

Development of Innovative Products from Recycled Plastic Wastes

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Abstract

The amount of solid waste generated annually continues to increase significantly. The Philippines' plastic trash problem has reached a critical stage. Addressing the plastic pollution crisis in the Philippines requires a comprehensive strategy. One such strategy is to develop useful products from plastic wastes. This study is focused on using plastic wastes for the production of useful materials / products in the form of bags, dress, earrings and other accessories with the hope that it will increase the attractiveness of plastics as recycled products, thereby contributing to plastic recycling. Evaluation of the created fashion accessories was done by professionals and students coming from Imelda, Santa Marcela, Apayao. There are 2 dresses product developed. There are 5 designs of earrings developed, 3 bags, and 4 necklaces, 2 bracelets, 2 pouches, 1 fan, and 3 head dress developed. The 2 dresses rated like very much, 5 earrings rated like very much, 3 bags rated like very much, 3 necklaces rated like very much (design a, design b, and design d) and design c rated like much. The 2 bracelets rated like very much, 2 pouches rated like very much, 1 fan rated like very much, and 3 head dress rated like very much. It is recommended that other novelty products such as anklet, shawl, scarf, hairband, hair clip, sling bag and belt, may be developed from plastic wastes. The research should apply for industrial design registration in the Intellectual Property Office (IPO) the developed fashion accessories. Dissemination of the results of this study to women and sectoral groups may be conducted. Training on product development may be conducted among women of Imelda, Santa Marcela, Apayao. Forward the result of this study to the barangay or municipal office and other offices for the promotion, adoption and possible marketing in order to contribute to plastic recycling programs.

Introduction

Over time, the world's plastic increased in tandem with the need for plastic in a variety of uses. Plastics have been used as packaging films, wrapping materials, shopping bags, trash bags, fluid containers, toys, apparel, and many other purposes. Over the course of several decades, plastics have been produced continuously, leading to the creation of massive amounts of plastic garbage worldwide. The contemporary world is challenged by mounting of plastic waste on the environment due to increase in economy and population [1].

The discipline of managing the generation, storage, collection, transport or transfer, processing, and disposal of solid waste materials like plastics in a way that best takes into account a variety of environmental factors, including engineering, public health, conservation, economics, and aesthetics. This is known as solid waste management, or SWM for short. Materials such as plastic, paper, glass, metal, and organic garbage can be used to classify waste. Hazard potential, such as that of radioactive, flammable, infectious, poisonous, or non-toxic wastes, can also be used to categorize materials [2].

The amount of solid waste generated annually continues to increase significantly. According to statistics [3], the world generates approximately 0.74 kilograms of solid waste per person daily, with an estimated 2.01 billion tons per year. The amount of waste produced worldwide is predicted to rise dramatically from

the current 2.01 billion tons per year to 3.40 billion tons by 2050 [3]. Plastics, including tires, food, animal dung, woody biomass, and their mixes are among the many solid wastes that are found across the world. Due to its large production volume and environmental impact, plastic is given a lot of attention among these solid wastes. Every year, a lot of plastics are thrown away globally, polluting the soil, air, and waterways and creating a substantial amount of waste in landfills. Plastics contribute significantly to the world's garbage because of their single-use uses in sterile packaging, storage, transportation, and disposable medical parts. Any technique that involves reusing plastic garbage instead of throwing it away is considered plastic waste recycling.[4]

In the Philippines, government drew up a decree to further the environmental cause. On July 24, 2000, the Philippine Congress enacted RA 9003 or the Ecological Solid Waste Management Act. This Act provides for an ecological solid waste management program [5]. Solid waste includes trashed food scraps, plastic, paper, documents, crates, and other components assumed to be unneeded and undesired [6]. Improper waste disposal, inefficient waste collection and lack of disposal facilities are some concerns on solid waste management in the Philippines including schools [7]. The Philippines was considered as world's leading plastic polluters [8].

The Philippines' plastic trash problem has reached a critical stage. These consist of an estimated 2.7 million tons of plastic waste are produced in the Philippines each year. A sizable amount of this garbage ends up in various waterways and landfills.

Marine Impact: About 20% of this plastic garbage ends up in the ocean, where it destroys marine ecosystems and puts marine life in jeopardy. When plastics are disposed of improperly, hazardous substances leak into the ground and water, endangering the health of nearby communities. Once-beautiful landscapes have been turned into unpleasant and polluted locations due to plastic pollution, which has an effect on both tourism and quality of life. Addressing the plastic pollution crisis in the Philippines requires a comprehensive strategy [9]. One such strategy is to develop useful products from plastic wastes.

This study is focused on using plastic wastes for the production of useful materials / products in the form of bags, dress, earrings and other accessories with the hope that it will increase the attractiveness of plastics as recycled products, thereby contributing to plastic recycling.

Method

The researcher made use of Research (R) and Development (D) by Borg and Gell as cited by Ocampo, et al [13]. This research is consisting of survey and literature search of novelty products from plastic wastes, production of fashion accessories from plastic wastes and product. The study was conducted at Imelda, Santa Marcela, Apayao.

The respondents who constitute the evaluators of the study are professionals and students. The researcher purposely chose 20 evaluators consisting of 10 professionals, 5 college students and 5 senior high school's students who are residents of Imelda, Santa Marcela, Apayao.

During the research phase of the study, the researcher read extensive literature search from published and unpublished sources bearing information about novelty product from plastic wastes. From literature search, plastic wastes were identified to be used in developing fashion and fashion accessories. The researcher considered the development of dress, bags, and other accessories.

After which the products were evaluated using Product Evaluation Form containing the following criteria: (a) quality of design (b) creativity of design (c) color combination (d) lay-out (art in designing) (e) intricateness of design (f) aesthetic appearance (g) relevance of the design adapted from the study of

Fronda [12]. In addition, a 5-point Likert scale was used. The researcher sought permission from the Barangay Captain of Imelda, Santa Marcela, Apayao

After the approval, the researcher developed the novelty products from plastic wastes. The evaluation form adapted from Froda [12] using the 5-points scale with indicators were administered among professionals, college students and senior high schools. The finished products were presented to the respondents. Data were tabulated and analyzed.

Result and Discussion

Novelty products developed from plastic wastes

Plastics have become an essential part of our modern lifestyle and contributed greatly to the production of plastic-related waste. Recycled plastic products are used in this study. The plastic wastes are developed into novelty products like dress, earrings, bags, necklaces, bracelet, pouch, fan and headdress.

Accessories Developed from Plastic Waste Materials

Table 1. Developed dress from plastic waste




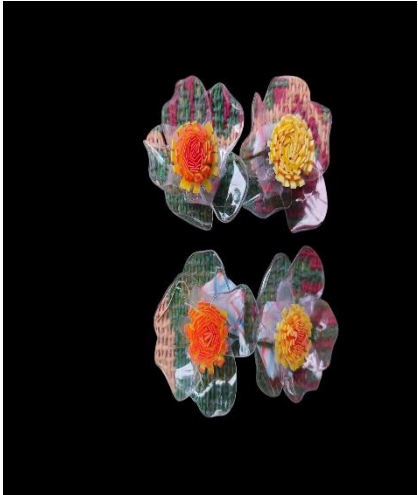
Item	Description
	<p>The dress is a vibrant, multi-layered garment. The body is decorated with small, colorful, flower-like applied arranged in geometric pattern, mostly in shades of red, green, blue, and yellow. The skirt is composed of numerous layers of crumpled fish net and mosquito net combination of color black, yellow, and pink creating a full, voluminous silhouette.</p>
	<p>This jacket is heavily decorated with small, colorful, flower-like that appear to be made of plastic straw. The collar is decorated with large number of craft foam. The body of the jacket is covered in a dense array of smaller, multicolored floral applied.</p>

Table 2. Developed earrings from different kind of plastic materials

Item	Description
 <p>Design A</p>	<p>These earrings consist of three artificial flowers stacked vertically. The top and bottom flowers are green, white, and pink striped roses, while the middle flower is a solid blue rose. The flowers appear to be encased in transparent made from plastic bottle.</p>
 <p>Design B</p>	<p>Earrings made from plastic bottle of coke shaped into two flower decorations with a color combination of yellow and orange.</p>




Design C

Pair of earrings has small, hexagonal element with blue and white stripes attached to two teardrop-shaped. The teardrop shapes made from craft foam and a plastic disc.



Design D


Pair of earrings made from plastic bottle and straw. Each earring features a bright orange flower-shaped component with a yellow center, attached to a long, dark-brown tassel.

 <p>Design E</p>	<p>Earrings are vertical arrangement of three bright green flower-shaped components, each with a small, dark-colored center. The flowers appear to be made of a translucent plastic bottle of Mountain dew.</p>
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The developed earrings are cut and fold in various shapes from different kind of plastic waste materials.

Table 3. Developed bags from plastics waste materials

There are 3 bags designs developed. These three bags were made from different types of plastic materials.

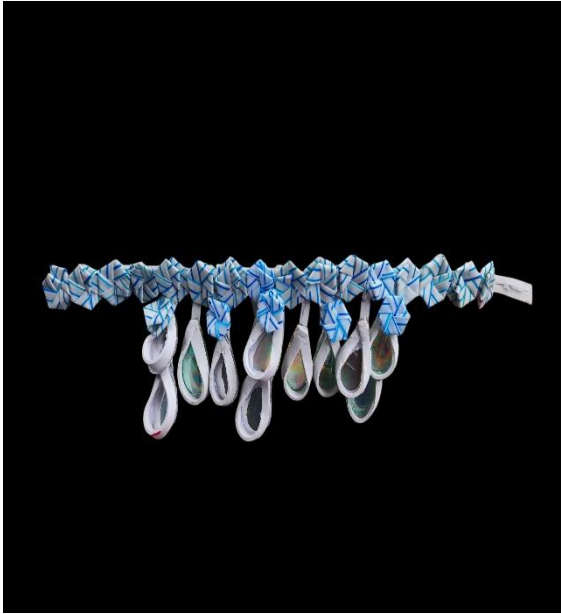

Item	Description
<p>Design A</p>  <p>Design B</p>	<p>This handmade woven bag is made of plastic strips in yellow, blue, white and green creating a checkered pattern. It has a small, lid-like top section. The bag is closed with simple hexagon shape made from plastic bottle cups.</p> <p>The handle is made of bright green woven plastic straw. Several small, heart-shaped decorations are affixed to the front of the bag. These hearts are also made of woven plastics straw in different color combination.</p>



Design C

The bag's body appear to be constructed from collage of red and white plastic, the based is made of black plastic trash bag. Sewn with a yarn onto a dark-colored backing. The bag has a simple, black braided handles made from plastic trash bag.

Table 4. Developed necklaces from plastic waste materials

Item	Description
<div data-bbox="225 376 788 987" data-label="Image">  </div> <p data-bbox="225 987 355 1025">Design A</p> <div data-bbox="256 1055 719 1541" data-label="Image">  </div> <p data-bbox="225 1541 355 1576">Design B</p>	<p data-bbox="815 394 1364 680">The necklace design into a teardrop-shaped pendant arranged in a row, connected by a craft foam base. The pendants appear to be white, made of a plastic disc. Modern and minimalist, with clean design and focus on the unique combination of different materials.</p> <p data-bbox="815 983 1364 1314">The base of this necklace is craft foam attached to the base are bright, neon green flower-shaped decoration. The flower appears to be made of a translucent plastic bottle. There are two prominent flowers clustered together, with addition smaller flower-like shapes forming a continuous garland around the necklace.</p>



Design C



Design D

The necklace features a reuse delicate gold chain as its base. Hanging from this chain is a cascade of numerous small, dark purple square shapes. These shapes appear to be layered and creating a textured, almost fringe-like effect. The overall design is modern and somewhat abstract, with a focus on the visual interest of the layered purple plastic shapes.

Necklace with a reuse gold chain and the pendant made from plastic bottles cut into small square. The plastic pieces is design into different style, creating an organic or floral effect

Table 5. Developed bracelet from plastic waste materials



Item	Description
 <p data-bbox="231 936 359 967">Design A</p>	<p data-bbox="810 398 1361 555">The bracelet crafted from recycled translucent plastic bottle. The plastic molded or shaped to resemble flower forms.</p>
 <p data-bbox="231 1554 359 1585">Design B</p>	<p data-bbox="810 902 1361 1189">This bracelet is made from different kind of plastic waste. Bracelet constructed from folded or layered plastic straw with various colors. The straw arranged in a geometric pattern, creating a textured and multifaced surface. CD's cut into small pieces are adding a shimmering effect.</p>

Table 6. Developed pouch bag from plastic materials



Item	Description
 <p>Design A</p>	<p>This pouch is made from junk food plastic, constructed from interwoven strips of silver. The top edge of the pouch is lined with a red strip from snack food wrappers, which are visible along the top.</p>
 <p>Design B</p>	<p>This was a plastic pouch decorated with a pattern of black and white, creating a checkered effect. The color appears mottled or textured, giving the impression of a marbled or distressed look.</p>

Table 7. Developed fan from plastic wastes





Item	Description
 <p>Design A</p>	<p>The fan's surface is composed of small broken fragments of CD's, creating a mosaic-like effect. Around the edge, there's a border of folded plastic in pink and blue. The fan's decorative include several plastic flowers in yellow and red, arranged in an appealing pattern. The fan's handle is made of wood.</p>

Table 8. Developed headdress from plastic materials

Item	Description
 <p data-bbox="228 954 352 987">Design A</p>	<p data-bbox="805 394 1366 763">This headdress features a circular base adorned with small, folded plastic flowers in teal and white. From the base long, thin, bright colored plastic straw create spiky crown-like. The color is varied and vibrant, including red, yellow, blue, green, and white. This headdress style is playful, festive, and artistic, demonstrating a creative use of recycled materials.</p>
 <p data-bbox="228 1612 352 1646">Design B</p>	<p data-bbox="805 1023 1366 1357">This headdress it features a green base decorated with small, folded plastic flowers in blue and yellow. The top base creates a spiky, almost crown-like effect from plastic straw. There's also a small section of gold beads embellishments net the top of the headdress. The style demonstrating creative upcycling.</p>

 <p>Design C</p>	<p>The headdress crafted from recycled plastic materials. It has triangular or slightly curved shape. The headdress is decorated with numerous colorful, flower-like made from folded plastic straw primarily in shades of orange, pink, red, yellow, and blue. There's also border curled green craft foam at the top edge. The color is bright and saturated, creating a visually striking effect.</p>
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Product Evaluation of the Novelty Products from Plastic Waste

The products develop from plastics were rated in seven (7) criteria namely: quality of the product design (criterion 1); creativity of the plastic product (criterion 2); color combination of the plastic product (criterion 3); art of the design of the plastic product /lay out (criterion 4); uniqueness/ intricateness of the plastic product design (criterion 5); aesthetic appearance of the plastic product (criterion 6); and relevance and use of the product (criterion 7).

Table 9. Product evaluation of the developed dress

	Criteria									
Design	1	2	3	4	5	6	7	Mean	Interpretation	Transposed Value
A	4.95	5.00	4.95	4.95	4.80	4.90	4.90	4.92	LVM	E
B	4.95	5.00	4.95	5.00	4.95	4.95	4.90	4.96	LVM	E

As presented in Table 9, the two (2) designs were liked very much by the evaluators in all seven (7) indicators. There is a very slight difference in the mean rating of Design B compared with Design A but both designs were excellently developed. Furthermore, this can be attributed to the vibrant, multi-layered garment, with colorful and flower-like applied arranged in geometric pattern of red, green, blue, and yellow. Meanwhile, the jacket is heavily decorated with colored plastic straw. These contributed to the very high rating of both designs.

Table 10. Rating of evaluators on the developed earrings from plastic waste

	Criteria									
Design	1	2	3	4	5	6	7	Mean	Interpretation	Transposed Value
A	4.70	4.95	4.70	4.85	4.85	4.75	4.95	4.82	LVM	E

B	5.00	5.00	4.95	4.95	4.85	4.95	4.95	4.95	LVM	E
C	4.95	4.80	4.80	4.90	4.90	4.85	4.95	4.88	LVM	E
D	4.95	4.95	4.95	4.85	4.80	5.00	4.95	4.92	LVM	E
E	4.75	4.70	4.75	4.80	4.85	4.85	4.85	4.79	LVM	E

As presented in Table 10, the five (5) designs were liked very much by the evaluators in seven (7) indicators. This implies that all five (5) designs were excellently developed. The highest mean rating is Design B 4.95 and the lowest mean rating is Design E with the mean of 4.79. Earrings Design B made from plastic bottle of coke shaped into two flower decorations with a color combination of yellow and orange.

Table 11. Product evaluation of the developed bags

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	5.00	4.90	4.80	4.65	4.90	4.80	4.95	4.86	LVM	E
B	4.85	4.85	4.55	4.65	4.75	4.80	4.95	4.77	LVM	E
C	4.90	4.85	4.95	4.85	4.95	4.90	4.85	4.89	LVM	E

As presented in Table 11, the three (3) designs for bags that obtained like very much from the evaluators. The attractiveness and colorful plastics provided the products to acceptable to the evaluators.

Table 12. Product evaluation of the developed necklaces

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	4.95	4.95	4.75	4.95	4.90	4.90	4.90	4.90	LVM	E
B	4.45	4.55	4.60	4.70	4.75	4.70	4.75	4.64	LVM	E
C	4.22	4.22	4.06	4.23	4.23	4.23	4.13	4.19	LM	VS
D	5.00	5.00	4.90	5.00	4.95	4.95	4.90	4.96	LVM	E

As presented in Table 12, the three (3) Design A, Design B, and Design D were rated like very much. The lowest rating was given to Design C which was rated Like much only. Design D obtained the highest mean rating of 4.96.

Table 13. Product evaluation of the developed bracelet

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	4.85	4.75	4.85	4.90	4.90	4.90	4.90	4.86	LVM	E
B	4.75	4.80	4.70	4.85	4.90	4.95	5.00	4.85	LVM	E

As presented in Table 13, the two (2) design obtained the like very much among the evaluated bracelet with the mean values of 4.86 and 4.85 respectively. However, Design A obtained the highest mean rating

and Design B got the lowest mean rating.

Table 14. Product evaluation of developed pouch

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	4.90	4.80	4.80	4.90	4.85	4.80	4.85	4.84	LVM	E
B	4.80	4.70	4.80	4.85	4.80	4.80	4.90	4.81	LVM	E

As presented in Table 14, the two (2) designs obtained rating as like very much from the evaluators. There is a slight difference in the mean rating of Design A and Design B, however, both designs are excellently developed.

Table 15. Product evaluation of the developed fan

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	4.90	4.95	4.90	4.90	4.90	4.90	4.90	4.90	LVM	E

As presented in Table 15, the design of fan obtained like very much. With all the criteria presented the design mean rating is 4.9. The fan’s decorative include several plastic flowers in yellow and red, arranged in an appealing pattern these contributed to the highest mean rating of the design.

Table 16. Product evaluation of the developed headdress

Design	Criteria							Mean	Interpretation	Transposed Value
	1	2	3	4	5	6	7			
A	4.85	4.95	4.85	4.90	4.90	4.90	4.90	4.89	LVM	E
B	5.00	5.00	5.00	4.95	4.95	5.00	5.00	4.99	LVM	E
C	4.90	4.90	5.00	4.95	4.85	4.95	4.95	4.93	LVM	E

As presented in Table 16, all the three (3) design for headdress obtained ratings as like very much from the evaluators. These are Design A, Design B, and Design C with the mean ratings of 4.89,4.99,4.93 respectively. Design B obtained the highest rating in all the criteria except criteria 4 and 5.

Conclusion and Suggestion

Based on the findings, the following conclusions are drawn. Novelty products can be developed from plastic wastes such as earrings, bags, necklaces, bracelets, dress, pouch, fan, and head dress. The plastic novelty products were rated as Like Veery much or excellent, except Design C for bracelets.

Other novelty products such as anklet, shawl, scarf, hairband, hair clip, sling bag and belt, may be developed from plastic wastes. The research should apply for industrial design registration in the Intellectual Property Office (IPO) the developed fashion accessories. Dissemination of the results of this

study to women and sectoral groups may be conducted. Training on product development may be conducted among women of Imelda, Santa Marcela, Apayao.

Forward the result of this study to the barangay or municipal office and other offices for the promotion, adoption and possible marketing in order to contribute to plastic recycling programs.

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