

Sustainable School and Office Supplies Using Agri-Waste and Air-Waste

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Abstract

This study aimed to provide sustainable school and office supplies through the utilization of air waste and one of the most abundant wastes in the Philippines, sugarcane bagasse. The bagasse is identified to be one of the top agricultural wastes in the country. Research suggests that it posed a great threat to the environment because of its underutilized remains. The study is from a premise that in a hectare of a sugarcane plantation, it may produce 11 to 21 tons of agricultural waste, subsequently, this waste is either left in a way it will rot or burned, which may be partly responsible for global warming. The research is focused on addressing environmental waste through a product that would generate income as well as reduce waste. The proponents developed a product named: CoalAsse. It is a sustainably made pencil from the residue of sugarcane, and agricultural waste. The need analysis was conducted using a qualitative study. Through further analysis, numerous tests, and assessment of the project, it demonstrated that bagasse is an effective material for sustainable school and office supplies.

Keywords

Agricultural Waste, Bagasse, Office and School Supplies, Pencil, Sustainability.

1. Introduction

The study focused on the feasibility of MaxiEma, an ecopreneur company that developed sustainable school and office supplies through the utilization of air and agricultural waste in the Philippines. The company aimed to determine the viability of MaxiEma, a company that promotes environmental science and offers solution to the increasing effect of climate change and helps reduce environmental waste. The company name, MaxiEma, was derived from the latin maxima, which means greatest or highest quantity of outcomes possible. The name gives relevance to the company's goal of attaining sustainable lifestyles by using sustainable school/office supplies through using air and agricultural waste in the Philippines. It also promotes awareness about the current issues of increasing agricultural waste and other pollutants in the Philippines. The launching product of MaxiEma is an alternative to commercial charcoal pencils made from air waste converted into charcoal, and its body is made from agricultural waste.

The MaxiEma's mission is to provide sustainable products mainly school office supplies that provide a solution to the increasing effect of environmental waste in the Philippines. The mockup company is also designed to help offer job opportunities for local sugarcane farmers in the Philippines, and increase awareness on the current issues of increasing agricultural waste and other pollutants in the Philippines. Air Pollution has been a problem for our environment. Additionally, according to the World Health Organization (WHO), almost 99% of the world's population breathes air that contains a high level of pollutants that exceeds the WHO guidelines. Casually, prolonged exposure to air pollution can affect every organ in the body, leading to a wide range of various diseases, such as lung cancer. The sugarcane industry produces 11 to 21 tons of waste; some of its waste is burned (Sugarcane Wastes Eyed as Animal Feed, Fuel Briquette 2020). One of the most prevalent agricultural processing wastes produced around the world is sugarcane bagasse (Doddapaneni and Kikas 2021). According to the UN, tree-cutting or deforestation where 8 Million trees are cut down yearly to produce commercial pencils.



Figure 1. Sustainable Development Goals

The Figure 1 shows that the study addresses five Sustainable Development Goals: SDG 11 - Sustainable cities and communities; SDG 12 - Responsible Consumption and Production; SDG 13 - Climate Action; SDG 15 - Life on Land; SDG 17 - Partnership for the Goal.

1.1 Objectives

The proponents first aimed to help in mitigating pollution and utilize it to create or make a new product. The proponents saw potential in using gathered air waste or air dust, which is incinerated and reduced into charcoal consistency as a substitute for charcoal pencil lead. Then, the bagasse, which is an agricultural waste, was utilized for the pencil's body. With the help of a service provider, these two ideas were combined to form the first prototype of CoalAsse. The proponents seized this opportunity to utilize agricultural waste and turn it into a sustainable product. For the charcoal lead of CoalAsse, the proponents used air dust gathered from air filters (e.g., vacuums, aircon filters, and air purifiers). The collected dust will be burned or incinerated until refined into black powder. Then it will be formed into a pencil lead and inserted into the pencil's body. The following are the objectives of the study: to develop a product that utilizes air and agricultural waste; to offer a product in the competitive market; and to determine if the launching product is financially feasible.

2. Literature Review

According to Lena (2022), Matt Palabrica, a member of the Iloilo Board, mentioned that the sugarcane business in Iloilo employs about 10,000 people. Sugarcane has been the most favorable harvest that has supported the province throughout this pandemic. It is worth close to 10 billion Philippine peso when all costs associated with the production chain are considered, including personnel, equipment, truck parts, gasoline, and fertilizer. In the Sangguniang Panlalawigan, sugarcane planters' cause is one that Palabrica has been promoting. In a similar study by Xu et al. (2018), it is also stated that when sugarcane is pressed to extract its juices, the fibrous material (bagasse) left from the plant is considered an abundant agricultural waste disposed of or often left to rot.

Sugarcane bagasse is not only abundant locally but also globally. The usefulness of this agricultural waste is beyond what is expected. Many researchers utilize bagasse for various applications in energy and environmental sustainability (Ajala et al. 2021). A study by Amin et al. (2020), turned bagasse into ash and used it to develop a sustainable engineered cementitious composite (ECCs). The results showed that ECC mixed with 10% of ground bagasse ash (GBA) has a higher comprehensive strength and exhibited similar tensile and flexural strengths (bend strength) compared to control ECC mixes. Another study by Nurdin et al. (2018) assessed the tensile strength of bagasse used as an alternative material in making particle board. The results showed that it has a 1.8 MPa pull strength. The study proved that bagasse can be an alternative raw material to wood powder. Thus, bagasse can potentially be used as an alternative to wood pencils as well.

Commercial charcoal is made from burning wood, which negatively impacts the environment. It may also be expensive and contain lead that may cause long-term harm to users, especially children. Furthermore, CoalAsse is a product that turns air pollution into something new, which can be a way to reduce air pollution that lessens greenhouse gas emissions making the product environmentally friendly (Soriano 2022).

3. Methods

There are three phases in this study, phase 1 of the study aimed to identify the target market's needs by deploying survey questionnaires to different individuals within the Marikina City, one of the leading cities in the National Capital Region (NCR). This analysis helped the proponents identify the product's best features and possible market needs. Phase 2 of the study is about technology development. The proponents asked help from a service provider and experts in the field to build the prototype effectively and accurately. This part focuses explicitly on creating the prototype, which follows the Theoria Resheneyva Isobretatelskeuh Zadach (TRIZ) Method or in English, the Theory of Inventive Problem Solving (see Figure 2).

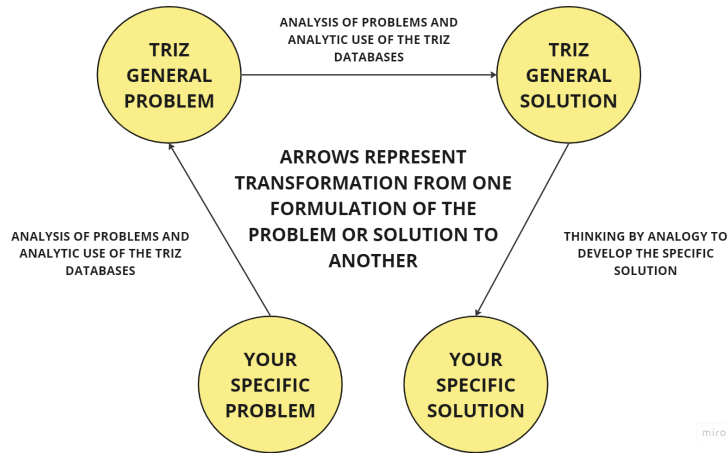


Figure 2. TRIZ Problem-Solving Method

The Figure 3 shows the project process using the Triz Model. It consists of defining, analyzing, generating, evaluating, and verifying the project. The Triz Methodology consists of 40 principles which are known solutions to the identified problems (see Table 1).

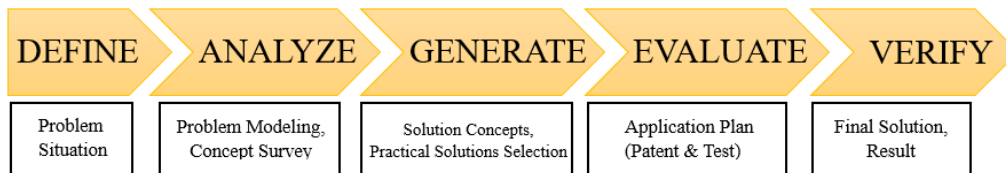


Figure 3. TRIZ Project Process

Principle Number 22 of Triz Methodology shown in Table 1 is about the concept of converting harmful into a benefit. The proponents utilized air waste and agricultural waste in producing a product that has a positive effect that is sustainable and helpful for the environment. Phase three includes the expert's validation.

Table 1. Principles of Triz

Triz Methodology: 40 Principles	
1. Segmentation	21. Rushing Through
2. Extraction (Extracting, Retrieving, Removing)	22. Convert Harm into Benefit
3. Local Quality	23. Feedback
4. Asymmetry	24. Mediator
5. Consolidation	25. Self-service
6. Universality	26. Copying
7. Nesting (Matrioshka)	27. Dispose
8. Counterweight	28. Replacement of Mechanical System
9. Prior Counteraction	29. Pneumatic or Hydraulic Constructions
10. Prior Action	30. Flexible Membranes or Thin Films
11. Cushion in Advance	31. Porous Material
12. Equipotentiality	32. Changing the Color
13. Do It in Reverse	33. Homogeneity
14. Spheroidality	34. Rejecting and Regenerating Parts
15. Dynamicity	35. Transformation of Properties
16. Partial or Excessive Action	36. Phase Transition
17. Transition into a New Dimension	37. Thermal Expansion
18. Mechanical Vibration	38. Accelerated Oxidation
19. Periodic Action	39. Inert Environment
20. Continuity of Useful Action	40. Composite Materials

An in-depth interview was conducted with the identified experts that may vary within the understanding of the informant's knowledge, perspective, and experiences within the scope and features of the product and its overall content.

4. Data Collection

A sampling size test was used to determine whether the identified sample was sufficient; thus, three tests for adequacy were used. These are the Raosoft, Slovin's Formula, and Survey Monkey. All of which satisfies the sample size of 156 respondents of the needs analysis. The results of the MaxiEMA survey comprised 156 respondents who answered the need analysis of CoalAsse. The Statistical Package for the Social Sciences or SPSS was used to compute the results. The insights into the target market have been established due to the examined results. This analysis helped the proponents to identify the product's best features and possible market needs. The expert's validation was also included in the data collection wherein an in-depth interview was conducted with the identified experts that consists of varying understandings of their knowledge, perspective, and experiences within the scope and features of the product and its overall content. The interview is all related to the expert's observation of the product. The qualitative approach was used to validate and verify the product's likeness to be released to the market. A qualitative study is a type of study that particularly provides a deeper perspective or insight into a certain problem, generating hypotheses and investigation (Tenny 2022).

5. Results and Discussion

CoalAsse is a product converted from air waste and agricultural waste into a sustainable product alternative to school supplies such as a pencil (see Figure 4). Sustainable charcoal pencils made from air and agricultural waste are the development of the company as an alternative to commercial charcoal pencils in the market, which are made from burnt wood. The product is sustainable, environmentally friendly, compostable, and biodegradable, which utilizes environmental waste in the Philippines. It can also reduce the air pollution and agricultural waste of sugarcane (bagasse) that contributes to climate change. MaxiEMA aimed to provide a solution to the increasing effect of climate change and help reduce environmental waste.



Figure 4. CoalAsse

Table 2. Importance of reducing air pollution and agricultural waste.

	N	%
Yes	156	100.0%

The proponents took the survey results into consideration in determining the importance of lessening air pollution and agricultural waste in the Philippines. This resulted in the majority of the respondents agreeing to the importance of mitigation of air pollution and agricultural waste. A total of 156 respondents answered yes, implying that it is important, which resulted in 100% for the whole sample size (see Table 2). The respondents' reason for this matter is that these wastes not only can harm the environment but can also harm humans as it poses various health risks. So by lessening waste, people are promoting a healthier and safer environment which also contributes to preserving our resources. As stated by one of the experts, the product addresses the environmental issues mentioned because, in proponent's own way as students, it raises awareness in providing a product for manufacturing a product that will give companies and residential spaces in Marikina what to do with their waste.

Table 3. Willingness to use sustainable pencil over commercial pencil

	N	%
Yes	154	98.7%
No	2	1.3%

Table 3 shows the willingness of the sample size to use sustainable pencils over commercial pencils. A total of 154 respondents answered yes, which has a percentage of 98.7%. On the other hand, two of the respondents answered no, which is 1.3%. The respondents were asked to specify or elaborate on their reasons as to why they are willing to change their commercial pencil into a more sustainable one. Based on their answers, they are open to changes especially those that will have positive impacts on the environment. The respondents are also considering the quality, price, functionality, and reliability of the sustainable pencil before changing their commercial pencils.

As part of the validation process of the product, the proponents sought help from different experts to further strengthen the technical and market aspects of the product. One of the experts is a Chemical Engineer and an Environmental and Sanitary professor. The expert mentioned that the product, CoalAsse, raised awareness by providing a product or manufacturing a product that will give companies and residential spaces in Marikina what to do with their waste. MaxIEMA's idea and vision are feasible given the right execution and given the right proper guidance from other experts in the field. Additionally, a user of sustainable products mentioned that the idea is beneficial for everyone because it addresses environmental actions toward the holistic development of the world's climate.

The proponents contacted and visited a stall to collect bagasse, it is a small food business that sells 100% natural and fresh sugarcane juice. As the stall daily crushes sugarcane to extract its juices, they produce a lot of bagasse which is oftentimes thrown away. Nearly 10 kilograms of bagasse were given to the proponents for free. Currently, the proponents are contacting the stall to secure a partnership as one of the suppliers of sugarcane bagasse which will also help the stall to expand its market which provides mutual benefits for both parties.

One of the major challenges in producing the product is finding a supplier for air waste or air dust. The initial plan of the company is to hire workers that will collect air waste from different sources that may produce air pollution like vacuums or aircon filters from households, small food businesses, fast food chains, and others. However, as the company expands its market reach through its project partners, it is better to seek help from them to promote and advertise the collection of air dust which can potentially encourage people to donate gathered air waste in exchange for small incentives. This can help in the company's advocacy to promote environmental consciousness which promotes people to be involved in mitigating pollution. The company also seeks to contact the Department of Environment and Natural Resources (DENR) and other bureaus responsible for pollution control and mitigation.

This section contains the decision analysis that will further help determine if the launching product is financially feasible. The price of the product is based on the materials and supplies, labor, utilities, and other costs that contribute to manufacturing the product. The price of CoalAsse by MaxiEma is ₱89 per unit.

Measurement	Value	Decision
Payback Period	1 year(s) and 7 month(s)	Approved since it is earlier than 4 years.
Net Present Value	₱6,213,801.78	Approved since the NPV is a positive number, a high decent one.
Profitability Index	3.49	Approved since it's greater than 1.
Internal Rate of Return	66.00%	Approved since it is higher than 15%

Figure 5. Decision Analysis

Figure 5 shows that the majority of the decision analysis is approved. The payback period is 1 year and 7 months shows that it is earlier than 5 years. The net present value shows a positive value and a high decent one. Also, the profitability index is approved as it is greater than 1. Lastly, the internal rate of return is 66% shows that it is higher than 15%. To sum up, the product proves that it is feasible.

6. Conclusion

The MaxiEma company was successful in utilizing pollution and developing it into a new product, CoalAsse. Based on the technical aspect of the study, the bagasse was a material that can be used for the body of the pencil. On the other hand, processed air dust was also an effective material for charcoal lead. Moreover, MaxiEma was successful in entering the competitive market through its introductory pencil product. Based on the survey of 156 respondents, 94.2% of them are willing to buy the product even if the price is higher than the existing charcoal pencil in the market. It also has a 1-year and 7-month payback period, which is within the 5-year range payback period to be accepted as financially feasible. Therefore, with the technical, market, and financial aspects of CoalAsse being feasible, MaxiEma was concluded by the proponents to be a successful and viable company.

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Biography

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