PROGRESS IN ENGINEERING APPLICATION AND TECHNOLOGY
e-ISSN: 2773-5303

PEAT

Vol. 7 No. 1 (2026) 46-54
https://publisher.uthm.edu.my/periodicals/index.php/peat

Community-Based Waste Cooking Oil (WCO) Soap-Making for Environmental Awareness and Economic Empowerment in Labis, Johor

Renu Yashwini Baskaran[1], Roslinda Ali[1*], Sumaya Mashori[2]

[1] *Department of Civil Engineering Technology/Faculty of Engineering Technology Universiti Tun Hussein Onn Malaysia, Pagoh, 84600, Johor, MALAYSIA*

[2] *Department of Electrical Engineering Technology/Faculty of Engineering Technology Universiti Tun Hussein Onn Malaysia, Pagoh, 84600, Johor, MALAYSIA*

*Corresponding Author: linda@uthm.edu.my
DOI: https://doi.org/10.30880/peat.2026.07.01.006

Article Info

Received: 12 January 2026
Accepted: 20 February 2026
Available online: 25 May 2026

Keywords

Waste Cooking Oil, Community Engagement, Soap-Making, Knowledge Transfer Program, Practical Knowledge

Abstract

The improper disposal of waste cooking oil (WCO) poses not only environmental and health risks but also represents an untapped economic potential. This study examined community awareness and readiness to adopt sustainable practices in Labis, Johor, through a hands-on soap-making demonstration using WCO. A questionnaire survey involving 73 respondents was conducted across pre-implementation, implementation, and post-implementation phases. Data were analysed using descriptive statistics, reliability analysis, and the Mann–Whitney U test. The findings revealed a moderate-to-high level of awareness regarding the risks associated with WCO. The hands-on soap-making demonstrations proved to be more effective than awareness initiatives alone in influencing behavioural change. Strong participation was observed among women, students, and older individuals, many of whom expressed interest in continuing soap-making for personal use or income generation. Employment and student status significantly influenced awareness levels, whereas gender did not. In conclusion, community-based soap-making from waste cooking oil (WCO) demonstrates strong potential to enhance environmental sustainability and promote local economic empowerment, as reflected in positive participant feedback, increased awareness, and active community engagement observed during the programme.

1. Introduction

The global rise in cooking oil consumption, driven by population growth, urbanisation, and the expansion of the food sector, has led to a significant increase in the generation of Waste Cooking Oil (WCO) [1]. Improper disposal of WCO poses substantial environmental and public health risks, including water pollution, sewage blockages, and the creation of toxic compounds when reused for cooking [2][3]. Although industrial applications such as biodiesel production and the use of green solvents can valorise WCO, these methods are often resource-intensive and inaccessible to small communities [4]. Therefore, community-based initiatives such as converting WCO into soap through a straightforward saponification process offer a practical, low-cost, and sustainable alternative that promotes environmental stewardship and socio-economic empowerment [5].

Labis, Johor, was chosen as the research site due to its semi-urban context, reliance on small food businesses, and strong social networks supporting grassroots initiatives [6]. This study aims to assess the Labis community's readiness, including residents and school participants, to adopt WCO soap-making through hands-on demonstrations and experiential learning. By evaluating awareness, attitudes, and engagement, the research aims to promote sustainable waste management practices while equipping participants, particularly women and low-income households, with practical, income-generating skills. In doing so, the study contributes to broader sustainability agendas, including the United Nations Sustainable Development Goals related to quality education (SDG 4), decent work and economic growth (SDG 8), and responsible consumption and production (SDG 12).

1.1 WCO: Environmental Challenges and Resource Potential

Waste cooking oil (WCO), if not managed properly, presents a range of environmental and health challenges that go beyond typical pollution, such as drainage blockages, flooding, the release of untreated wastewater, diminished soil fertility, disrupted microbial activity, and methane emissions in anaerobic conditions [3][7]. Prolonged heating and the illegal reuse of degraded WCO can lead to the formation of toxic compounds, including free fatty acids, aldehydes, ketones, and polymerised triglycerides. These substances increase the risk of gastrointestinal, cardiovascular, and carcinogenic effects within communities [8][9].

However, WCO also holds significant promise as a renewable resource that can be transformed into biodiesel, bio-lubricants, surfactants, and various everyday household products, such as soap. This potential offers avenues for environmental protection, economic benefits, and community engagement [10][11]. Pilot programmes have shown that well-structured collection systems, financial incentives, and hands-on interventions can enhance WCO recovery rates while empowering local communities to adopt sustainable practices [12]. This dual perspective of WCO as both an environmental hazard and a resource underscores the need for community-based approaches that integrate practical knowledge with experiential learning.

1.2 Community Readiness for Sustainable Environmental Practices

Community readiness reflects the extent to which a community is both willing and able to engage in collective action for sustainable practices, including WCO management [13][14]. This readiness is shaped by a combination of cognitive, structural, and cultural factors. Awareness of environmental risks and the benefits of recycling form the foundation for engagement, while leadership, the presence of local champions, and access to necessary infrastructure enable communities to translate motivation into action [3][15]. Social norms and shared cultural values also play a significant role in influencing readiness, as they can either reinforce or hinder sustainable behaviours. Community-based initiatives that integrate environmental practices into daily routines, such as soap-making using WCO, have demonstrated success in increasing participation and fostering a sense of ownership [16]. Empirical studies suggest that certain demographics, particularly students and working individuals, tend to engage more readily in sustainability initiatives due to their exposure to structured learning environments, institutional support, or workplace sustainability practices [3][14]. Understanding these factors is crucial for designing targeted strategies that facilitate a shift from passive awareness to active engagement in sustainable waste management.

1.3 Role of Knowledge in Promoting Sustainable Practices

Knowledge plays a crucial role in transforming community readiness into sustainable action, especially in managing waste cooking oil [2][7]. Theoretical knowledge, obtained through formal education or awareness campaigns, enables individuals to understand the environmental and health risks associated with improper waste collection and disposal, and frames local practices within the larger context of sustainability [17][18]. However, awareness alone is often insufficient to drive behavioural change, as structural constraints and ingrained habits may remain. Practical knowledge, acquired through hands-on involvement and experiential activities such as soap-making workshops, equips communities with the technical skills and confidence needed to implement sustainability principles in everyday life [5]. Research has shown that combining theoretical understanding with practical experience enhances the likelihood of adoption and fosters a sense of ownership, ensuring that sustainable practices are upheld over time [4]. Therefore, interventions that integrate conceptual awareness with experiential learning are more effective in bridging the gap between knowledge and action, thereby promoting environmental stewardship and community empowerment.

2. Methodology

This study was conducted in Labis, Johor, a semi-rural community with a growing interest in sustainable practices and grassroots environmental initiatives. The project focused on Community-Based Waste Cooking Oil (WCO) Soap-Making, selected as both an environmental awareness programme and a potential avenue for economic empowerment. The study site included local schools, community centres, and neighbourhood

associations, which serve as focal points for collective action and knowledge-sharing. Respondents comprised students, teachers, homemakers, and members of community organisations, representing key influencers of household waste management behaviours and participants in small-scale entrepreneurial activities.

The data collection is carried out in three phases. The first phase is the pre-implementation stage. The pre-implementation stage included a Training-of-Trainers (ToT) session specifically for researchers, equipping them with the technical knowledge and facilitation skills to lead the WCO soap-making workshops. At the same time, the researcher conducted preliminary outreach activities to identify and secure suitable participants, as well as to determine communities and locations most appropriate for programme implementation. Other participants, including teachers, homemakers, and community members, were briefed on the programme objectives and informed of the required materials and apparatus, ensuring readiness and a smooth execution during the implementation phase.

The second phase, the implementation stage, involved hands-on demonstrations of soap-making using Waste Cooking Oil (WCO) under the guidance of trained researchers from the ToT programme. Respondents were provided with step-by-step instructions, ensuring that each participant understood the technical process and safety measures involved. Throughout the workshops, facilitators and researchers closely monitored respondents' progress, offering support and clarification as needed. This stage not only strengthened practical skills but also reinforced environmental awareness by showcasing the benefits of repurposing WCO into usable household products

The post-implementation stage centred on evaluating the outcomes of the WCO soap-making programme. A structured questionnaire was distributed to participants to assess their understanding of the WCO-to-soap process and to gather feedback on the programme's content, delivery, and relevance. In addition, observations were conducted to capture qualitative insights into changes in environmental awareness, household practices, and community participation. This stage also examined the effectiveness of student facilitators trained during the ToT, highlighting their role in sustaining knowledge transfer within the community.

3. Results and Discussion

The data were analysed using a combination of descriptive and inferential statistical methods, including frequency distributions, mean scores, reliability analyses, and the Mann-Whitney U test. This combination of analytical approaches provided both a general overview of community awareness and a deeper understanding of the factors influencing behavioural readiness toward WCO recycling practices.

3.1 Background of Respondents

This study collected responses from 73 participants in the Labis community, including residents, students, and teachers. According to [19], there is no universal guideline for determining an ideal sample size in community-based studies [15]. However, previous research suggests that a minimum of 40 respondents is generally adequate to effectively represent population behaviour in small-scale interventions [5]. Thus, the sample size in this study is deemed sufficient for meaningful analysis.

Participants were asked to provide demographic information, including age, gender, employment status, and student status, to evaluate how these factors influenced their awareness and readiness to adopt waste cooking oil (WCO) recycling practices. This demographic profile also enabled comparisons across groups, such as employed versus unemployed respondents and students versus non-students, to analyse variations in awareness levels. The findings are summarised in Table 1.

Table 1 *Demographic profile of respondents (n=73)*

Item		Frequency (n)	Percentage (%)
Are you a school student?	Yes	51	69.9
	No	22	30.1
Age	Below 30 years old	53	72.6
	31-40 years old	5	6.8
	41-50 years old	4	5.5
	51-60 years old	3	4.1
	61 years old and above	8	11.0
Gender	Male	24	32.9
	Female	49	67.1
Employment status	Unemployed / Retired	55	75.3
	Homemaker	7	9.6
	Government sector	7	9.6

Progress in Engineering Application and Technology Vol. 7 No. 1 (2026) p. 46-54

	Private sector	1	1.4
	Self-employed	3	4.1
How often do you cook at home	Never	12	16.4
	Rarely (1-2 times in a week)	30	41.1
	Sometimes (3-4 times in a week)	13	17.8
	Often (5-6 times a week)	9	12.3
	Always (more than 6 times a week)	9	12.3
How do you dispose of Waste Cooking Oil (WCO	Dispose of in the sink	18	24.7
	Dispose into the drain	7	9.6
	Dispose of it in the trash bin together with other waste	4	5.5
	Dispose of the ground surface	9	12.3
	Collect it and send it to a recycling centre	32	43.8
	Store and reuse	1	1.4
	Produce/make soap	2	2.7
Have you attended the demonstration program?	Yes	39	53.4
	No	34	46.6

According to Table 1, the majority of respondents (n = 51) were students, followed by employed community members (n = 18) and unemployed individuals (n = 4). A substantial portion of the respondents were affiliated with local schools and educational institutions in Labis, which play a crucial role in disseminating knowledge and promoting environmental awareness initiatives. The remaining participants are residents and small-scale business operators in the town.

Geographically, most respondents reside in Labis town itself, while smaller groups hail from surrounding villages and semi-urban neighbourhoods in the Segamat district. This distribution aligns with the study's focus on semi-urban communities that possess limited waste management infrastructure but strong social networks.

In terms of gender distribution, females represented the majority of respondents, with 49 participants (67.1%), while males accounted for 24 participants (32.9). To further examine potential differences in awareness levels across demographic groups, a Mann-Whitney U test was conducted to investigate the relationship between selected demographic variables and awareness of WCO management practices.

3.2 Awareness Level of Respondents on WCO Management

In this section, respondents were asked to share their level of agreement with statements designed to evaluate their knowledge and awareness of waste cooking oil (WCO) management. The questionnaire focused on the environmental and health risks associated with improper disposal, safe storage practices, and the potential benefits of recycling WCO into value-added products, such as soap.

The analysis indicated that respondents displayed a moderate to high level of awareness regarding the dangers of reusing WCO for cooking and the environmental consequences of improper disposal, consistent with findings by [8]. Notably, both male and female respondents expressed similar levels of agreement, suggesting that gender did not significantly influence awareness when equal access to information was available. However, further statistical testing using the Mann-Whitney U test revealed that employment status and student status were significant factors. Employed individuals and students demonstrated greater awareness than unemployed individuals or non-students. This implies that structured environments, such as schools and workplaces, foster greater receptivity to sustainable practices as practised by [21].

The overall results reflecting respondents' level of agreement with the awareness statements on WCO management are illustrated in Fig. 2 below.

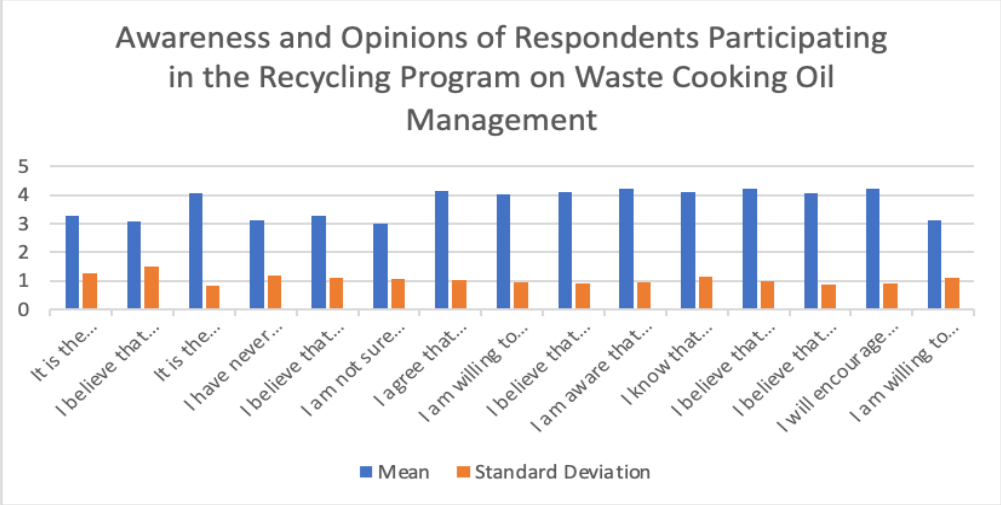

Fig. 2 *Awareness and Opinions of Respondents Participating in the Recycling Program on Waste Cooking Oil Management*

Overall, the implementation of the WCO soap-making programme contributed to a notable improvement in awareness of sustainable waste management practices within the Labis community. The practical demonstrations were more effective than awareness initiatives alone, as they offered valuable experiential learning opportunities that translated knowledge into actionable behaviour consistent with [5]. This outcome underscores the importance of integrating theoretical education with hands-on activities to foster long-term environmental responsibility and empower the community.

3.3 Reliability Analysis

To ensure the consistency and internal validity of the questionnaire responses, a reliability analysis was performed using Cronbach's Alpha. This statistical test assesses the degree of correlation among items within a scale, thereby indicating the reliability of the instrument utilised. In this study, the reliability coefficient for the awareness-related items was 0.733, surpassing the commonly accepted threshold of 0.70 for internal consistency (Gliem & Gliem, 2003). This outcome suggests that the questionnaire items were well-consistently interpreted by respondents and were appropriate for measuring awareness of waste cooking oil (WCO) management. The result of the reliability analysis is presented in Table 2.

Table 2 *Reliability Statistics*

Reliability Statistics	
Cronbach's Alpha	N of Items
0.733	15

3.4 Comparison Between Respondent Background and Awareness

The Mann–Whitney U test was used to investigate differences in awareness levels regarding the management of waste cooking oil (WCO) between students and non-students, including teachers and community members. As shown in Table 3, the analysis revealed a statistically significant difference between the two groups ($Z = -2.300$, $p = 0.021$). The mean rank for awareness was notably higher among non-students (Mean Rank = 45.68) than among students (Mean Rank = 33.25). This result indicates that community members and teachers demonstrated a higher level of awareness of WCO management practices than students. Such differences may be attributed to greater exposure to practical experience, workplace-based sustainability practices, or prior involvement in community programmes.

Table 3 *Comparison of Awareness Levels by Respondents' Status Using the Mann-Whitney U Test*

Ranks				
Grouping variable	Mean likert scale awareness			
		N	Mean Rank	Sum of Ranks

Progress in Engineering Application and Technology Vol. 7 No. 1 (2026) p. 46-54

Are you a school student?	Yes	51	33.25	1696.00
	No	22	45.68	1005.00
Test Statistics				
	Mean likert scale awareness			
Mann-Whitney U	187.000			
Wilcoxon W	215.000			
Z	-2.300			
Asymp. Sig. (2-tailed)	0.021			

This finding is consistent with previous research, such as [21], which reported that individuals engaged in environmental-related fields or community-based initiatives tend to exhibit higher sustainability awareness than those operating in more conventional educational settings [8].

In contrast, the results of the Mann–Whitney U test conducted for Gender, Participation in the Demonstration Programme, Willingness to Produce Soap from Waste Cooking Oil (WCO), and Willingness to Teach Soap-Making from WCO did not indicate any statistically significant differences, as all p-values exceeded the 0.05 significance level. These findings suggest that awareness of WCO management remains relatively consistent across respondents, regardless of gender, participation in demonstration activities, or their inclination to engage in soap-making initiatives.

3.5 Feedback on the Program

The feedback analysis revealed that the most significant benefit of attending the Demonstration Programme was the knowledge gained in soap making, with 22 respondents (56.4%) identifying this as a valuable outcome. This highlights the programme's effectiveness in delivering practical, hands-on learning experiences that participants can directly apply to sustainable living practices, consistent with studies by [23], which demonstrated that soap-making from waste cooking oil fosters both skill development and sustainability awareness. Additionally, 14 respondents (35.9%) reported that the programme enhanced their ability to recycle waste cooking oil (WCO), reflecting increased awareness of environmental responsibility and resource recovery. This finding aligns with [3], who emphasised that community-based initiatives significantly improve household participation in WCO recycling and promote environmental consciousness. A small minority (3 respondents, 7.7%) indicated that the programme was not related to their interests, suggesting that while the majority found the content relevant, future iterations may benefit from clearer communication of objectives to ensure alignment with participant expectations. This observation is consistent with [2], who noted that experiential learning programmes must be tailored to diverse participant needs to maximise engagement and behavioural change. The benefits respondents gained from joining the demonstration program are illustrated in Fig. 3.

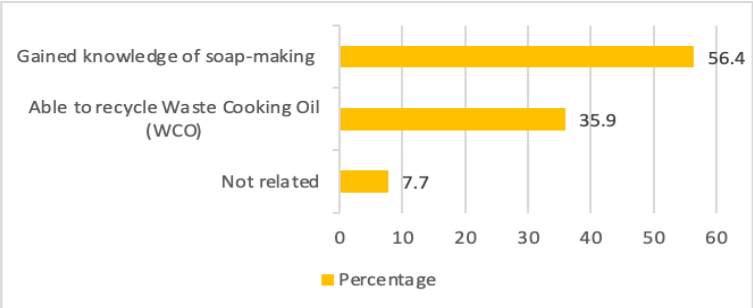

Fig.3 *Benefits Derived from Attending the Demonstration Program*

Subsequently, participants were invited to identify the shortcomings of the demonstration programme, providing researchers with invaluable insights into future enhancements. Despite its strengths, several weaknesses were noted during the implementation of the soap-making demonstration programme. The most frequently mentioned issue was a lack of relevance, reported by 12 respondents (30.8%), suggesting a potential

disconnect between participant expectations and program content. Technical challenges were also highlighted: 7 respondents (17.9%) found soap production difficult, and 5 respondents (12.8%) indicated that students lacked the necessary skills for soap-making. Additional concerns included limited time allocation (12.8%), insufficient explanations (10.3%), and safety issues (7.7%), all of which indicate a need for clearer instructions, enhanced risk management, and improved planning. Minor issues, such as the absence of fragrance (5.1%) and inadequate materials (2.6%), were also mentioned, underscoring the impact of logistical and sensory factors on participant satisfaction. These findings align with the research conducted by Zayed et al. (2024), which emphasised that hands-on recycling initiatives necessitate proper preparation and support to yield significant learning outcomes [23]. The weaknesses identified during the implementation of the soap-making demonstration programme are illustrated in Fig. 4.

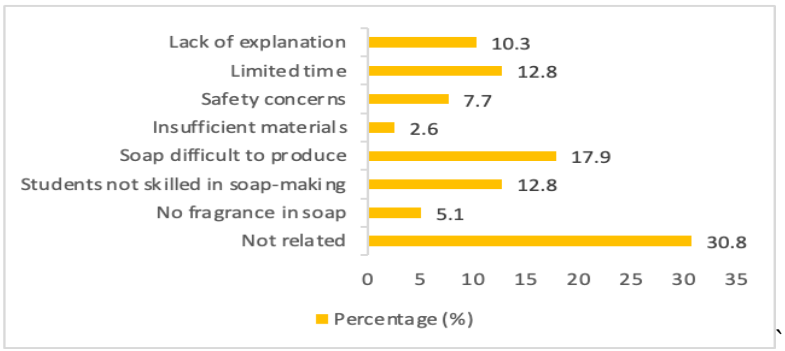

Fig.4 *Weaknesses Encountered During the WCO Demonstration Program*

Lastly, respondents were invited to propose enhancements for future iterations of the demonstration programme. Several recommendations have been made to increase its effectiveness. The most frequently mentioned suggestion was to broaden the programme's implementation, as highlighted by 19 respondents (48.7%), indicating a strong interest in scaling the initiative to engage more communities or integrating it into broader sustainability efforts. Additional recommendations included an emphasis on soap-making as a craft (7.7%) and a desire to extend the programme's duration (7.7%), both reflecting participants' interest in deeper engagement and creative exploration. Less frequently mentioned were appeals for programme materials (5.1%) and enhanced safety measures (2.6%), underscoring the importance of logistical preparedness and risk management in hands-on activities. Collectively, these suggestions illustrate that participants valued the program and recognised its potential for expansion while also identifying practical adjustments to enhance its delivery and impact. These findings are consistent with [22], who noted that participant satisfaction and programme effectiveness improve when logistical support and safety considerations are prioritised alongside educational content [4]. Suggestions for improving future implementation are depicted in Fig. 5.

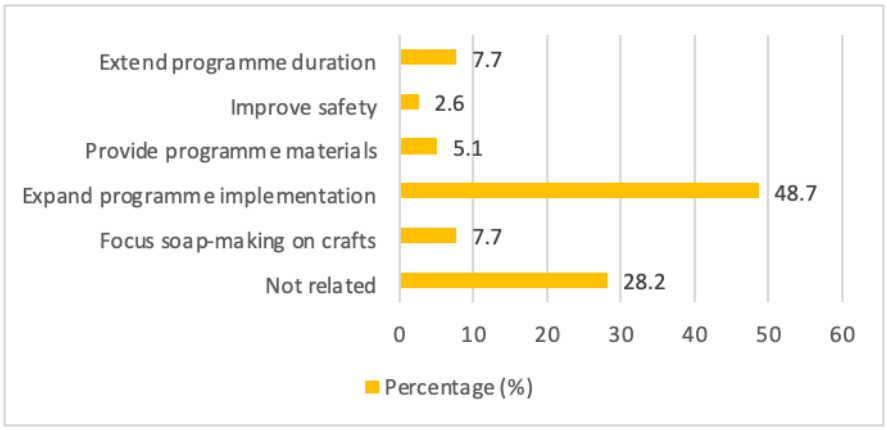

Fig.5 *Suggested Improvements for The WCO Demonstration Program*

4. Conclusion

In summary, this study demonstrated that the WCO demonstration programme significantly enhanced participants' knowledge, skills, and awareness regarding sustainable practices. The program was particularly effective in introducing soap-making as a viable recycling approach for WCO, although several challenges were identified, including time constraints, minor technical difficulties, and the need for clearer explanations during

certain stages of the demonstration [23]. Overall, the program has strong potential to foster positive behavioural change by encouraging participants to view household waste as a valuable resource [5]. Future studies should therefore involve larger and more diverse participant groups to generate more comprehensive insights into the long-term impacts of hands-on recycling interventions on awareness, behaviour, and community empowerment [4].

Acknowledgement

This author would like to thank you and appreciate the Department of Civil Engineering Technology, Faculty of Engineering Technology, and Universiti Tun Hussein Onn Malaysia for the support and encouragement for author to finish this research.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

References

[1] Alhaji, A. M., Almeida, E. S., Carneiro, C. R., Sodré da Silva, C. A., Monteiro, S., & Coimbra, J. S. R. (2024). Palm oil (Elaeis guineensis): A journey through sustainability, processing, and utilization. https://doi.org/10.3390/foods13172814 Foods, 13(17), 2814.

[2] Arifin, A. S., Johari, S., & Mohamad, N. (2024). Oil to earth: Raising consciousness on used cooking oil recycling in Shah Alam. ConCEPt – Conference on Community Engagement Project, 4(1), https://journal.uib.ac.id/index.php/concept/article/view/9091

[3] Mat Daud, N., Hassan, H., & Ismail, N. (2020). Environmental implications of improper waste cooking oil disposal in urban drainage systems. Journal of Environmental Engineering and Management, 24(3), 145–153.

[4] Lopresto, C., Petrillo, M., & Calabrò, V. (2024). Valorisation of waste cooking oil into biodiesel and eco-friendly solvents: Advances, challenges, and perspectives. Journal of Cleaner Production, https://doi.org/10.1016/j.jclepro.2023.137004 412, 137004.

[5] Medhiatika, N. L. M. V. (2021). Making soap from waste cooking oil as a creative product and behavioral change in housing area. ICCD, 3(1), 70–75. https://doi.org/10.33068/iccd.vol3.iss1.304

[6] Subri, U. S., Ghani, N. M., Rus, R. C., Zakaria, A. F., & Affandi, H. M. (2025). Waste no more: Empowering communities through education and participation in sustainable waste management. Multidisciplinary Reviews, 8(7), 2025204. https://doi.org/10.31893/multirev.2025204

[7] Kumar, A., Bhayana, S., Singh, P. K., Tripathi, A. D., Paul, V., Balodi, V., & Agarwal, A. (2025). Valorization of used cooking oil: Challenges, current developments, life cycle assessment and future prospects. Discover Sustainability, 6(1). https://doi.org/10.1007/s43621-025-00905-7

[8] Ali, R. F. M., & El-Anany, A. M. (2025). Physico-chemical characteristics, nutritional quality, and oxidative stability of cold-pressed chia seed oil, date palm seed oil, along with their binary mixtures. Cogent Food & Agriculture, 11(1). https://doi.org/10.1080/23311932.2025.2466061

[9] Rahman, S., & Serletis, A. (2019). Oil prices and the stock markets: Evidence from high-frequency data. The Energy https://doi.org/10.5547/01956574.40.si2.srah Journal, 40(1).

[10] Foo, W. H., Chia, W. Y., Tang, D. Y. Y., Koay, S. S. N., Lim, S. S., & Chew, K. W. (2021). The conundrum of waste cooking oil: Transforming hazard into 82 energy. Journal of Hazardous Materials, 417, 126129. https://doi.org/10.1016/j.jhazmat.2021.126129

[11] Olu-Arotiowa, O. A., Odesanmi, A. A., Adedotun, B. K., Ajibade, O. A., Olasesan, I. P., Odofin, O. L., & Abass, A. O. (2023). Review on environmental impact and valorisation of waste cooking oil. IOP Conference Series: Earth and Environmental Science, 1201(1), 012034. https://doi.org/10.1088/1755 1315/1201/1/012034

[12] Mannu, A., Ferro, M., Di Pietro, M. E., & Mele, A. (2019). Innovative applications of waste cooking oil as raw material. Science Progress, 102(2), 153–160. https://doi.org/10.1177/0036850419854252

[13] Umar, S., Sutapa, I. W., Saparuddin, S., & Wicana, S. (2021). Community readiness model for social forestry in Central Sulawesi, Indonesia. IOP Conference Series: Earth and Environmental Science, https://doi.org/10.1088/1755-1315/713/1/012010 713(1), 012010.

[14] Muellmann, S., Brand, T., Jürgens, D., Gansefort, D., & Zeeb, H. (2021). How many key informants are enough? Analysing the validity of the community readiness assessment. BMC Research Notes, 14(1), 85. https://doi.org/10.1186/s13104 021-05497-9

[15] De Feo, G., Di Domenico, A., Ferrara, C., Abate, S., & Sesti Osseo, L. (2020). Evolution of waste cooking oil collection in an area with long-standing waste management problems. https://doi.org/10.3390/su12208578 Sustainability, 12(20), 8578.

[16] Pickering, G. J., Pickering, H. M. G., Northcotte, A., & Habermehl, C. (2020). Participation in residential organic waste diversion programs: Motivators and optimizing educational messaging. Resources, Conservation and Recycling, 158, 104807. https://doi.org/10.1016/j.resconrec.2020.104807
[17] Mokhsin, M., Harun, A. F., Abu Bakar, M., Abdullah, F., & Japar, A. E. (2020). The conceptual idea of recycling used cooking oil mobile application. Borneo Akademika, 4(3), 9–18. https://ir.uitm.edu.my/id/eprint/50192/
[18] Leask, C. F., Sandlund, M., Skelton, D. A., & Chastin, S. F. M. (2020). Modelling the theoretical foundations of sustainability and environmental risk awareness in community health promotion. Global Sustainability, 3(e22), 1–12. https://doi.org/10.1017/sus.2020.22
[19] Memon, M. A., Ting, H., Cheah, J., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling*, *4*(2), i–xx. https://doi.org/10.47263/jasem.4(2)01
[20] Budiu, R., & Moran, K. (2021, July 25). *How many participants for Quantitative usability studies: A summary of Sample-Size Recommendations*. Nielsen Norman Group. https://www.nngroup.com/articles/summary-quant-sample-sizes/
[21] Fytopoulou, E., Karasmanaki, E., Tampakis, S., & Tsantopoulos, G. (2023). Effects of curriculum on environmental attitudes: A comparative analysis of environmental and non-environmental disciplines. *Education Sciences*, *13*(6), 554. https://doi.org/10.3390/educsci13060554
[22] Azme, S. N. K., Yusoff, N. S. I. M., Chin, L. Y., Mohd, Y., Hamid, R. D., Jalil, M. N., Zaki, H. M., Saleh, S. H., Ahmat, N., Manan, M. A. F. A., Yury, N., Hum, N. N. F., Latif, F. A., & Zain, Z. M. (2023). Recycling waste cooking oil into soap: Knowledge transfer through community service learning. Cleaner Waste Systems, 4, 100084. https://doi.org/10.1016/j.clwas.2023.100084
[23] Zayed, L., Gablo, N., Kalcakova, L., Dordevic, S., Kushkevych, I., Dordevic, D., & Tremlova, B. (2024). Utilizing used cooking oil and organic waste: A sustainable approach to soap production. *Processes (Basel, Switzerland)*, *12*(6), 1279. https://doi.org/10.3390/pr12061279