INVESTIGATING THE VIABILITY OF RECYCLED COOKING OIL AS BASE FOR A SUSTAINABLE EMERGENCY LIGHT SOURCE THROUGH ECO-FRIENDLY SCENTED CANDLES

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ABSTRACT

Perceived This quantitative experimental study, entitled "Investigating the Viability of Recycled Cooking Oil as a Base for a Sustainable Emergency Light Source through Eco-Friendly Scented Candles, explored the potential of recycled cooking oil as a sustainable base material for eco-friendly candles that can serve as emergency light sources. The study aimed to provide a cost-effective and environmentally responsible lighting alternative. Used cooking oil wax filtered, blended with stearic acid, and infused with fragrance oils to produce candles. These were then compared with commercial paraffin wax candles in terms of burn duration, cost efficiency, and user perception. Ninety-four household respondents from Gawad Kalinga, Barangay Salian, Abucay, Bataan participated in a Likert-scale survey evaluating familiarity, practicality, performance, and safety. Results revealed that recycled-oil candles burned longer—averaging 4 hours and 59 minutes versus 3 hours and 12 minutes for paraffin—and were 48% cheaper to produce. Respondents expressed high satisfaction in scent diffusion, light quality, affordability, and safety, with strong willingness to recommend the product. The study concludes that recycled cooking oil is a practical, safe, and sustainable candle base that supports waste reduction and resource efficiency. It is recommended that the study explores large-scale production by partnering with establishments and oil-generating manufacturers, ensuring stable production while expanding its environmental and economic benefits for community and commercial use.

Keywords: Recycled Cooking Oil, Sustainable Candles, Eco-Friendly Lighting, Cost Efficiency, Waste Reduction

INTRODUCTION

In our modern world where environmental crises fuses with digitalization and technological advancements, a portion of the population still frequently experience power outages, significantly affecting people's productivity (Francisco, 2022). In the Philippines, a recent comprehensive study showed that power outages in the Philippines have become a significant problem affecting both consumers and local economies (PIDS, 2023).In response to frequent power interruptions, alternative and sustainable lighting sources have gained attention, with candles remaining a practical backup during brownouts. However, rising costs and environmental concerns highlight the need for more sustainable options. This study explores the use of discarded cooking oil as a base material for scented candles, offering an innovative solution that addresses waste management while providing an eco-friendly and affordable lighting alternative for local communities.

The idea of repurposing used oil has been explored in areas such as biodiesel (Araujo et.al., 2013) and soap making (Mustakim et.al., 2020) yet limited studies have focused on its potential in candle manufacturing. While most scented candles in the market rely on paraffin wax which is petroleum-based and not biodegradable (Ökometric Wax and Emissions Study, 2007). By identifying this research gap, this study seeks to fill the void by investigating the feasibility of used oil as an alternative candle base with a focus on luminosity, burn time, overall safety, and scent capability.

This research aims to determine whether used cooking oil can be efficiently utilized to create candles that are both safe and aromatic. It also seeks to contribute to sustainable practices by transforming a common household waste into a valuable product. By innovating within the realm of waste up-cycling, the study may pave the way for livelihood opportunities and environmental awareness, especially in low-resource settings.

STATEMENT OF THE PROBLEM:

This paper intends to investigate the Viability of Recycled Cooking Oil as a Sustainable Emergency Light Source through Eco-friendly Scented Candles. Specifically, it seeks to answer the following questions:

1. How may the recycled cooking oil be described in terms of burn duration, and production cost (candle's properties) compared to a specific type of conventional candles, such as paraffin candles?

2. How safe and practical are recycled cooking oil candles for emergencies?

3. What significant environmental benefits can be derived from repurposing used cooking oil into eco-friendly candles?

4. How do respondents assess the viability of the product in terms of Familiarity, Candle Performance (Scent, Light, Smoke), Practicality, and Overall Safety.

HYPOTHESES:

Null Hypothesis (H_0):

There is no significant difference in burn duration, brightness, or flame stability between recycled cooking oil candles and conventional candles, and recycled cooking oil candles do not offer notable safety or environmental benefits both in terms of observation and in terms of Likert Scale response.

Alternative Hypotheses (H_1):

1. Recycled cooking oil candles have significantly different burn durations, brightness, and flame stability than conventional ones.
2. Recycled cooking oil candles are safe and practical for household emergency lighting.

3. Repurposing used cooking oil into candles provides measurable environmental benefits, such as waste reduction and decreased reliance on petroleum-based candle products?

4. Respondents do not significantly perceive the recycled cooking oil–based eco-friendly candles as a viable and effective source of sustainable emergency light in terms of Familiarity, Candle Performance (Scent, Light, Smoke), Practicality, and Safety.

OBJECTIVES OF THE STUDY

The main objective of the study is to determine the practicality and viability of recycled cooking oil as a sustainable emergency light source by producing and evaluating eco-friendly candles.

Specific Objectives:

1. To collect, filter, and refine used cooking oil from households and combine it with eco-friendly materials to produce sustainable candles.

2. To compare the burn duration, brightness, and flame stability of recycled cooking oil candles with conventional candles.

3. To assess the safety and practicality of recycled cooking oil candles for use in household emergency lighting.

4. To determine how respondents assess the viability of the product in terms of familiarity, candle performance (scent, light, and smoke), practicality, and overall safety.

5. To provide recommendations for producing and using recycled cooking oil candles as a sustainable emergency lighting alternative.

SIGNIFICANCE OF THE STUDY:

The results of this study will be salutary to the beneficiaries. Benefiting this study are the various sectors as follows:

- Students. This study provides a practical and sustainable option for students who use scented candles as a means to cope with stress and improve focus.
- People Who Frequently Experience Power Interruptions. This study offers a practical lighting alternative for individuals and households regularly affected by power outages.

- Chandlers. Candle makers, or chandlers, may benefit from this study by discovering the potential of used cooking oil as an additive or extender in candle production

- Retailers.For retailers and small-scale investors, the findings of this study present a promising low-cost business opportunity.

- Commercial Users. Commercial users of scented candles, such as spa owners, cafés, and wellness spaces, may consider this product as a viable alternative to traditional options.

- Used Oil Generator. Establishments that generate large amounts of used oil, such as restaurants or food stalls, can find a new avenue to reduce waste through this study.

- Other Future Researchers. This study serves as a foundational reference for future researchers exploring eco-friendly innovations.

SCOPE AND DELIMITATION:

This study focuses on the utilization of used cooking oil as the primary base for producing scented candles. It aims to assess the safety and feasibility of candles made from waste oil by evaluating burn time, brightness, stability, and scent diffusion in comparison to traditional paraffin-based candles. The research also examines the environmental and economic benefits of reusing discarded oil, particularly in reducing household waste and providing an alternative lighting source during power outages.

However, the study is limited to small-scale candle production using oil collected solely from kitchens. Only one type of used oil base—palm oil—will be utilized, as it is the most commonly used oil in household and rural settings and is the cheapest vegetable oil on the global market due to its low production cost (Bentivoglio et al., 2018). The experiment is further confined to testing a limited number of commercially purchased essential oils for scent diffusion. Other variables, such as long-term storage effects and potential health risks from prolonged use, are beyond the scope of the study. Additionally, the final product is not intended for commercial sale and does not meet industry production standards, which may result in limited polish, consistency, and safety certification.

LITERATURE REVIEW

Burn Time

Candle flames are classified as laminar diffusion flames, where the fuel (candle wax composed of hydrocarbons) and oxygen from the surrounding air are supplied separately to the reaction zone (Hickman, 2022). Candle burn time varies based on several factors, including size, material, wick thickness, and lighting conditions (Candles, 2023). Kral (2014) found that burn time increases with greater candle thickness and wick diameter. Similarly, the National Candle Association (2021) reported that burn rate is strongly influenced by the candle base and structural properties, such as wax type (paraffin, soy, beeswax) and base diameter.

Salthammer et al. (2021) reported burn rates of approximately 2.9–4.6 g/hr in scented candle blends, demonstrating how variations in wax and oil composition affect burn duration. Studies on olive oil candles indicate burn times of approximately 2–3 hours per ounce of oil, with smaller flames producing longer burn times but lower brightness (Question About Olive Oil Candle Burn Time, 2025). Overall, burn time and efficiency depend largely on base type, wick size, and candle design, regardless of the fuel source (Bulk Lamp Oil, Tiki Torch Fuel, Oil Lamps and Refillable Liquid Oil Candles, n.d.)

Familiarity

Several studies incorporating community awareness components show that while many individuals have experimented with homemade candles, familiarity varies. Used cooking oil candles are promoted as affordable and eco-friendly alternatives to paraffin candles (Santos, n.d.). Educational outreach and proper disposal programs emphasize safe storage and reuse of used oil, such as in candle-making, to increase public awareness and reduce waste (Kamalov, 2024). However, improper disposal remains common, with many people pouring oil down drains, causing pipe clogging and water pollution (Abrajano et al., 2023).

Regarding emergency lighting, Herzog (2023) notes that individuals and institutions primarily rely on electric-based systems, including LED lights, battery-powered luminaires, and solar-assisted lighting. Candles, whether homemade or commercial, are less commonly used as primary emergency lighting but remain practical backup options in low-resource or off-grid settings.

Scent

A scented candle contains fragrance or essential oils added to wax or fuel to release aroma during burning (Karla, 2025). Egan (2024) explains that scent diffusion, like burn time, is strongly influenced by candle characteristics, including wax type and fragrance chemistry. While natural essential oils may offer benefits and slower diffusion, they are more susceptible to heat degradation, whereas synthetic fragrance oils provide greater consistency (PMC, 2022).

Numerous studies indicate that scented candles influence mood and psychological states. Research published in Evidence-Based Complementary and Alternative Medicine found measurable effects on relaxation and emotional well-being (Sowndhararajan & Kim, 2016). Similarly, Jungle Culture (2021) reported reduced stress and improved well-being among participants exposed to scented candles compared to unscented ones. Putri and Putri (2024) further confirmed that aromatherapy candles can relieve stress, enhance mood, and eliminate unpleasant indoor odors, supporting their psychological benefits.

User Satisfaction

Due to health and environmental concerns, consumers increasingly prefer eco-friendly scented candles made from natural, renewable materials over conventional paraffin wax (Scented Candles Market Size, Share & Trends Report, 2030, n.d.). As sustainability awareness grows, the eco-friendly candle market is projected to expand at a CAGR of nearly 7% from 2024 to 2032 (GVR, 2023). Market studies also indicate that frequent candle buyers favor scented varieties for their ability to eliminate unpleasant odors and enhance mood, with over 75% of consumers purchasing candles primarily for their aroma. Similar preferences are observed across other household products, reflecting a broader demand for scented items to improve ambiance and emotional appeal, not limited to candles alone (Herz et al., 2022)

Production Cost

In companies that make candles, raw ingredients like soy wax, beeswax, and essential oils usually make up 30–40% of the overall cost of production (Team, 2025). Due to more costly raw materials, ethical sourcing, and environmentally friendly packaging, sustainable candles often have production costs that are 10–15% higher than those of conventional paraffin (Bung, 2025). Although producing sustainable candles is typically more expensive, people are becoming more prepared to pay for sustainable features including eco-friendly packaging, clean burning, and health benefits (Sustainable Candles Market Size, Growth & Forecast Report - 2033, n.d.).

Due to waste cooking oil's (WCO) raw materials being cheap and the reaction conditions being mild, it can generally be converted into wax at a comparatively low cost. For instance, compared to conventional waxes, epoxidation and modification using materials like stearic acid can yield a wax with high hardness, melting point, and combustion qualities at a cheaper cost (Liu et al., 2022). Using recycled oils significantly reduces the raw material cost portion, as cooking oil is typically a waste product, often being considered free (Fischer, 2025).

Innovation and Sustainability

Community-based projects convert WCO into safe, high-quality candles through systematic processes such as filtration, bleaching, melting, molding, and packaging, ensuring impurity removal and product safety (Community Circular Economy Projects, 2024). Recycling WCO into candles reduces improper disposal, which can otherwise pollute water sources, clog drainage systems, and harm wildlife. Studies in Indonesia further examined WCO-based aromatherapy candles combined with stearic acid to optimize hardness, burn time, and melting point, identifying a 3:5 WCO-to-stearic acid ratio as producing the best physical properties and meeting national candle standards (Anggraini & Kurniasih, 2024).

Kamalov (2024) reported that improper WCO decomposition releases methane, a potent greenhouse gas, and that recycling WCO into candles or biofuels significantly reduces these emissions while lowering reliance on fossil fuels. Overall, reusing

WCO in eco-friendly products supports sustainability by minimizing pollution, reducing emissions, conserving finite resources, and promoting social and economic benefits.

THEORETICAL FRAMEWORK

This study addresses the need for sustainable solutions in waste management and household energy consumption by examining recycled waste cooking oil (WCO) as a base material for eco-friendly scented candles. Guided by Combustion Theory, Aromatherapy and Olfactory Response Theory, Consumer Behavior Theory, and Circular Economy Theory, the research evaluates the functional performance, user acceptance, cost-efficiency, and environmental value of WCO-based candles.

Combustion Theory explains candle performance through fuel composition, wick behavior, and combustion efficiency. Nabizadeh (2025) describes combustion as an exothermic reaction producing heat and light, while El Hage et al. (2012) reported paraffin's high combustion efficiency (96–97%). To improve WCO performance, solidifiers such as stearic acid are required. Anggraini and Kurniasih (2024) demonstrated that a 3:5 WCO–stearic acid ratio met quality standards with burn times exceeding 250 minutes. Choi et al. (2022) found WCO-based wax comparable to soy wax, while Liu et al. (2023) emphasized the influence of wick properties on combustion stability.

Aromatherapy and Olfactory Response Theory supports scent diffusion as a key variable. Choi et al. (2022) and Chen and Zhang (2022) explain how scent molecules stimulate the limbic system, affecting mood and behavior. Studies by Cavanagh and Wilkinson (2003) and Kumalasari et al. (2023) confirmed that essential oil–infused candles enhance relaxation and user satisfaction.

Consumer Behavior Theory explains acceptance of sustainable products through perceived functional, emotional, and environmental value (Siyarifah Hudayah et al., 2023; Frontiers, 2021; Frontiers, 2024). Symbolic consumption and green identity further influence purchase intention (Emerald Insight, 2023; Khoula et al., 2025; Sharma, 2023).

Finally, Circular Economy Theory frames WCO reuse as waste valorization. Mannu et al. (2024), PubMed (2022), and MDPI (2024) highlighted the environmental and economic benefits of WCO reuse, particularly in non-fuel applications such as candle production.

Together, these theories and studies establish a strong foundation for evaluating WCO-based scented candles as a functional, sustainable, and socially acceptable household innovation.

CONCEPTUAL FRAMEWORK

Figure 1

The figure presents the conceptual framework of the study. The Input phase identifies the materials used to produce eco-friendly candles, with recycled cooking oil serving as the primary base material. Stearic acid, a fatty acid commonly used in candle making to enhance burning and physical properties (Prodchem, 2023), is added as a binder to solidify the mixture. Candle wicks and containers are also included to support and shape the candles.

The Process phase outlines a six-step procedure. Used cooking oil is first filtered to remove impurities, then mixed with stearic acid in a fixed ratio and heated to form a stable base. Fragrance is added during cooling, followed by preparation of the wicks and containers. The mixture is then poured into the containers and left to cool and cure at room temperature to ensure proper setting and scent stabilization.

The Output phase focuses on the evaluation of the finished candles as sustainable emergency light sources. The products are assessed based on burn time, production cost, and user satisfaction. Burn time measures longevity, cost evaluates affordability, and user satisfaction is determined through a Likert-scale survey assessing overall performance, cost and practicality, and safety.

MATERIALS AND METHODS

This quantitative study employed an experimental research design to produce candles using used cooking oil as the base and to compare their burn time, scent diffusion, and production cost with commercially available paraffin-based candles. Quantitative data were collected to measure burn duration, production cost, and respondents' perceptions of familiarity, candle performance (scent, light, and smoke), practicality, and safety using a standardized Likert scale.

The experimental approach involved the controlled production and testing of both candle types to ensure objective comparison. Key variables, including oil type, fragrance essence, and stearic acid content, were systematically manipulated to assess their effects on candle performance. Data obtained from performance tests and user evaluations provided measurable outcomes, making this experimental quantitative design appropriate for determining the feasibility of used cooking oil as an effective candle base.

SAMPLE AND SETTING

The researchers conducted the experimental procedures to measure burn time and production cost, while user satisfaction data were collected via a Likert scale survey administered to residents of Gawad Kalinga, Barangay Salian, Abucay, Bataan, a community initiative for informal settlers (Welcome to Gawad Kalinga, n.d.).

The survey targeted a population of 120 households (Municipal Planning and Development Office, 2023). Using the Raosoft Sample Size Calculator with a 95% confidence level and 5% margin of error, a minimum of 92 respondents was required. Simple random sampling was applied to reduce bias, resulting in 94 respondents, exceeding the minimum and ensuring reliable, statistically valid data for assessing user satisfaction with the used-oil scented candles.

RESEARCH INSTRUMENT

Aside from the experimental product. The primary research instrument used in this study is a Likert scale questionnaire developed by the researchers. This survey aims to measure the respondents' perception in areas such as familiarity, candle's overall performance, practicality, and overall safety. The questionnaire consists of several statements rated on a five-point scale, ranging from Strongly Disagree (1) to Strongly Agree (5). After handing out samples, the Likert scale survey was administered through Google Forms, maintaining respondent anonymity and confidentiality. While the candle product itself was not a research instrument, its creation and controlled testing were essential components of the experimental procedure.

DATA COLLECTION PROCEDURE

The data collection procedures systematically measured both objective and subjective characteristics of the used oil–based scented candles. Objective data included burn time and production cost, while subjective feedback covered candle performance, scent diffusion, practicality, and overall safety for analysis of user satisfaction.

Burn Time. The burn time of a 16-gram used oil–based candle was measured under controlled conditions and tested three times, with the average calculated using the mean. Results were compared to commercially available paraffin wax candles, which burn at approximately 5 g per hour (or 12 minutes per gram) under typical conditions (Cheng, 2023), to evaluate efficiency and longevity.

Production Cost. Production cost was determined by summing the cost of all raw materials. A separate calculation focused solely on the candle base (excluding wick and container) to assess cost efficiency and market competitiveness, since containers may vary depending on preference or availability.

User Satisfaction. Candle samples were distributed to the target locale, with respondents completing a Google Form Likert scale questionnaire. The survey measured Candle Performance (Scent, Light, Smoke), Practicality, Safety, and included sections for recommendations and suggestions. Respondents received explanations about the candle's purpose, materials, and cost before evaluation.

DATA ANALYSIS

The data collected in this study were analyzed using both descriptive and comparative methods to address the research questions.

Burn Time. Three candles were utilized whose burn time was measured in hours, minutes, and seconds in an elapsed time format. The candle was observed every hour before its time of being out. The results were compared to determine which is likely to be extinguished first, providing an indication of relative burn efficiency. The analysis will be observed through the materials' burn time per gram.

Production Cost. The computed production cost per unit of the used oil-based candle was compared to the sourced cost of a commercially available paraffin wax candle. The comparison will give an emphasis on the base since container and wick may vary depending on preferability, and because this study focuses on the base of the product and its viability. The analysis will be observed through a 1 kilogram base comparison excluding container and wick.

Likert Scale Responses. Responses from the Likert scale questionnaires were tabulated and analyzed using descriptive statistics and graphed in a table. The results were examined to determine patterns and trends that reflect the respondents' overall perception of the product's feasibility, particularly in terms of candle performance, practicality, and safety.

TRUSTWORTHINESS

The study ensured trustworthiness through careful planning, consistent procedures, and accurate documentation throughout the research process. Materials and measurements were standardized to produce comparable candle samples, while data collection tools such as timers and Likert-scale questionnaires were applied uniformly. Survey responses were collected anonymously to promote honest feedback. Data were systematically checked, verified against the research objectives, and reviewed for inconsistencies. Transparency and detailed documentation were maintained to support reliability, confirmability, and future replicability of the study.

ETHICAL CONSIDERATION

The study followed the ethical guidelines of Colegio de San Juan de Letran – Bataan. Approval was obtained from the appropriate authorities before conducting the experiment. Participant anonymity and confidentiality were strictly observed, and survey participation was voluntary, with the right to withdraw at any time without penalty. No compensation was provided, as the study posed no foreseeable risks. The researchers declared no conflicts of interest that could affect the study's conduct or findings.

RESULTS

PRESENTATION OF DATA

This chapter presents and discusses the findings of the study on the viability of recycled cooking oil–based eco-friendly candles, wherein objective data on burn time and production cost were obtained through controlled experiments conducted by the researchers, while subjective data on user perceptions were gathered through a Google Form survey.

Objective Results

This section presents the results for Burn Time and Production Cost obtained from the experiments carried out by the researchers.

Time of recorded trials	
1st trial	4:59 hours
2nd trial	4:47 hours
3rd trial	5:12 hours

$$\text{Mean } (\bar{x}) = \frac{\sum x}{n}$$

$$\text{Mean } (\bar{x}) = \frac{(4:59) + (4:47) + (5:12)}{3}$$

$$\text{Mean } (\bar{x}) = \frac{299+287+312}{3} \rightarrow \text{converted to minutes}$$

$$\text{Mean } (\bar{x}) = 299.333 \text{ minutes}$$

Average Time = **4 hours, 59 minutes, and 20 seconds**

Used Oil Base	Paraffin Wax Base
4 hours, 59 minutes, and 20 seconds	**3 hours, 12 minutes** (Cheng, 2023)
18.8 minutes per gram	12 minutes per gram

Burn Time

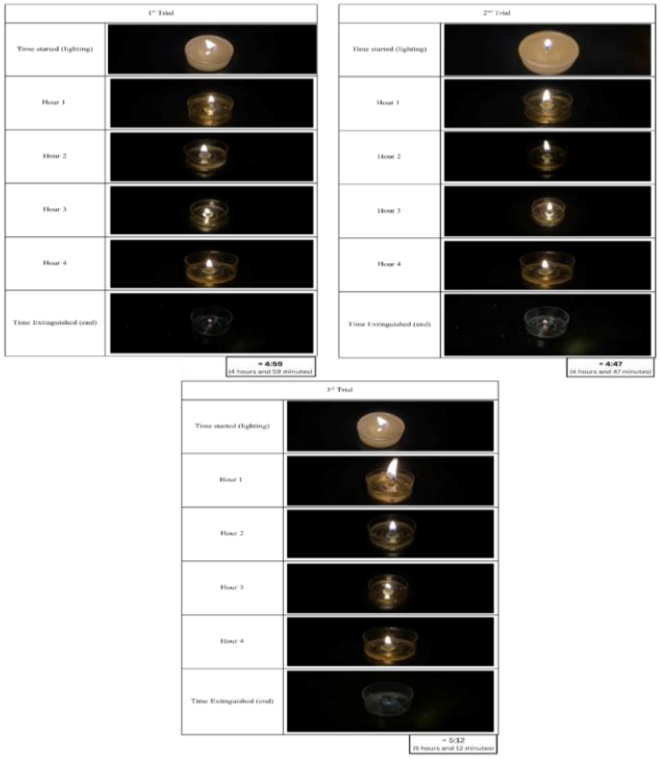


Figure 2

The burn tests in Figure 2 (Tables 1–3) show the performance of used cooking oil–based candles under controlled conditions. Each candle was lit at different times to assess consistency. All samples exhibited stable combustion without unnecessary extinguishing, demonstrating efficient fuel use and flame stability. Total burn times were 4 h 47 min, 4 h 59 min, and 5 h 12 min, confirming that the candles provide reliable and consistent performance suitable for practical lighting applications.

The mean formula was used to calculate the average burn time of three used oil–based candle samples, resulting in 4 h 59 min 20 sec. In comparison, a 16-gram paraffin wax candle burned for 3 h 12 min (Cheng, 2023). The used oil candles had a burn efficiency of 18.8 min/g, versus 12 min/g for paraffin wax. These results indicate that the used oil–based formulation burns longer and more efficiently than conventional paraffin candles.

Production/Raw Material Cost

The production cost results illustrate the cost analysis conducted by the researchers to determine the economic feasibility of producing eco-friendly candles made from used cooking oil and stearic acid as a binder. Each table outlines the breakdown of material expenses, including the cost of used oil, stearic acid, wick, and container.

16 gram candle
(this formula makes 110 teapot candles)

Category	Ingredients / Items	Cost ₱	Amount Used
Fragrance	½ cup	₱1000 for 2 cups	*₱250*
Stearic Acid	3 cups	₱208 per kilo	*₱139*
Oil	7 cups	Free	*Free*
Container & Wick	110 pieces	₱632	*₱632*
			= ₱1021

$$\frac{₱1021}{110}$$

- ₱1021 - materials raw cost
- 110 - amount of candles produced

= ₱9.28 per 16 g candle

Figure 3

Figure 3 above presents the production cost computation for a single batch of 16 gram eco-friendly candles made from used cooking oil and stearic acid as a binder. The total material cost for the batch amounted to ₱1,021, which was sufficient to produce 110 candles weighing 16 grams each. To determine the production cost per candle, the total expense was divided by 110, resulting in an estimated cost of ₱9.28 per 16-gram candle. This calculation represents the cost analysis for one of the presented product.

94 gram candle (this formula makes 12 candles)			
Category	**Ingredients / Items**	**Cost ₱**	**Amount Used**
Fragrance	0.21 cup	₱1000 for 2 cups	*₱105*
Stearic Acid	1.3 cups	₱208 per kilo	*₱60*
Oil	3 cups	Free	*Free*
Wick	12 pieces	₱45 for 25 pieces	*₱21.6*
Container	12 pieces	₱22 per piece	*₱264*
			= ₱450.6

₱450.6 / 12
- ₱450.6- materials raw cost
- 12 - amount of candles produced

= ₱37.55 per 94g candle

Figure 4

Figure 4 presents the production cost computation for a batch of eco-friendly candles made from used cooking oil and stearic acid as a binder, specifically formulated for 94-gram candles. The total material cost for this batch amounted to ₱450.60, which produced 12 candles in total. To determine the production cost per candle, the total expense was divided by 12, resulting in an estimated cost of ₱37.55 per 94-gram candle. This figure represents the cost analysis for another one of the presented products, contributing to the overall assessment of the candle's economic practicality and material efficiency

1kg table comparison

1kg oil batch		
Category	**Amount**	**Cost**
Oil	1kg	*Free*
Stearic Acid	430g	*₱89.50*
Fragrance oil	.32 cup	*₱160*
		₱249.50

1kg Paraffin Wax		
Category	**Amount**	**Cost**
Paraffin Wax	1kg	*₱239* (Shopee Philippines, n.d.)
Fragrance oil	.32 cup	*₱160*
		₱369

₱119.50 / ₱369 = (1.4789) 100 %

= 48% cheaper
(1.48 times cheaper)
(₱119.50 price difference)

Figure 5

Figure 5 presents the cost analysis, focusing on the candle base while excluding interchangeable components like the container and wick. Shared elements, such as fragrance oil, were standardized. The cost of 1 kg paraffin wax was ₱369 (with ₱239 from the wax; Shopee, n.d., retrieved October 19, 2025), while 1 kg of used oil–stearic acid base cost ₱249.50, with fragrance oil being the highest-cost component. Comparison shows the eco-friendly candle base is 48% cheaper, with a ₱119.50 savings, demonstrating that recycled oil–based candles are significantly more cost-efficient than paraffin-based alternatives.

Subjective Results.

Subjective data were collected via a Google Form administered house-to-house by the researchers. The form included eight sections covering Familiarity, Candle Performance, Practicality and Safety, Recommendability, and open-ended Suggestions.
A total of 94 respondents participated, mostly aged 15–20, indicating strong engagement from adolescents and young adults who may be receptive to sustainable innovations. Regarding power outages, 48.9% reported frequent brownouts and 29.8% occasional interruptions, highlighting the need for reliable emergency lighting solutions.

Familiarity

Typical Emergency Lighting Used - F1

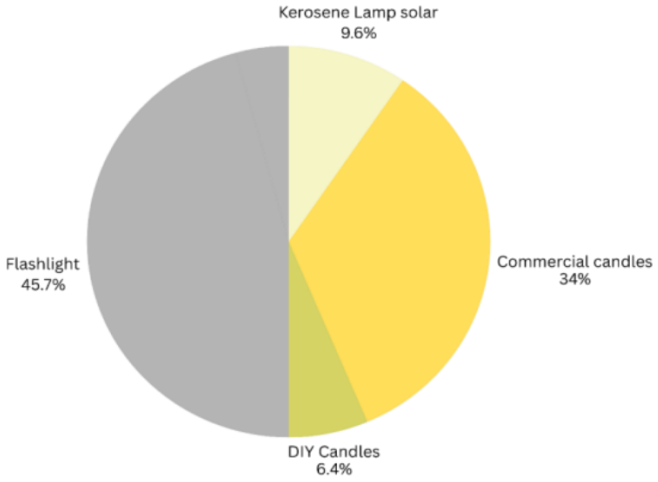
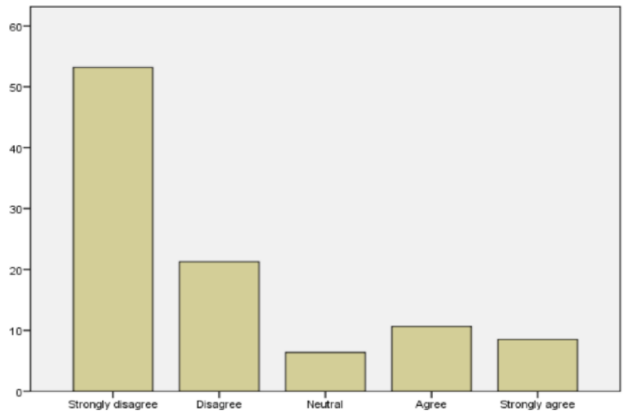


Figure 6 : F1

Respondents were asked about their typical emergency lighting source during power interruptions. The results revealed that the most commonly used source was the flashlight, accounting for 45.7% of the responses. This was followed by commercial candles with 34%, while DIY candles comprised 10.6%. Along with that, kerosene lamps were used by 9.6% of respondents, and solar-powered lights had the lowest usage.

Homemade Candle Prior Experience - F2

" I have used homemade candles before "

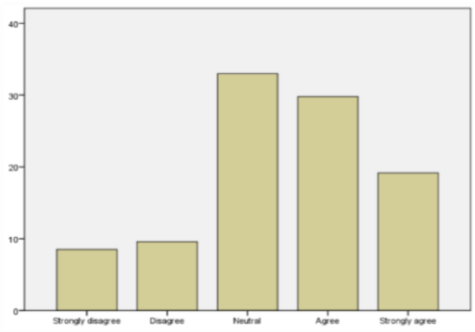


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	50	53.2	53.2	53.2
	Disagree	20	21.3	21.3	74.5
	Neutral	6	6.4	6.4	80.9
	Agree	10	10.6	10.6	91.5
	Strongly agree	8	8.5	8.5	100.0
	Total	94	100.0	100.0	

Figure 7 : F2

For Figure 7, allotted for homemade Candle Prior Experience – F2 (Likert Scale) "I have used homemade candles", reveals that most respondents indicated limited prior experience with homemade candles. A majority of 50 respondents (53.2%) strongly disagreed, while 20 respondents (21.3%) disagreed, showing that over 74% of participants have not previously used homemade candles. Meanwhile 10 respondents (10.6%) agreed and 8 respondents (8.5%) strongly agreed.

Discarded Oil Disposal- F3
"I have disposed of used cooking oil in household sinks/garbage."



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	8	8.5	8.5	8.5
	Disagree	9	9.6	9.6	18.1
	Neutral	31	33.0	33.0	51.1
	Agree	28	29.8	29.8	80.9
	Strongly agree	18	19.1	19.1	100.0
	Total	94	100.0	100.0	

Figure 8: F3

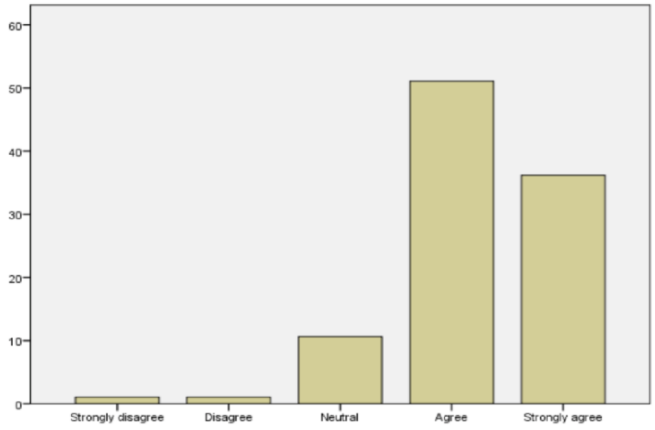
For Figure 8, Discarded Oil Disposal – F3 ("I have disposed of used cooking oil in household sinks/garbage"), most respondents were neutral (31; 33%), while 28 (29.8%) agreed and 18 (19.1%) strongly agreed. Only 9 (9.6%) disagreed and 8 (8.5%) strongly disagreed.

Overall, Familiarity results (F1–F3) indicate limited experience with homemade candles, making recycled cooking oil as a candle base relatively unfamiliar. Improper disposal of used oil via sinks or garbage was common. For emergency lighting, flashlights were most frequently used, followed by commercial and homemade candles, while kerosene lamps and solar lights were less common. These findings underscore the low familiarity with homemade candles but highlight the potential impact of introducing eco-friendly, recycled-oil alternative.

Candle Performance

Candle Scent - CP1

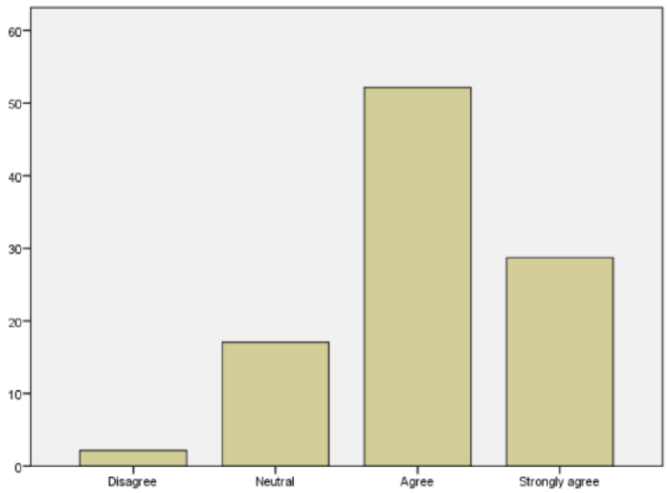
"The candle scent was easily noticeable in a room setting,"



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.1	1.1
	Disagree	1	1.1	1.1	2.1
	Neutral	10	10.6	10.6	12.8
	Agree	48	51.1	51.1	63.8
	Strongly agree	34	36.2	36.2	100.0
	Total	94	100.0	100.0	

Figure 9: CP1
For Figure 9, Candle Scent Perception – CP1 (Likert Scale) "The candle scent was easily noticeable in a room setting," the chart illustrates the respondents' perception of the candle's scent intensity. The majority of the respondents, 48 (51.1%), agreed that the candle scent was noticeable, while 34 (36.2%) strongly agreed. Meanwhile, 10 respondents (10.6%) remained neutral, and only 1 respondent (1.1%) disagreed, with 1 respondent (1.1%) strongly disagreeing.

Candle Luminosity / Light - CP2
"The light is consistent and sufficient for simple tasks like reading or as a corner light in the room,"



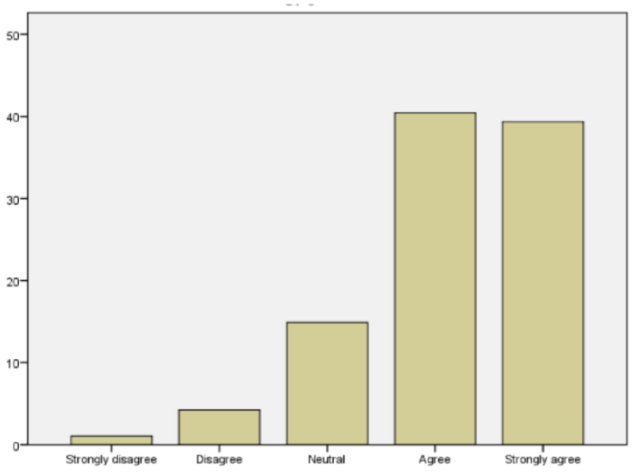
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	2.1	2.1	2.1
	Neutral	16	17.0	17.0	19.1
	Agree	49	52.1	52.1	71.3
	Strongly agree	27	28.7	28.7	100.0
	Total	94	100.0	100.0	

Figure 10: CP2

For Figure 10, Candle Luminosity/Light – CP2 (Likert Scale): "The light is consistent and sufficient for simple tasks like reading or as a corner light in the room," the chart shows the respondents' perception of the candle's brightness and usability as a light source. The majority, 49 respondents (52.1%), agreed that the candle's light was adequate for basic activities, while 27 respondents (28.7%) strongly agreed. Meanwhile, 16 respondents (17%) remained neutral, and only 2 respondents (2.1%) disagreed.

Smoke Risk - CP3

"No excessive smoke is emitted during use."

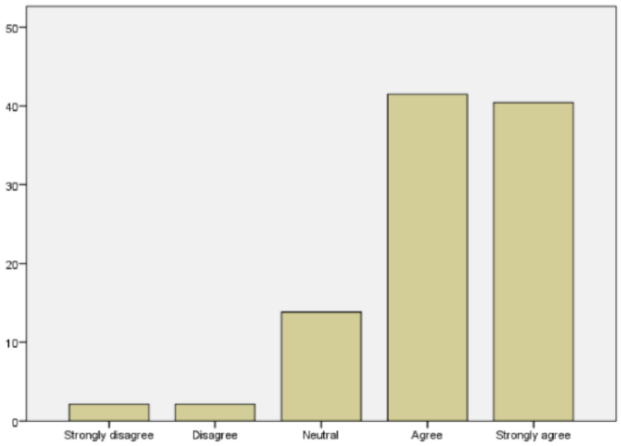


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.1	1.1
	Disagree	4	4.3	4.3	5.3
	Neutral	14	14.9	14.9	20.2
	Agree	38	40.4	40.4	60.6
	Strongly agree	37	39.4	39.4	100.0
	Total	94	100.0	100.0	

Figure 11: CP3

For Figure 11, Smoke Risk – CP3 ("No excessive smoke is emitted during use"), most respondents reported minimal smoke: 38 (40.4%) agreed and 37 (39.4%) strongly agreed, while 14 (14.9%) were neutral, 4 (4.3%) disagreed, and 1 (1.1%) strongly disagreed.
Overall, findings from CP1, CP2, and CP3 indicate that the candle performed well in scent, luminosity, and smoke emission. Most respondents found the fragrance pleasant, light output sufficient for indoor tasks, and smoke emission minimal. These results suggest that the candle meets user expectations for sensory appeal, functionality, and safety, effectively balancing aesthetic quality and practical performance.
Practicality and Safety

Safety - PS1
"Safe to use at home"

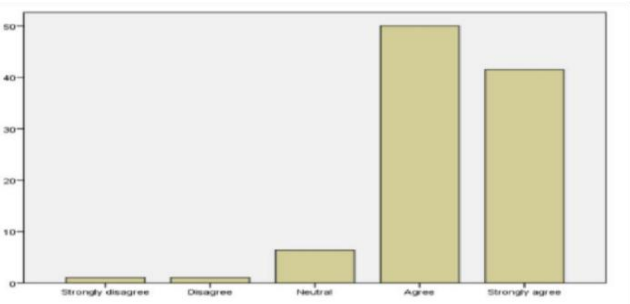


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.1	2.1	2.1
	Disagree	2	2.1	2.1	4.3
	Neutral	13	13.8	13.8	18.1
	Agree	39	41.5	41.5	59.6
	Strongly agree	38	40.4	40.4	100.0
	Total	94	100.0	100.0	

Figure 12: PS1

For Figure 12, Safety – PS1 (Likert Scale): "Safe to use at home," the chart presents the respondents' perception of the candle's safety during household use. The majority, 39 respondents (41.5%), agreed that the candle is safe for home use, while 38 respondents (40.4%) strongly agreed. Meanwhile, 13 respondents (13.8%) remained neutral, 2 respondents (2.1%) disagreed, and 2 respondent (2.1%) strongly disagreed.

Efficiency During Power Interruptions - PS2
"I believe this candle could be useful during future power outages in my household."

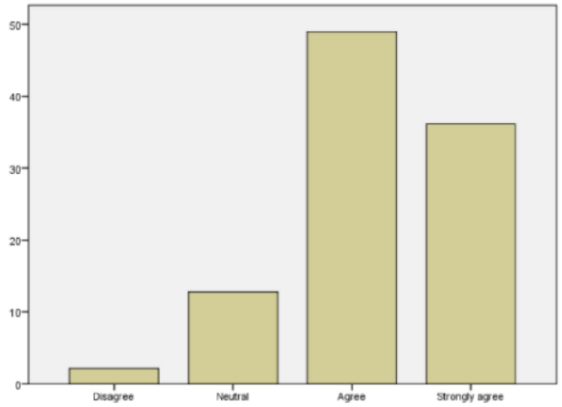


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.1	1.1
	Disagree	1	1.1	1.1	2.1
	Neutral	6	6.4	6.4	8.5
	Agree	47	50.0	50.0	58.5
	Strongly agree	39	41.5	41.5	100.0
	Total	94	100.0	100.0	

Figure 13: PS2

For Figure 13, Efficiency During Power Interruptions – PS2 (Likert Scale): "I believe this candle could be useful during future power outages in my household," the chart displays the respondents' perception of the candle's practicality as an emergency lighting option. The majority, 47 respondent (50%), agreed that the candle would be beneficial during power outages, while 39 respondents (41.5%) strongly agreed. Only 6 respondents (6.4%) remained neutral, and one disagreed or strongly disagreed.

Environmental Safety Over Commercial Candle - PS3
"This candle is safer for the environment over improvised lighting (e.g., kerosene lamp, open oil lamp during outages."

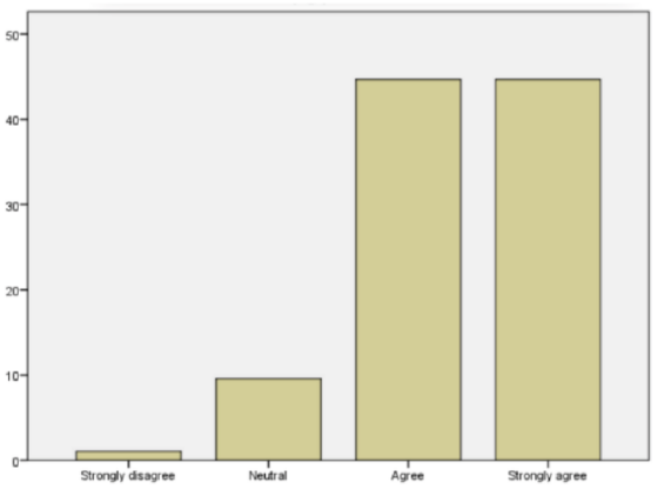


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	2.1	2.1	2.1
	Neutral	12	12.8	12.8	14.9
	Agree	46	48.9	48.9	63.8
	Strongly agree	34	36.2	36.2	100.0
	Total	94	100.0	100.0	

Figure 14 : PS3

For Figure 14, Environmental Safety Over Commercial Candle – PS3 (Likert Scale): "This candle is safer for the environment over improvised lighting (e.g., kerosene lamp, open oil lamp) during outages,"the chart presents the respondents' perception of the candle's environmental safety and sustainability. The majority, 46 respondents (48.9%), agreed that the candle is a safer and more eco-friendly option compared to improvised lighting sources, while 34 respondents (36.2%) strongly agreed. Meanwhile, 12 respondents (12.8%) disagreed, and only 2 respondents (2.1%) strongly disagreed.

Affordability - PS4
"The candle seems affordable compared to store-bought candles."



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.1	1.1
	Neutral	9	9.6	9.6	10.6
	Agree	42	44.7	44.7	55.3
	Strongly agree	42	44.7	44.7	100.0
	Total	94	100.0	100.0	

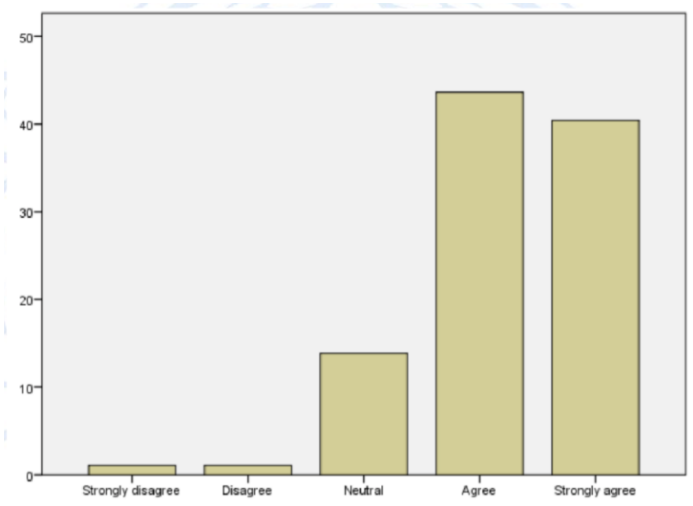
Figure 15: PS4

For Figure 15, Affordability – PS4 (Likert Scale): "The candle seems affordable compared to store-bought candles," the chart illustrates the respondents' perception of the product's cost-effectiveness. The majority, 42 respondents (44.7%), agreed that the candle is affordable, while another 42 respondents (44.7%) strongly agreed. Meanwhile, 9 respondents (9.6%) remained neutral, and only 1 respondent (1.1%) strongly disagreed.

Overall, the results indicate that the candle was positively received in terms of safety, practicality, environmental friendliness, and affordability. Respondents perceived it as safe, with minimal fire risk and stable burn performance, and dependable during power interruptions, providing sufficient illumination. Its eco-friendly advantages over improvised lighting sources were also recognized, along with its cost-effectiveness compared to store-bought candles. In conclusion, the candle demonstrates a balanced combination of safety, efficiency, sustainability, and affordability, making it a reliable household lighting option.

Recommendability

Recommendability - R1
"I would recommend this candle"



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.1	1.1
	Disagree	1	1.1	1.1	2.1
	Neutral	13	13.8	13.8	16.0
	Agree	41	43.6	43.6	59.6
	Strongly agree	38	40.4	40.4	100.0
	Total	94	100.0	100.0	

Figure 16: R1

For Figure 16, Recommendability – R1 (Likert Scale): "I would recommend this candle," the chart shows the respondents' overall perception of the product's quality and reliability. The majority, 41 respondents (43.6%), agreed that they would recommend the candle, while 38 respondents (40.4%) strongly agreed. Meanwhile, 13 respondents (13.8%) remained neutral, and only 1 respondent (1.1%)disagreed and 1 respondent (1.1%) strongly disagreed.

Concerns- R2
"Main safety concerns/ concern in general"

While most respondents found the candle feasible, safe, and practical, a few raised concerns. Safety issues included accidental burns, particularly around children ("pag natumba baka may natamaan"; "may not be safe if you have kids"). Minor usability issues were noted, such as container heating ("umiinit lalagyan"), wick residue ("may burnt particles kapag nasusunog"), and the candle's oily appearance. Practical limitations were also mentioned, including limited availability of used oil ("wala masyado used oil sa amin dahil hangga't maubos ginagamit"). Although these concerns were limited, they provide valuable guidance for improving formulation, container safety, and overall usability without affecting the candle's generally positive reception.

Suggestions - R3
Regarding recommendability, respondents expressed general satisfaction with the candle's performance and base, with no critical comments. Suggestions focused on aesthetics, such as using attractive containers, adding designs or decorations, and creating themed sets with varied scents. Appreciation was also noted for eco-friendly materials, like the abaca wick.

Overall, the candle was well received, with most respondents satisfied with its safety, functionality, and cost-efficiency. Minor concerns regarding heat, residue, and material availability did not affect overall perception. These findings indicate that the candle is highly recommendable as a reliable, practical, and eco-friendly household lighting option.

DISCUSSION

ANALYSIS OF DATA

Burn Time

Used cooking oil–based candles exhibited stable flames with burn times ranging from 4 h 47 min to 5 h 12 min (mean: 4 h 59 min), burning efficiently without unnecessary extinguishing. Compared to a similar-mass paraffin candle (3 h 12 min; Cheng, 2023), the used oil candles demonstrated longer and more efficient burn performance. These results align with studies emphasizing the influence of fuel type, wick size, and candle base on burn efficiency (Kral, 2014; Candle Science, 2021; Salthammer et al., 2021; Question About Olive Oil Candle Burn Time, 2025; Bulk Lamp Oil, n.d.). Overall, recycled cooking oil enhanced burn efficiency while adhering to standard combustion principles.

Cost Analysis

Production cost analysis revealed strong economic advantages. A 16 g candle cost ₱9.28, while a 94 g candle cost ₱37.55. The base material cost was ₱249.50/kg for used oil wax, compared to ₱369/kg for paraffin, reflecting a 48% reduction and ₱119.50 savings. These findings align with studies highlighting raw materials as major cost drivers (Team, 2025) and support evidence that waste cooking oil lowers expenses due to accessibility and minimal processing (Liu et al., 2022; Fischer, 2025). This contradicts claims that sustainable materials inherently increase costs (Bung, 2025). Overall, recycled cooking oil enables cost-effective and sustainable candle production.

Familiarity

Respondents showed limited familiarity with homemade and recycled oil-based candles. Flashlights were the primary emergency lighting source, followed by commercial candles, homemade candles, and solar lights. Most disposed of used oil through sinks or garbage, indicating low awareness of proper disposal. These trends align with Santos (n.d.), Kamalov (2024), and Abrajano et al. (2023), who reported inconsistent public engagement and widespread improper disposal. While Herzog (2023) emphasized electric-based dominance, candles remained accessible in this setting, highlighting opportunities for awareness and sustainability education.

Candle Performance

Used cooking oil candles demonstrated effective scent diffusion, consistent brightness, and minimal smoke, providing functional and sensory satisfaction. Respondents reported noticeable fragrance, stable illumination suitable for indoor use, and clean burning. These results align with studies on fuel type and fragrance composition effects (Karla, 2025; Egan, 2024; PMC, 2022) and confirm the psychological benefits of scented candles (Sowndhararajan & Kim, 2016; Putri & Putri, 2024). Findings also support combustion efficiency standards emphasizing base material and wick design (Salthammer et al., 2021; Candle Science–NCA, 2021). Overall, recycled cooking oil proved to be a high-performing, sustainable candle base.

Practicality and Safety

Respondents rated the candles as safe, practical, affordable, and environmentally beneficial, citing stable flames, low smoke, and reliability during power outages. Compared to kerosene lamps, the candles were safer and more eco-friendly. These findings align with circular economy studies demonstrating that refined WCO produces safe, durable, and clean-burning candles (Community Circular Economy Projects, 2024; Anggraini & Kurniasih, 2024; Kamalov, 2024; Liu et al., 2022). Contrary to claims of higher costs for sustainable candles (Team, 2025; Bung, 2025), this formulation proved economical and accessible, supporting household adoption.

User Satisfaction and Recommendability

Overall satisfaction was high, with respondents expressing strong willingness to recommend the product. Positive feedback centered on safety, performance, affordability, and sustainability, while suggestions focused on aesthetics, container safety, and scent variety. These results reflect broader market trends favoring eco-friendly, scented candles, where over 75% of consumers prioritize aroma and emotional appeal (Herz et al., 2022; GVR, 2023; Scented Candles Market Report, 2030). The findings indicate strong acceptance and market viability for recycled oil-based candles.

CONCLUSION

This study entitled, “Investigating the Viability of Recycled Cooking Oil as a Base for a Sustainable Emergency Light Source through Eco-friendly Scented Candles,” explored recycled cooking oil as a safe, practical alternative to paraffin wax, drawing on Combustion, Aromatherapy, Consumer Behavior, and Circular Economy Theories.

The study utilized a quantitative experimental design to evaluate recycled cooking oil as a base material for eco-friendly emergency candles. The candles were produced through a six-step process involving filtration of used palm oil, blending with stearic acid, heating, fragrance incorporation, pouring into containers with secured wicks, and curing at room temperature under controlled conditions. Burn time was tested on three 16-gram samples, production cost was computed from material expenses, and subjective data were collected through a Likert-scale survey administered to 94 randomly selected households from Gawad Kalinga, Barangay Salian, Abucay, Bataan. Descriptive statistics and direct comparisons with a paraffin candle were used for analysis.

Results showed that the recycled-oil candle burned longer (4 hours and 59 minutes) than a paraffin candle of the same mass (3 hours and 12 minutes) and was 48% cheaper to produce, demonstrating superior fuel efficiency and affordability. Survey responses indicated high satisfaction in scent diffusion, light quality, safety, practicality, and environmental value, with only minor concerns regarding container heat and material sourcing. Most respondents recommended the product.

Based on both objective and subjective findings, the null hypothesis was rejected, confirming significant differences in performance, cost, and user perception between recycled-oil and paraffin candles. Overall, the study concludes that recycled cooking oil is a viable, cost-effective, and sustainable base for eco-friendly emergency candles,

promoting waste reduction and sustainable household practices.

The study therefore concludes that recycled cooking oil is a viable base for an eco-friendly emergency candle: it delivers longer burn time, lower material cost per unit, and favorable user perception regarding practicality and environmental value.

RECOMMENDATION

Product Recommendations

- Explore other types of used cooking oil beyond palm oil to improve burn stability, scent diffusion, and consistency.
- Standardize the oil-to-solidifier ratio, wick size, and container type for uniform performance and appearance.
- Use heat-resistant containers and proper wick placement to enhance safety and burn efficiency.
- Adjust the oil-to-solidifier ratio or increase stearic acid to reduce greasy surface residue and improve candle firmness.
- Improve texture and color using natural stabilizers or colorants.
- Optimize wick performance by testing different materials and thicknesses (e.g., cotton, hemp, wood).
- Partner with local food establishments to collect used cooking oil for sustainable and community-based production.
- Use eco-friendly packaging such as recycled glass jars and biodegradable labels.
- Obtain safety and environmental certifications before commercialization.
- Encourage households and communities to collect and repurpose used cooking oil instead of discarding it.

Research Paper Recommendations

- Conduct chemical and emission analyses to assess combustion by-products and environmental impact.
- Compare different oil purification methods to determine the most effective process for candle production.
- Study candle durability, storage stability, and scent retention under varying environmental conditions.
- Perform economic feasibility and life-cycle assessments to evaluate scalability and sustainability.
- Include a larger respondent sample to improve statistical reliability.
- Apply interdisciplinary approaches combining chemistry, environmental science, and business studies for broader validation.

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