

## Design and Development of Ecobangku from Medium Density Polyethylene Boards

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**Abstract:** The main thrust of this study was to design, make, and assess the acceptability level of the design and development of ecobangku from pressed upcycled plastic sheets with resin called medium density polyethylene (MDPE) boards as the main material of the chair. The study employed the experimental and descriptive research design in the conduct of the study and used a self-made questionnaire to get its acceptability. The data gathered were treated, analyzed and interpreted through the average weighted mean. This was conducted at Bohol Island State University – Main Campus. The questionnaires were distributed in the province of Bohol specifically in the furniture and plastic sheets local firms during the school year 2018-2019 with one hundred forty-five (145) respondents from design experts, design instructors, and end users. It was found out that the design and development of ecobangku from medium density polyethylene boards has an average weighted mean of 3.64 which is described as highly acceptable and interpreted as very high or effective to a great extent. Based from the results, the researcher concluded that the ecobangku using the medium density polyethylene boards is as acceptable as the conventional luxury chair. Thus, the use of upcycled plastic sheets could be applied into different furniture designs..

**Keywords:** acceptability, plastic, recycling, technology

### 1. Introduction

More than five trillion pieces of plastics are already in the oceans, and by 2050 there will be more plastics in the sea than fish (MacArthur, 2016). Not to mention, China, Indonesia, Philippines, Vietnam, and Sri Lanka are considered the five worst offenders when it comes to plastic pollution (Walsh, Formanek, Loo, & Phillips, 2016). Furthermore, Philippines produces 2.7 million metric tons of plastic waste every year, with half a million metric tons believed to be exiting into the Pacific Ocean (Mateo, 2018). And in 2016, approximately 1,620 tons of waste is being collected in the City of Tagbilaran a month excluding the uncollected wastes in streets and sewers, according to the City Solid Waste Management Office of Tagbilaran. One of the solutions for this problem is to reduce, reuse, and recycle these wastes especially plastic wastes with the help of non-government and government agencies to gain fund to help in conducting better waste management practices and infrastructure.

Bohol has no local plastic manufacturers and ironically, the province used tons of plastics a year. The City of Tagbilaran is adapting the “Plastic Recycling Project for Improving Women’s Income” in partnership with Japan Keio University, the project funded by Japan International Cooperation Agency (JICA), wherein waste plastic shopping bags are pressed to make the upcycled plastic sheets and used as main material for fashion accessories and souvenir items through heat press machines. These upcycled plastic sheets are made by KALUPI women community, an organization of women initiated by DSWD, aiming in strengthening and institutionalizing of national and local programs for women.

Plastics are made up of polymers and these can be recycled, but the proliferation of plastic bags have also contributed to flooding and environmental pollution and the only option is to reduce, reuse, and recycle plastic bags (Carillo, 2007). According to Quinn et al. (2013) that the predominant early natural plastic was from The Horners Company of London, with horn and tortoiseshell in 1284. And in 1950s, the polyethylene bag had its first appearance. And from 1950s to 2017, the world plastic production totaled around 348 million metric tons (Baron 2019).

Moreover, one out of every ten items picked up in an International Coastal Cleanup in 2009 was a plastic bag. And this makes plastic bags the second most common kind of waste item found in that coastal cleanup (Leblanc, 2018).

But the plastic sheets upcycling is only applied in smaller scale like fashion accessories. Thus, widening the usage of these sheets, ecobangku was developed.

Ecobangku is a luxury chair wherein the name is coined from “eco” meaning ecofriendly design, and “bangku”, a vernacular term for chair with the application of ergonomics, which uses the waste plastic shopping bags as main material specifically the mixed Low-Density polyethylene (LDPE) and the High-density Polyethylene (HDPE) with resin as adhesive. These theories make environment safer and more comfortable for workers using design and anthropometric data (Ryan, 2013).

The combined LDPE and HDPE with resin is called the medium density polyethylene (MDPE) boards. This could lessen the plastic shopping bags problem and an introduction of plastic sheets upcycling designs to local furniture firms in Bohol. Thus, there will be an increase of demand in plastic sheets upcycling, helping the province a plastic-free area and at the same time generate livelihood for local communities gearing towards its goal: Environment, Empowerment and Economic Development.

## 2. Methodology

### A. Design

This study utilized the experimental design in the assembly of the Ecobangku from MDPE boards. Various trial-and-errors were conducted upon the making of the MDPE boards while applying the resin; and the assembly to guarantee an ergonomically designed chair. A self-made questionnaire was given after the experiment for the acceptability level of the Design and Development of Ecobangku from Medium Density Polyethylene Boards in order to gather the necessary data. After the participants answered the self-made questionnaire, the researcher gathered all the data, analyzed and interpreted the result.

### 3. Environment And Participants

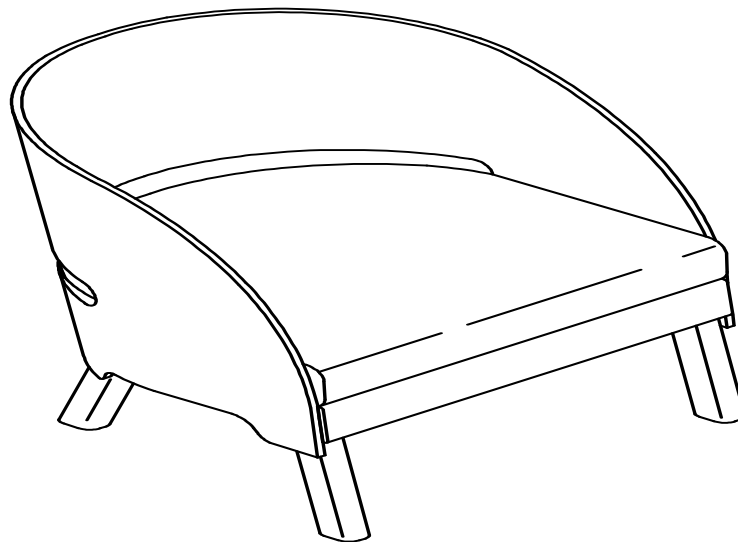
The study was conducted at Bohol Island State University – Main Campus, Tagbilaran City, Bohol. The respondents for the acceptability level was in the province of Bohol specifically in the furniture and plastic sheets local firms during the school year 2018-2019. The province of Bohol is the prime mover of “Plastic Sheets Upcycling” through the use of press machines developed by Fabrication Laboratory Bohol (FABALAB – Bohol).

Most of the furniture firms are from Loboc, Bohol because it is the furniture capital of the province. They are also known for its carvings and now spread to the neighboring towns of Loay, Albur, Sevilla, and Sikatuna.

The participants of the study were forty-eight (48) design experts from local furniture firms and press machine firms in Bohol recognized by the Department of Trade and Industry (DTI), six (6) BS Design instructors, five (5) Fablab Technical Staff, six (6) Plastic Recycling Project for the Improvement of Women’s Income (PRP4IWI) Staff, and eighty (80) randomly selected end users, a total of one hundred forty-five (145) respondents.

## 4. Results And Discussion

The ecobangku is made from upcycled plastic shopping bags and pressed to make a medium density polyethylene boards as backrest and legs. A seat cover was used so that the user can easily wash it from time to time and can change the color if the user wanted another theme.



**Figure 1.** Perspective View of the Ecobangku

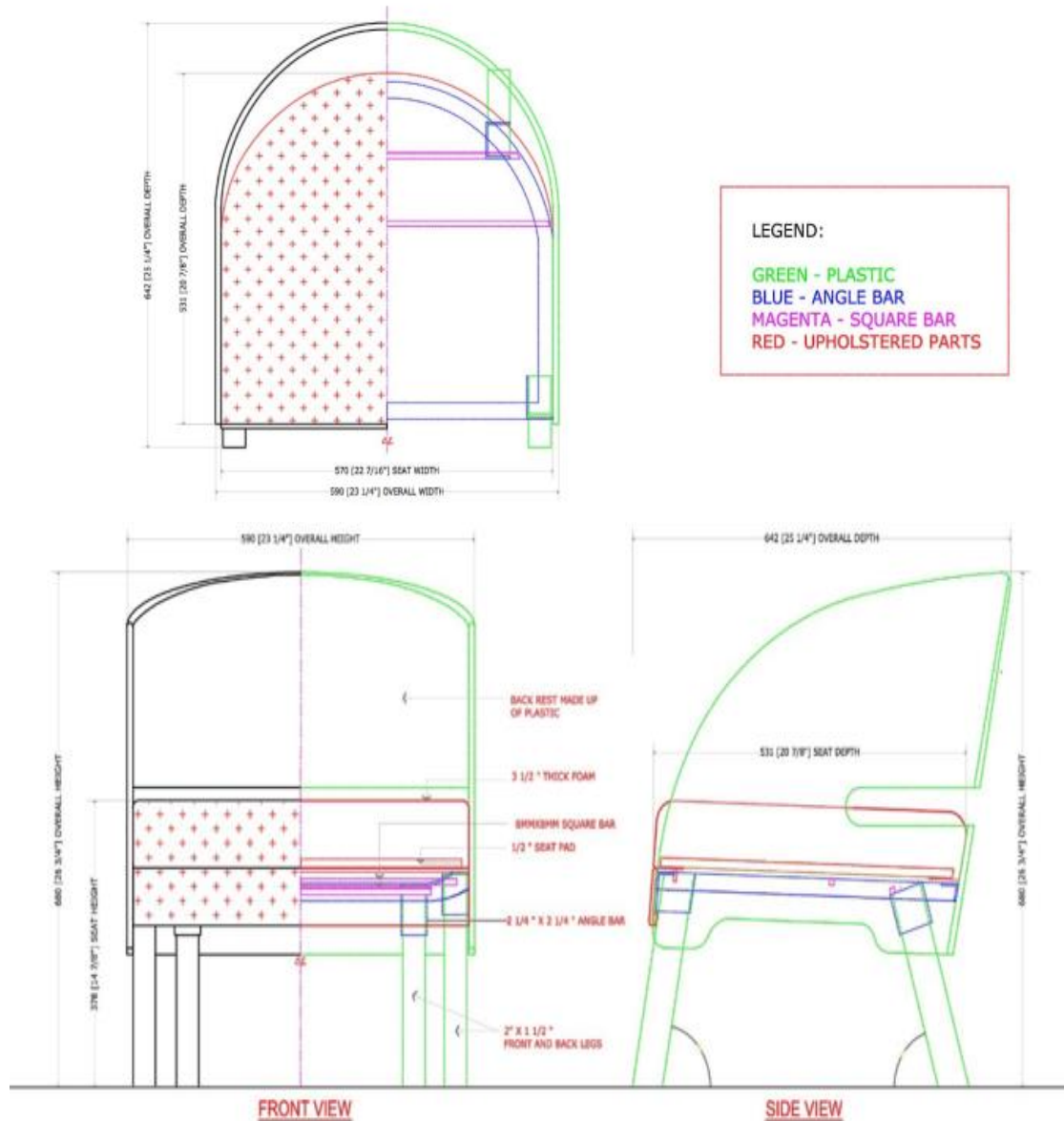


Figure 2. Orthographic Views of the Ecobangku

Table 1 Acceptability Level of the Design and Development of Ecobangcu from Medium Density Polyethylene Boards

A. Aesthetics	WM	Description	R
1. The pattern applied in the backrest is pleasing to the eye.	3.77	Highly Acceptable	
2. There is harmony in color combination of the plastic bags.	3.79	Highly Acceptable	
3. The design has a beautiful shape.	3.74	Highly Acceptable	
4. The surface of the backrest has high quality finish.	3.75	Highly Acceptable	
Average WM	3.77		2
B. Functionality			
1. The chair is ergonomically-designed.	3.92	Highly Acceptable	
2. The chair is stable and safe to	3.85	Highly	

sit on.		Acceptable	
3. The armrest serves its purpose.	3.52	Highly Acceptable	
4. The connections and joints are done properly.	3.75	Highly Acceptable	
Average WM	3.76		3
<b>C. Materials Used</b>			
1. The materials are available in the locality.	3.83	Highly Acceptable	
2. Upcycled plastic sheets are flexible that can be manipulated in any shape.	3.81	Highly Acceptable	
3. The laminated backrest and legs are durable to carry the weight of the user.	3.77	Highly Acceptable	
4. The thickness of the upholstery makes it comfortable to sit.	3.84	Highly Acceptable	
Average WM	3.81		1
<b>D. Cost</b>			
1. The chair is sold at Php 42,500 each including overhead and local margin.	3.22	Acceptable	
2. The cost is reasonable for the product because it lessens the plastic problems as well as giving livelihood to the local firms.	3.74	Highly Acceptable	
3. The upcycled plastic sheets per a4 size is Php 150.00 (Price from PRP4IW1)	3.19	Acceptable	
Average WM	3.38		5
<b>E. Eco-friendly</b>			
1. Upcycled plastic shopping bags are the dominant material.	3.38	Highly Acceptable	
2. 3 kilos of plastic shopping bags are being utilized for a chair.	3.36	Highly Acceptable	
3. The plastic shopping bags pollution is lessened through upcycling them into furniture.	3.73	Highly Acceptable	
Average WM	3.49		4
<b>General Weighted Mean</b>	<b>3.64</b>	<b>Highly Acceptable</b>	

Table 1 presents the acceptability level of Ecobangku. It reflects that respondents have positive response as shown in the grand mean of 3.64 described as “highly acceptable”.

This reveals that the respondents highly accepted the ecobangku in terms of materials used, beauty, functionality being eco-friendly and the cost.

The highest mean 3.81 which is interpreted as “very high or effective to a great extent” belongs to material used category. This suggests that the respondents highly accepted the new material or the upcycled waste shopping bags applied into the chair because aside from it can lessen the plastic problem pollution, it is also flexible and easy to manipulate different shapes and forms. It also reduces the amount of energy usage, raw materials, and pollution (Poly, 2015).

However, the lowest mean 3.38 belongs to the cost section which the respondents believed that the cost is too expensive for a chair. This suggests that the cost of plastic sheets per A4 size which is Php 150.00 is too high as well as the cost of ecobangku per piece is Php 42, 500 which has the weighted mean of 3.19 and 3.22 respectively.

According to Leblanc (2018), the selling price of recycled plastics is a couple of times more than the cost because 1,000–2,000 gallons of gasoline can be saved by recycling just one ton of plastics and producing plastic products from recycled plastics reduces energy requirements by 66 percent.

Additionally, one-seater luxury chairs price ranges from Php 41,000 – Php 189,000 (Cobonpue, n.d). The target is also for business to business (B2B) wherein the possible markets are the resorts, hotels and other tourist destinations.

## 5. Conclusion

The design and development of ecobangku from medium density polyethylene boards is described as very high or effective to a great extent and as highly acceptable as the conventional luxury chair. Thus, using upcycled plastic sheets into different furniture designs was highly acceptable.

## 6. Recommendations

a. The government may come up with upcycling programs which may include the current press firms and furniture firms in Bohol as takers of the study. This could be in a form of collaboration with government, non-government agencies, and private sectors.

b. The designers may use the design as an inspiration to create other home accessory designs using plastic upcycling and may use organic resin as adhesive.

Future researchers may replicate this study to further verify the physical and performance capacity of the material. The procedures and contents may serve as guide in conducting related studies..

## References

1. Baron, C. (2019). Production of plastics worldwide from 1950
2. to 2017. Retrieved from: <https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/>
3. Carillo, L. A. (2007). Development and evaluation of the pipe moulded from plastic bags. TIP Research Journal Quezon City,4(1). Retrieved from: <http://ejournals.ph/form/cite.php?id=9174>
4. Chiu, R.A. (2019). Pressed creativity: City women make history from plastic trash. Philippine Information Agency. Retrieved from: <https://pia.gov.ph/news/articles/1020325>
5. Leblanc, R., (2018). Plastic recycling facts and figures.
6. Retrieved from: <https://www.thebalancesmb.com/plastic-recycling-facts-and-figures-2877886>
7. MacArthur, E. (2016). More plastic than fish in the sea by
8. 2050. Retrieved from:
9. <https://www.theguardian.com/business/2016/jan/19/more-plastic-than-fish-in-the-sea-by-2050-warns-ellen-macarthur>
10. Mateo, J. (2018). Philippines major contributor to plastic
11. in oceans. Retrieved from: <https://www.philstar.com/business/science-and-environment/2018/05/03/1811546/philippines-major-contributor-plastic-oceans#HlhQ2ETmDGMMDP6L.99>
12. Ryan, V. (2013) Design of sustainability. Retrieved from:
13. [www.technologystudent.com/desproflsh/revise11.html](http://www.technologystudent.com/desproflsh/revise11.html)
14. Quinn, C., Estrada, J., Hummel, T., Perez, J., Hinds, S. (2013). History of plastics. Retrieved from: [http://www.dartmouth.edu/~iispacs/Education/EARS18/Plastic\\_2013/History%20of%20Plastics/History%20of%20Plastics.html](http://www.dartmouth.edu/~iispacs/Education/EARS18/Plastic_2013/History%20of%20Plastics/History%20of%20Plastics.html)
15. Walsh, N., Formanek, I., Loo, J., Phillips, M. (2016).
16. Plastic island. How our throwaway culture is turning paradise into graveyard. Retrieved from:
17. <http://edition.cnn.com/interactive/2016/12/world/midway-plastic-island/>.

## Author's Profile



Angeline D. Baldapan was born in Bohol, Philippines in the year 1992. Graduated Doctor of Philosophy in Technology Management from Bohol Island State University- Main Campus (BISU-MC) in 2019. A full-time instructor in the Industrial Design Department under the College of Engineering and Architecture of BISU-Main Campus. She is also an active associate member of the National Research Council of the Philippines (NRCPP).