-34.

Yang, J., & Shan, H. (2021). The willingness of submitting waste cooking oil (WCO) to biofuel companies in China: An evolutionary analysis in catering networks. Journal of Cleaner Production 282, 125331. https://doi.org/10.1016/j.jclepro.2020.125331

Yap, C. K., Peng, S. H. T., & Leow, C. S. (2019). Contamination in Pasir Gudang Area, Peninsular Malaysia: What can we learn from Kim Kim River chemical waste contamination? International Journal of Humanities and Education Development (IJHED), 1(2), 84-87. https://doi.org/10.22161/jhed.1.2.4

Zalman Zain, Z. S. (2021). The physicochemical properties of waste palm oil were obtained from different types of fried chips, and a sleeve-type waste heat recovery device was proposed via simulation (Doctoral dissertation, Universiti Teknologi MARA (UiTM).

Zhang, W., Ji, H., Song, Y., Ma, S., Xiong, W., Chen, C., ... & Zhang, X. (2020). Green preparation of branched lubricant by chemically modifying waste cooking oil with lipase and ionic liquid. Journal of Cleaner Production, 274, 122918 https://doi.org/10.1016/j.jclepro.2020.122918