A Project Feasibility Study on the Production of Pest Off: A Mosquito Repellent Scented Incense

Alyssa Nicole V. Alog

Rufo Janus C. Bautista

Jhun Jhun B. Capili

Adrian H. Enriquez

Alexis B. Garcia

Roi John S. Piquit

Raven Joyce E. Silva

Quezon City University
Quezon City, Philippines

ABSTRACT

Cigarette butts are the most prevalent form of litter, with an estimated 4.5 trillion cigarette butts discarded worldwide each year. As increasing concern arises from growing environmental issues, product innovation made from recycled materials is vital. Reducing the enormous amount of plastic waste while providing outstanding marketing opportunities conceived the production of mosquito repellent scented incense made from tipping paper of cigarette butt. The tipping paper of the cigarette butt is recycled and used as a primary raw material of mosquito repellent. The paper is ground to a pulp with an organic binder, and fragrances such as citronella or oregano are added to turn waste into a valuable resource for killing mosquitoes. Using the Cochran formula, three hundred seventy-six (376) of sixteen thousand six hundred ninety (16,690), or 2.25% of the household, were selected as a sample size of the study, particularly the District 4, Brgy. Tatalon, Quezon City. Hence, this paper provides a comprehensive analysis and discussion of the feasibility and sustainability of mosquito repellent out of recycled material.

Keywords: Sustainable Development Goals, mosquito repellent; National Tobacco Administration; Cigarette Butts; Product Innovation

Introduction

Every year, around 6.5 trillion cigarettes are purchased by smokers worldwide. Every day that equates to 18 billion, making cigarette butts one of the world's most abundant forms of plastic waste. While most of a cigarette's contents and paper wrapping are destroyed when smoked, not all is consumed. Trillions of cigarette filters, commonly known as cigarette butts or ends, are left over, with only about a third of them ending up in the trash. With such disturbing figures, one would think there would be a strong emphasis on the environmental impact of cigarette butts. However, due to their small size, people often disregard cigarette butts as waste and dispose of them carelessly. Cigarette butts carried as runoff from streets to drains, rivers, and eventually to the ocean and its beaches, harm the environment by clogging roadways, walkways, and other open spaces.

With the increasing concern arising from growing environmental awareness, there is a critical need for properly disposing of, especially recycling, a cigarette butt. Reducing the enormous amount of plastic waste while providing outstanding marketing opportunities led the way for mosquito repellent scented incense made from tipping paper of cigarette butt. The tipping paper of the cigarette butt is recycled and used as a primary raw material of mosquito repellent. The paper is ground to a pulp with an organic binder, and fragrances such as citronella or oregano are added to turn waste into a valuable resource for killing mosquitoes. Furthermore, the mosquito repellent made from cigarette butts is odorless, and there is no trait of the tobacco smell that a cigarette produces. This means that this innovation, therefore, solves not only a crucial but also undermined issue while minimizing mosquito bites among individuals as well as mosquito- borne viral diseases such as dengue, malaria, and chikungunya. It also ensures that cigarette butts don't end up in a landfill. Instead, they are collected and recycled and make final products out of recycled items

Increasing awareness of the environmental impacts posed by discarded cigarette butt waste conceived the feasibility study on the production of mosquito repellent scented incense. This feasibility study is benefiting the environment and educating society about the consequences of cigarette butt waste. Creating this product out of recycled waste also creates value for consumers who purchase the products. Moreover, it promotes recycling as a way of life, which will further educate the public on the necessity of continuous innovation while fostering sustainable development and public health importance.

Materials and Methods

Product Making & Production Process Flow Chart

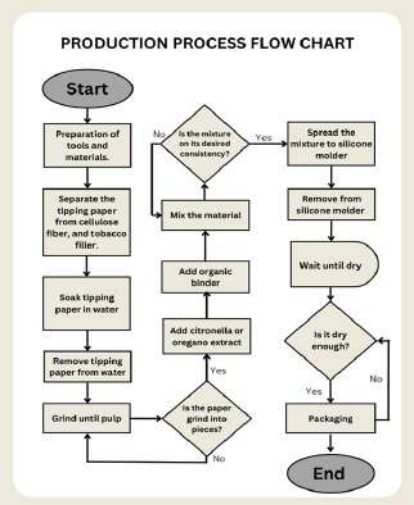

Figure 1. Production Process Flow Chart

This study used the tipping paper of cigarette butts as the primary material for mosquito repellent scented incense. The primary material for this incense comes from the most littered item in the world, cigarette butts (tipping paper). The operation will start by separating the tipping paper from cellulose fiber and tobacco filler. This process requires a distinct operation to ensure that each component of cigarette butts is separated. Once done, the tipping paper will be soaked in the mixture of water and baking soda to rinse the nicotine before grinding it into pulp. Organic binders and fragrances such as citronella and oregano will be added to the mixture as part of the process. When the product achieves its desired consistency, it will spread to the silicone molder to achieve the hexagonal shape of the product. After this process, the product can now proceed for drying and packaging.

Design of Experiment was used to determine the product specification, including the required size, thickness, color, texture, scent, shape, and product duration. The total population in Barangay Tatalon, Quezon City is 16,690. The Cochran formula is used to determine the number of respondents who identified the market acceptability of the product through the form of survey. The sample size is determined while achieving the desired level of confidence in their results and minimizing the margin of error. The calculated sample size is 376 respondents and disseminated using Simple Random Sampling wherein each member of a population has an equal probability of being selected. The study was conducted from January to April of 2023 in Quezon City, Philippines

Results and Discussions

In this section, the researchers present the market survey result, demand and sales analysis, and product innovation. It provides a comprehensive understanding of the findings of the study.

MARKET SURVEY

Demographic Segmentation

The researchers used in-person surveys to acquire information about the market's acceptance of the company's product. The data collection is carried out in Quezon City's 4th district, Barangay Tatalon with a sample size of 376 respondents determined using Cochran Formula. The respondents consist of residents of the Barangay Tatalon of Quezon City.

The table (1) below shows that most respondents are 21-30 years old, with 197 frequencies or 52.4% of the total participants. This is followed by 86 frequencies or 22.9% of the total responses representing participants of ages 20 years old and below. Then, ages 31-40 years old have 41 frequencies or 10.9% of the total respondents. While ages 41-50 years old have 28 frequencies or 7.4% of the total participants. Next, ages 61 -years old and above have 13 frequencies or 3.5% of the total respondents. Lastly, 11 frequencies or 2.9% of the total responses, are reported for respondents 51-60 years old.

Table 1. Age of the Respondents

		Frequency	Percent	Cumulative %
Valid	20 years old and below	86	22.9	22.9
	21 - 30 years old	197	52.4	75.3
	31 - 40 years old	41	10.9	86.2
	41 - 50 years old	28	7.4	93.6
	51 - 60 years old	11	2.9	96.5
	61 years old and above	13	3.5	100.0
	Total	376	100.0	

The table (2) below reveals that most respondents are female, accounting for 183 frequencies, or 48.7% of the total participants. Next, 168 frequencies or 44.7% of total respondents, represent female participants. On the other hand, 25 frequencies or 6.6% of the total participants are prefer not to say their gender.

Table 2. Gender of the Respondents

		Frequency	Percent	Cumulative Percent
Valid	Male	168	44.7	44.7
	Female	183	48.7	93.4
	Prefer not to say	25	6.6	100.0
	Total	376	100.0	

Table 3. Employment Status of the Respondents

		Frequency	Percent	Cumulative Percent
Valid	Employed	114	30.3	30.3
	Currently Unemployed	79	21.0	51.3
	Student	177	47.1	98.4
	Other	6	1.6	100.0
	Total	376	100.0	

Market Opportunities

Based on the result of the market survey, it emphasizes that most of the residents in Brgy. Tatalon used mosquito repellent with 300 frequencies, or 79.8% of the total participant, as shown in Table 4. However, 76 or 20.2% of the respondents do not use mosquito repellent. Withal, according to the respondents, they will consider buying mosquito repellent in the future, with 59 frequency or 77.6% of the total respondents, as shown in Table 5. With these, the product will have many potential customers by establishing it in the barangay.

Table 4. Usage of Mosquito Repellent by the Respondents

		Frequency	Percent	Cumulative Percent
Valid	Yes	300	79.8	79.8
	No	76	20.2	100.0
	Total	376	100.0	

Table 5. Frequency Distribution of Respondent's Consideration in Buying a Mosquito Repellent Incense in the Future

If not, do you consider buying mosquito repellent incense in the future?

		Frequency	Percent	Cumulative Percent
Valid	Yes	59	15.7	77.6
	No	17	4.5	100.0
	Total	76	20.2	
Missing	System	300	79.8	
Total		376	100.0	

Consideration in Buying a Mosquito Repellent Incense in the Future

Moreover, the mosquito repellent made from cigarette butt waste is not well known to the respondents as per the market survey, with 339 frequencies, or 90.16% of the participants said they are unfamiliar with the product. Since it was new for them with an affordable price and an eco- friendly product, the potential customer will be curious and, eventually, buy and use it. Choi et al. (2022) found out that after accidentally utilizing an unfamiliar product, customers had a more favorable reaction to it.

Market Share Analysis

This section shows how well a company performs in the market compared to its competitors.

To get the market share need to calculate the annual capacity divided by the annual demand and multiply it by 100, as the formula given below:

$$\textit{Market Share} = \frac{\textit{Annual Capacity}}{\textit{Annual Demand}} \times 100$$

To get the annual capacity, the production capacity per day is multiplied to the number of days in a year and number of workers in the production as of follow:

$$\textit{Annual Production Capacity} = 185 \textit{ units per day} \times \textit{No. of Working Days} \times \textit{No. of Workers}$$

To calculate the total available time, standard time, and production capacity per day, the formulas are expressed as:

$$\text{Total Available Time} = \frac{1 \text{ shift}}{\text{day}} \times \frac{8 \text{ hours}}{\text{shift}} \times \frac{60 \text{ minutes}}{\text{hour}}$$

$$\textbf{Total Available Time} = 480 \text{ minutes per day}$$

$$\text{Standard Time} = \text{Normal Time } (1+\text{Allowance Factor})$$
$$\text{Standard Time} = 59.25\ (1+14.01\%)$$
$$\textbf{Standard Time} = 67.55$$

$$\text{Production Capacity per day} = \frac{\frac{480 \text{ minutes}}{\text{day}}}{\frac{67.55 \text{ minutes}}{26 \text{ boxes}}}$$

$$\textbf{Production Capacity per day} = 184.75 \approx 185 \text{ boxes per day}$$

The table (6) below reveals that the capacity for this year 2023 since the business will start on July is 105,304 boxes while in 2024, there are 322,010 boxes, 412,350 boxes for the year 2025, 503,984 boxes for the year 2026, 595,617 boxes for the year 2027, and 690,021 boxes for 2028. The projection clearly shows that there is an increase in the capacity since the business decided to hire 2 workers every year to comply with the demand.

Table 6. Annual Capacity of Pest Off! in ZEROMOZ Company Ltd

Year	Produced box/day	Working Days/years	No. of Workers	Annual Capacity
2023	185	114	5	105,304
2024	185	249	7	322,010
2025	185	248	9	412,350
2026	185	248	11	503,984
2027	185	248	13	595,617
2028	185	249	15	690,021

The table (7) below shows the market share analysis of the researchers, ZEROMOZ Company Ltd., for five (5) years starting from the year 2023 to the year 2028. The table shows below that in the year 2023, given that the actual operation of the business is in July, the company still has a market share of 28% of the annual demand, while in the year 2024, it increases to 43%. The market share for the year 2025 is 54%, while in the year 2026 is 65%. Next year, there will be a 76% market share, while in 2028, there will be an 87% market share.

Table 7. Market Share Analysis

Year	Operating Days	Annual Demand	Annual Capacity	Market Share
2023	114	371,720	105,304	28%
2024	249	752,584	322,010	43%
2025	248	761,840	412,350	54%
2026	248	771,211	503,984	65%
2027	248	780,697	595,617	76%
2028	249	790,300	690,021	87%

DEMAND AND SALES ANALYSIS

Projected Demand

This part illustrates demand by displaying the market acceptability of mosquito repellent incense made from cigarette waste as a percentage. The company estimates the demand for the product by using the information from the target market's responses to the survey done in their Barangay.

The table (8) below show that most respondents are willing to buy Pest Off, a mosquito repellent scented incense with 349 frequencies or 92.82% of the total respondents. On the other hand, 27 frequencies, or 7.18% of the total respondents, are unwilling to buy the company's product. Therefore, the market acceptability of Pest Off is 92.82%.

Table 8. Frequency Distribution of Market Acceptability

Are you willing to buy mosquito repellent incense made from cigarette waste?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	349	92.8	92.8	92.8
	No	27	7.2	7.2	100.0

The table (9) and graph (Figure 2.) below reveal that most respondents used mosquito repellent 3 - 4 times a week with 100 frequencies, with 26.6% of the total respondents. Thus, potential customers can purchase four (4) boxes in one month of daily use.

Table 9. Frequency Distribution of Market Usage

How often do you use mosquito repellent?

		Frequency	Percent	Cumulative Percent
Valid	Everyday	57	15.2	19.0
	1 - 2 times a week	91	24.2	49.3
	3 - 4 times a week	100	26.6	82.7
	5 - 6 times a week	33	8.8	93.7
	Once a month	8	2.1	96.3
	Other	11	2.9	100.0
	Total	300	79.8	
Missing	System	76	20.2	
Total		376	100.0	

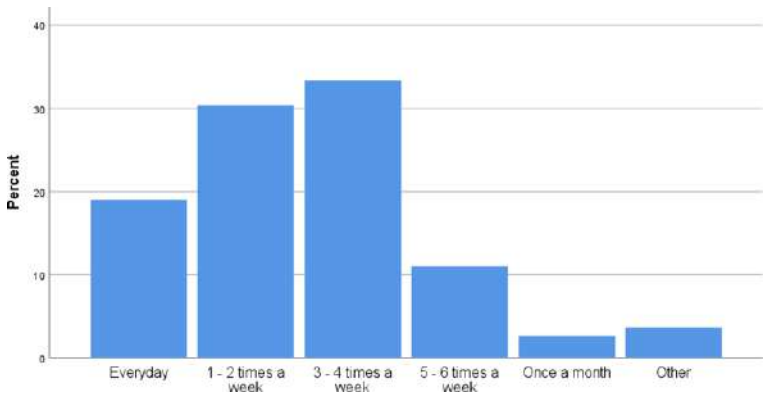

Figure 2. Bar Graph of Frequency Distribution of Market Usage

Overall, the annual demand prediction for the following five years, with a constant market acceptability of 92.80% based on the most recent market survey, is shown in the table below. Multiply the target population by the market acceptability and frequency to get the annual projection demand. Hence, the projected annual demand is 371,720, 752,584, 761,840, 771,211, 780,697, and 790,300 for the years 2023, 2024, 2025, 2026, 2027, and 2028 respectively. Meanwhile, the target population was supported by the

Philippine Statistical Authority that the annual growth rate of Quezon City is 1.23%. Therefore, the target population is calculated by multiplying the original population by the quantity of 1 plus the growth rate and by the number of years.

Table 10. Annual Projected Demand for the next Five (5) years

Year	*Target Population (Households)*	*Market Acceptability (%)*	*Market Usage*	*Annual Projected Demand*
2023	16,690	92.80%	24	371,720
2024	16,895	92.80%	48	752,584
2025	17,103	92.80%	48	761,840
2026	17,313	92.80%	48	771,211
2027	17,526	92.80%	48	780,697
2028	17,742	92.80%	48	790,300

PRODUCT DESIGN

Table 11. Product Specifications

Product	Pest Off!
Characteristic	Mosquito Repellent Scented Incense, Color: Light Brown, Texture: Papery rough, Scent: Citronella and Oregano.
Design	Hexagonal Coil Shape
Size Du- ration	11.9x11.9 cm and thickness is 1cm It can last up to 2 Hours

Figure 3. Product Dimensions

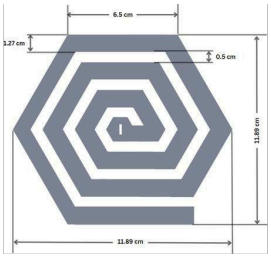

Figure 4. *Actual Product*

Figure 5. *Packaging*

Product Safety

One of the safety concerns of this study is the nicotine absorption of tipping paper from cigarette butts since the product innovation is made from it as a primary material. However, according to Science Research Specialist II-TLSID, Engr. Justito A. Ambros of the National Tobacco Administration, "The tipping paper may absorb nicotine but in a very small amount and will completely remove when washed with water." With that statement, the smoke from the burned hexagonal coil mosquito repellent will not be considered secondhand smoke because nicotine is almost negligible in tipping paper. Also, as he added, "Nicotine is miscible with water, and it is not volatile when mixed with water. Nicotine is readily volatile when exposed to ultraviolet light with a vapor pressure of 5.5 Pa at 25 or various oxidizing agents; nicotine is converted to nicotine oxide, nicotine acid, and methylamine."

Since the product's safety was assessed and validated by an expert; therefore, the researchers guarantee that the product innovation is safe to use by the consumers.

Table 10. Product Pros & Cons

PROS	CONS
Made from recycled cigarette butts.	Not recommended for person who is sensitive to smoke or suffers from asthma.
Made with organic ingredients and essential oils.	Poses serious fire hazard if left mosquito coil burning.
Fast killing action that instantly gets rid of mosquitoes	They may even irritate the eyes or cause allergies.
Can last up to 30 minutes – 2 hours	Burning and exposure to mosquito coil smoke daily can cause serious diseases like lung cancer.
No irritating odour that stink up the house.	Not allowed for children using it.
Convenient to use	
Environmental friendly	
Affordable compared to other brands.	

Conclusion

This study drawn to the following conclusions:

1. The researchers conclude that the study is feasible to the market due to high market acceptability in accordance with the result from the market survey; many would want to support and purchase Pest Off, a mosquito repellent scented incense made from tipping paper of cigarette butts.
2. The process and materials for the product are easily accessible in the market in terms of manufacturing and technical feasibility and;

3. Since cigarette butts are rarely recycled, this is one way to reduce the world's most abundant form of plastic waste while preventing mosquito bites among individuals thus, minimizing mosquito-borne viral diseases such as dengue, malaria, etc.

With this, the study would promote green engineering and help create a sustainable environment by turning waste into a usable product.

Acknowledgement

Above all, the researchers would like to thank God, the Almighty, for His showers of blessings throughout our study and its successful completion. The researchers would also like to express their deep and sincere gratitude to our project feasibility professor, Engr. Dennis Abesamis for his invaluable supervision and support for the success of this study. Our thanks and appreciation also go to the faculty and management of the College of Engineering for giving us a wonderful opportunity to have this feasibility study, our friends, and parents for their words of encouragement, and to all those people who have willingly helped us out with their abilities. Soli Deo Gloria.

References

PROS	CONS
Made from recycled cigarette butts.	Not recommended for person who is sensitive to smoke or suffers from asthma.
Made with organic ingredients and essential oils.	Poses serious fire hazard if left mosquito coil burning.
Fast killing action that instantly gets rid of mosquitoes	They may even irritate the eyes or cause allergies.
Can last up to 30 minutes – 2 hours	Burning and exposure to mosquito coil smoke daily can cause serious diseases like lung cancer.
No irritating odour that stink up the house.	Not allowed for children using it.
Convenient to use	
Environmental friendly	
Affordable compared to other brands.	

Cranley, E. (2019, August 2). Discarded cigarette butts are the most widespread man-made pollutant, according to study. World Economic Forum. https://www.weforum.org/agenda/2019/08/littered- cigarette-butts-are-the-most-widespread-man-made-pollutant-and-they-harm-plant-growth- according-to- study?DAG=3&gclid=Cj0KCQjwuLShBhC_ARIsAFod4flkQ6NYNimoLx_PpwIRBti4mzgv8jtv67 PWYz4PYwtb1bC6EEGnjdAaAs3yEALw_wcB

Edillo, F. E., Halasa, Y. A., Largo, F. M., Erasmo, J. N. V., Amoin, N. B., Alera, M. T. P., Yoon, I.- K., Alcantara, A. C., & Shepard, D. S. (2015). Economic Cost and Burden of Dengue in the Philippines. The American Journal of Tropical Medicine and Hygiene, 92(2), 360–366. https://doi.org/10.4269/ajtmh.14-0139

Frost & Sullivan. (2020). The Philippine Insect Repellent Market: Companies Invest in Developing Natural and Innovative Products. https://ww2.frost.com/frost-perspectives/the-philippine-insect- repellent-market-companies-invest-in-developing-natural-and-innovative-products/

Grand View Research. (2021). Mosquito Repellent Market Size, Share & Trends Analysis Report By Product (Coils, Vaporizers, Sprays, Mats), By Distribution Channel (Offline, Online), By Region (APAC, MEA, CSA), And Segment Forecasts, 2021-2028.

https://www.grandviewresearch.com/industry-analysis/mosquito-repellent-market

Jayaraman, K. S. (2017, September 22). Cigarette butts to eliminate mosquitoes? The Economic Times. https://economictimes.indiatimes.com/news/science/cigarette-butts-to-eliminate- mosquitoes/articleshow/60791804.cms

Martins, A. (2019, June 4). Most Consumers Want Sustainable Products and Packaging. Business News Daily; businessnewsdaily.com. https://www.businessnewsdaily.com/15087-consumers-want-sustainable products.html

Quezon City Epidemiology & Disease Surveillance - Posts. (2023). https://www.facebook.com/QCEpidemiologyDiseaseSurveillance/posts/pfbid029qkRdHc8RfwnqG6VQrq3FdeGHP3zA25xhNoVuEvnNpjiu6TBLrUcPb6nHBjsJzf4l

Rubenstein, J. (2020, August 28). Tiny but deadly: Cigarette butts are the most commonly polluted plastic. Earth Day. https://www.earthday.org/tiny-but-deadly-cigarette-butts-are-the-most- commonly-polluted-plastic/