

Designing Modular Jewelry Product Through Plastic Waste Exploration

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ABSTRACT

According to Databoks statistic, Indonesia is one of the world's largest producer of buying online products in 2024. The society's lifestyle increased online products including food and drink has using plastic packaged. Jewelry is the second most popular product on E-Commerce platforms (Kredivo, 2021). Jewelry comes in various types based on its design and materials. Fashion jewelry that typically utilizes recycled materials such as metal or plastic. Recycled-material-based jewelry has become quite popular in the market in 2023 as it is deemed to possess its own allure. Some communities admire the beauty of the transformation process from original materials to exquisite jewelry, while also providing a positive impact on the earth and its environment.

Keywords: Modular System, Polypropylene-based material, Material Driven Design, Material Experience, Material Exploration

INTRODUCTION

Plastic is a widely used material in society despite its difficulty in decomposition. According to data from the National Waste Management Information System (SIPSN) of the Ministry of Environment and Forestry (KLHK), Indonesia's national waste production in 2022 reached 65.8 million tons with 20% coming from plastic. The increase in sales of plastic cup beverage brands has become a concern, supported by data indicating Indonesia as the top market for plastic beverages in Southeast Asia (Momentum Works, 2022) and the fifth-largest world's producer of ocean waste. Various government actions have been taken, yet this issue remains worrying. Jewelry is a product that has been used since ancient civilizations that continues to evolve, becoming a tertiary necessity product widely used today. Jewelry is readily available in various retail outlets, including E-Commerce platforms. Technological advancements and globalization enable people to fulfill their primary or tertiary needs from both local and international brands.

According to data from Kredivo, jewelry was the second-highest selling product category on E-Commerce platform in 2022 and the first-highest selling product in

2023. The abundance of international jewelry brands on E-Commerce platform has led local Micro, Small, and Medium Enterprises (MSMEs) struggle to compete with international products due to the perceived attractiveness of their design with high quality and low prices compared to local brand. Therefore, how might we design jewelry product that using plastic waste as main materials with an allure that captivates buyers? The jewelry product is designed with a modular system that allowed it to transform into three types of jewelry in one product purchase using plastic waste as main material. The Material Driven Design (MDD) method is a process carried out using Meaning Driven Materials Selection in four stages. There were understanding the material, creating material experience visions by using Vision in Product Design (ViP) technique, manifesting material experience patterns, and designing material/product concepts.

LITERATURE REVIEW

Plastic-Based Jewelry

Based on their function, jewelry generally consists of necklaces, bracelets, anklets, brooches, rings, and toe rings. Based on their material, jewelry is divided into fine jewelry, semi-fine jewelry, and fashion jewelry.

Modular System in Design

According to the Cambridge Dictionary, modular refers to something consisting of several separate parts that form a single cohesive unit when combined. In product design, modular design or modularity refers to pre-made unit products usually in the form of sheets or pieces that can be assembled in various ways into standard shapes with functions. Understanding modular design according to KBBI is a design principle where a design consists of several small parts (modules) that can be made, modified, or replaced with other modules or between different systems. A modular product can consist of modules with the same or different shapes and sizes with the same assembly system.



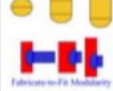

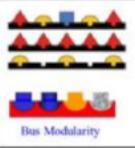

No.	Jenis	Definisi	Sistem
1.	<i>Component-Sharing Modularity</i>	Modul yang dapat memiliki bentuk dan ukuran berbeda dengan menggunakan satu modul inti sebagai komponen penyambung / connector antar modul	 Sharing Modularity
2.	<i>Component-Swapping Modularity</i>	Modul yang dapat memiliki bentuk berbeda dengan komponen penyambung yang berbeda	 Swapping Modularity
3.	<i>Cut-To-Fit Modularity</i>	Modularitas yang dapat disesuaikan dimensinya dengan cara mengubah bentuknya seperti dibuat lebih pendek atau lebih panjang	 Cut-To-Fit Modularity
4.	<i>Mix Modularity</i>	Modularitas ini mirip dengan <i>component-swapping</i> , namun komponen diubah setelah dicampur	 Mix Modularity
5.	<i>Bus Modularity</i>	Menggabungkan berbagai modul berbeda dalam satu sistem penghubung linear	 Bus Modularity
6.	<i>Sectional Modularity</i>	Beberapa modul berbeda digabungkan menjadi bentuk baru dengan penyambung yang berbeda	

Image 1 Modular Types. (Source: Jessica, 2024)

Material Benchmarking

Observation table of PET, HDPE, and PP materials after undergoing recycling processes in the market. PET is applied in cloth, non-food container, jewelry with

a moderate strength and roughness and high flexibility. HDPE is applied in trash bin, non-food container, and floor. Polypropylene is applied in products such as automotive parts, clothing, storage containers (food-safe), and plastic bottles. The material has moderate strength, roughness, and flexibility levels, high resistance, is very easy to shape, and has a moderate level of recyclability.

Jenis Material	PET	HDPE	PP
			
Aplikasi Produk	Pakaian, wadah penyimpanan (<i>non-food</i>), perhiasan	Tempat sampah, wadah penyimpanan (<i>non-food</i>), ubin lantai	Peralatan otomotif, pakaian, wadah penyimpanan (<i>food-safe</i>), botol plastik
Tingkat Kekuatan	sedang	tinggi	sedang
Fleksibilitas	rendah	tinggi	sedang
Ketahanan	tinggi	tinggi	tinggi
Kemudahan dibentuk	sangat mudah	mudah	sangat mudah
Tingkat Kekasaran	sedang	tinggi	sedang
Intensitas Aroma <i>recycle</i>	aroma pekat	tidak terlalu beraroma	agak beraroma

Image 2 Material Benchmarking. (Source: Jessica, 2024)

Material Experience Vision

There are three important dimensions to consider as reference levels for the author’s management level in creating environmentally friendly sustainable products. First dimension involves individual’s basic abilities personally, leading towards sustainable management for oneself, oneself-and-society, and for the entire environment-and-universe.

The second dimension represents sustainable organizations aiming to create value in profit, people, and planet, which leads to the last dimension comprising economic, social, and environmental values. Managing plastic waste can be done by applying the 3R principle, those are Reduce, Reuse, Recycle, Recover (Waste to Energy), and Disposal. The author’s processing approach will focus on recycling, transforming PP waste into new characteristics for final products. The author aims to achieve a sustainable organization level focusing on care for oneself and society, and social value beneficial for the author, social community, and living beings.

Waste Sourcing Techniques

The development of plastic bottled beverage brands is one of the supporting factors for the accumulation of plastic waste. The author obtained source of PP waste from several beverage brands, such as Tomoro Coffee and Fore Coffee located in Benton Junction shopping area and Supermall Karawaci.

According to the staff, around 100 or more various of cups size are sold every day and even more on weekends. These cups are collected and disposed of in the trash bins provided for the store in that area. The process began with collecting PET, PP, and HDPE plastic waste. A total personal consumption of over 1.2 kg of PET, HDPE, and PP material was obtained along with 1 kg of PP cups from Tomoro Coffee and Fore Coffee. Subsequently, the waste was cleaned using a cleaning tool and dishwashing soap.



Image 3 Plastic Waste Resource. (Source: Jessica, 2024)

METHODOLOGY

The Material Driven Design (MDD) method is a process carried out using Meaning Driven Materials Selection in four stages. There are understanding the materials where Author must have to gain material experience and understanding obtained from exploration to comprehend user problems through sensory, interpretive (meaning), affective (emotion), and performative (action) levels.

Creating materials experience is where the Author is create and manifesting material experience visions where the exploration results from the previous stage are gathered and grouped according to those considered interesting and potentially further developed, presented through mood boards. This technique is called Vision in Product Design (ViP). Then, all of the results gathered for designing material concepts for the final product.

RESULT & DISCUSSION

Plastic is a thermoplastic synthetic polymer material with different melting and decomposition points depending on the type of monomer used in its formation. Plastic itself is divided into two types, there are thermoplastics which have low resistance to temperature and chemicals that making them easily reshaped repeatedly through heating, and thermosets, which have higher resistance to chemicals and temperature, thus cannot be reshaped (permanent).

Based on their recycling type, plastics are classified into seven types along with their respective forming temperatures. Polypropylene plastic is the fifth type that commonly used in straws, beverage packaging, and bottle caps.

This material has a melting point of 130°C - 171°C, a decomposition temperature of 500°C, and a crystallization point of 130°C - 135°C. Its physical characteristics include being lightweight, solid, transparent or translucent, thin, and not very resistant to high temperatures and chemicals. It's not elastic, not rigid, and has low strength.

This material easily changes shape when interacting with hard or sharp materials or tools and the change is permanent. Its technological properties include being easily flammable, meltable, and moldable at specific heating levels, both through direct heating and indirectly using simple tools or machines, such as candles, irons, heat guns, injection molding machines, polyester molding machines, rolling machines, etc. Based on their recycling type, plastics are divided into seven types as follows along with their forming temperatures.

No.	Logo	Ilustrasi	Jenis Plastik	Penggunaan	Titik Leleh	Suhu Dekomposisi	Titik Kristalisasi
1.			Polystyrene terapan (PET / PETE)	Botol kemasan minuman, kosmetik sekali pakai	200°C - 250°C	400°C	70°C - 190°C
2.			High Density Polyethylene (HDPE)	Kemasan sabun, deterjen, shampoo, botol susu, tangki bensin	200°C - 280°C	400°C	280°C - 320°C
3.			Polyvinyl Chloride (PVC)	Pipa saluran, pembungkusan kabel, selang selang	160°C - 180°C	280°C - 400°C	200°C - 320°C
4.			Low Density Polyethylene (LDPE)	Kantong plastik	100°C - 240°C	400°C	150°C - 190°C
5.			Polypropylene (PP)	Sekam, kemasan minuman, dan tangki	130°C - 171°C	500°C	150°C - 170°C

				botol			
6.			Polystyrene (PS)	Box shipping, wadah makanan, nampan, kemasan yogurt	180°C - 260°C	>300°C	30°C - 150°C
7.			Styrene acrylonitrile (SAN)	Suku cadang otomotif, komputer, peralatan	220°C - 280°C	>270°C	325°C - 375 °C
			Acrylonitrile butadiene styrene (ABS)	makan, sikat gigi, mainan anak, akrilik	230°C - 250°C	250°C - 270°C	>400 °C
			Nylon		240°C - 290°C	>290°C	280°C - 450°C

Image 4 Plastic Recycling Types. (Source: Jessica, 2024)

The Author need to do exploration of waste plastic cup to gain technical characteristics needed for the subsequent steps. The physical properties of PET and PP materials are lightweight, solid, transparent or translucent, thin, not very resistant to chemicals and high temperatures.

They are not elastic, not rigid, and have low strength. The physical properties of HDPE materials are lightweight, solid, rigid, not elastic, very hard, resistant to chemicals, and have quite high heat resistance. The properties of PET, PP, and HDPE materials are the strengthened and struck without water or air are, easily change shape with hard and blunt tools, difficult to return to their original shape due to rigidity and hardness, easily pierced and cut with sharp objects and punctured.

Materials dropped from a certain height do not change shape. Materials containing water and air are difficult to change shape, will break when dropped from a certain height. When subjected to force, they do not change shape, struck with simple hard and blunt tools will crack and break, forming a permanent shape. Being pierced with sharp objects produces bulges. Difficult to cut and pierce. Materials dropped from a height do not change shape.

The technological properties of PET and PP materials are flammable, easy to melted and formed at a certain level of heat, either directly or indirectly heated using simple tools or machines, such as wax, iron, heat gun, injection molding machine, polyester molding machine, roll machine, etc. Meanwhile, the technological properties of HDPE materials are easily to burned, melted, and formed at a certain level of heat, either directly or indirectly heated using simple tools such as heat gun or flame, can be shaped and molded using machines, such as plastic press machine, molding, etc. The material is harder to melt and its shape change is more fluid compared

to PET or PP. Shape experiments using casting techniques is the best techniques for mass produce were to determine the shape and characteristics produced as well as the temperature and duration of their creation. Experiments are divided into three based on their purposes, those are shape, color, and modular system experiments. Shape experiments using casting techniques is the best techniques for mass produce. Color experiments aim to obtain color options that can be used for the final product. Modular system experiments aim to obtain the best type of modular system for the final product. The equipment used includes a toaster oven set at 220 °C, tweezers, aluminum molds, and a small fan.

Material	Tempera- ture	Duration	Result	Illustration	Material	Tempera- ture	Duration	Result	Illustration
10g Fragments of PET Baggie Coffee	0°C - 170°C	15 minutes	The top melted and solidified, slightly brownish due to burning. The bottom surface is sticky due to soot-like temperature and the absence of parchment paper.		10g Fragments of PP Bag- transparent	240°C	7 minutes	The color is not significantly different from the original pastel color, but there are slight white burn, and the result appears dry.	
10g Fragments of PET Baggie Coffee	0°C - 170°C	15 minutes	The surface is more brown (burnt) compared to the unheated fragments.		5g Fragments of PET Baggie Coffee	240°C	2 minutes	The color is appealing because it still appears translucent. It's a transparent color with a thickness of 0.2 cm.	
10g Fragments of PET Baggie Coffee, heated and used with parchment paper	220°C	11 minutes	The surface still appears slightly burnt, but the melting result is more appealing due to the duration being too long.		10g Fragments of PP Baggie Coffee mixed with soft particle powder	240°C	2 minutes	Solid color with a red pattern of soft pastel hue. The visual is appealing due to the abstract pattern visible within the surface.	
10g Fragments of PET Baggie Coffee, heated and used with parchment paper	220°C	8 minutes	The fragments have not completely melted, and some result in powder form.		10g Fragments of PP Baggie Coffee mixed with dry soft particle	240°C	2 minutes	Solid color with a red soft pastel pattern on one surface. The color is intriguing as it appears like an abstract pattern.	
10g Fragments of PET Baggie Coffee	170°C - 220°C	7 minutes	Melts more easily and evenly, but there is a slight brownish burnt color appearance.		10g PET Fragments and 1g colored PP	240°C	2 minutes	The surface is uneven, and the color remains distinct.	
10g Fragments of PET Baggie Coffee	-	-	Brown in color, hard, and brittle. The bottom is smooth.		10g PET Fragments and 1g colored PP	240°C	5 minutes	The surface is even, and the color distinct.	
5g Fragments of PET Baggie Coffee, 10 g of PET Baggie Coffee	220°C	6 minutes	Irregular and hardened in shape, slightly burnt but the bottom has not melted evenly.		10g PET Fragments and 1g colored PP	240°C	2 minutes	The larger sized fragment is visible in the slightly translucent PP. The visual is intriguing as there seems to be fragments inside the surface.	
10g Fragments of PP Baggie Coffee	220°C	4 minutes	PP melts more easily and evenly, resulting in a translucent white form.						

System	Details	Experiments
PP with steel ring		The system quite challenging because the material is prone to shape change and can easily detach if the process isn't correct, difficult to use.
Block		The easiest system to use by user.
Magnet heated and coated with PP		The magnet doesn't function after heated.
Block steel		Not quite easy to use, strong mechanism.
Rotating steel		
Magnet		Easy to use.

Image 5 Shape, Color and Modular Exploration. (Source: Jessica, 2024)

Creating Material Experience Vision

Therefore, it can be understood that fashion jewelry is the jewelry with moderate quality and durability as well as low prices making it the most affordable. Semi-fine and fashion jewelry products from plastic materials are the most commonly found and are now widely developed and circulated. The grouping of explorations is analyzed and adjusted with user studies aiming to understand the user's mindset when using and interacting with the product. The questionnaire was directed towards women and men, including students, workers, and non-workers with a target of 90 respondents aged approximately 15-35 years old.

The purpose of conducting this questionnaire is to understand the usage habits of jewelry, especially plastic jewelry in the daily lives of users. Through these habits, author can develop a product that aligns with the types, needs, and designs preferred by users. Results were obtained from 92 respondents, including 81 females and 11 males, of whom 73 were students and the rest were workers.

The majority have worn plastic jewelry with 62 respondents wearing them for specific events, 52 for daily use, and the remainder wearing them without specific reasons. The three most commonly used jewelry are necklaces, bracelets, and earrings with the preferred jewelry color being translucent with patterns. The level of interest in modular jewelry that can be detached and reattached made from recycled plastic is around 90%. Therefore, jewelry design is made to be modular

into three types, those are necklaces, bracelets, and earrings, with translucent colors and patterns.

The author conducted an interview with Mr. Amir, the owner of Rubysh Jewelry Brand, a jewelry brand made from mix materials of recycled PET and steel. The result of interview reveals differences in approaches related to the design and manufacturing processes of the brand, stemming from variations in academic backgrounds. In the initial stages of design and production, Mr. Amir followed the integrated waste management procedures of the environmental science department, focusing on empowering the target program participants, the women in the Waste Disposal Site. Product inspiration stemmed from design trends at Jakarta Fashion Week or popular entertainment among the community, such as the latest films or specific clothing styles. The materials used included waste PET, HDPE, PP, LDPE, and metal for construction, as they were dominant materials in the Waste Disposal Site and metal provided strength and durability suitable for product construction.

PET is the thinner and easier material to process, was more suitable for small jewelry items. HDPE is much harder was suitable for other products requiring strength and durability, though its color could change easily during heating processes. PP was more prone to breakage. HDPE posed the most difficulty during heating processes, as its melted form would alter in color from its original shade and lose precision in shape.

The processing stages from material acquisition to final product creation included material collection, sorting usable or damaged materials, cleaning, prototyping, melting, molding, crafting, and assembling by the women at the Waste Disposal Site, followed by plating and stone setting at the main office. Collaborative products could be made separately and sent to each other for assembly. Equipment used included simple crafting tools like scissors, pliers, molding tools, sandpaper, clamps, plating machines, bezel rollers, prong pushers, stone setting pliers, etc. Initially, the production process was challenging, particularly in achieving the desired luxury product colors with limited colors from waste materials. Overcoming this involved documenting all failures and seeking alternative ideas and techniques to address them. These technical failures were kept for potential use in new for more suitable future product ideas.

Mr. Amir's advice as a producer of mixed-waste-material jewelry includes frequently visiting the work field and examining the original materials, as much can be gained from seeing and touching the actual materials. Always observe and participate in the production processing as techniques and processes are learned through experience. Preserve all failures as they can be valuable for future projects.

No.	Kategori Pertanyaan	Pertanyaan	Jawaban
1.		Perkenalkan dengan wawancara	Peneliti Rahyb Jewelry.
2.		Apakah ada brand lokal yang sudah ada?	Rahyb adalah proyek lanjutan dari kegiatan habits mengenai waste management tahun 2013. Diawali dengan recycling sampah di salah satu daerah Bandung dengan kapasitas pembusukan brand <i>eco-friendly</i> .
3.	Label Bekas Brand	Faktor yang memengaruhi perubahan brand <i>eco-friendly</i> ?	Ditemukan kembali perubahan dari para pelajar Tempus Pendidikan Kegiatan (TPK) sebagai label di bagian proyek kerja untuk menyediakan para itu terdapat. Para itu diwajibkan untuk melakukan kegiatan perbaikan dari sampah plastik. Proyek ini kemudian didanai oleh Non Governmental Organization (NGO) Australia dan atau Development Bank yang diartikan menjadi bisnis waste material jewelry. Nama Rahyb muncul pada akhir tahun 2014 dan diumumkan tahun 2016. Rahyb melakukan rebranding pada 2019 untuk mengikuti kebutuhan perbaikan bisnis dan menjadi bagian <i>eco-friendly</i> .
4.		Apakah pernah terapan dalam <i>eco-friendly</i> produk sebelumnya?	Sebelumnya sudah terapan di sisi di label <i>habits</i> yang digunakan, kemudian dipikirkan pada proyek akhir kuliah terdapat.
5.		Alasan spesifik memilih perbaikan sebagai produk brand?	Perbaikan adalah produk yang paling mudah dibuat dan <i>eco-friendly</i> juga itu.
6.		Bagaimana dalam mendesain perbaikan material bekas?	Terdapat pada <i>habits</i> Fashion Week atau label yang sedang ada di kalangan masyarakat, misalnya film terdapat atau <i>eco-friendly</i> terdapat.
7.		Material yang digunakan sebagai material dasar produk.	Plastik PET, HDPE, PP, LDPE dan logam sebagai konstruksi.

Image 6 Jewelry Habit Survey. (Source: Jessica, 2024)

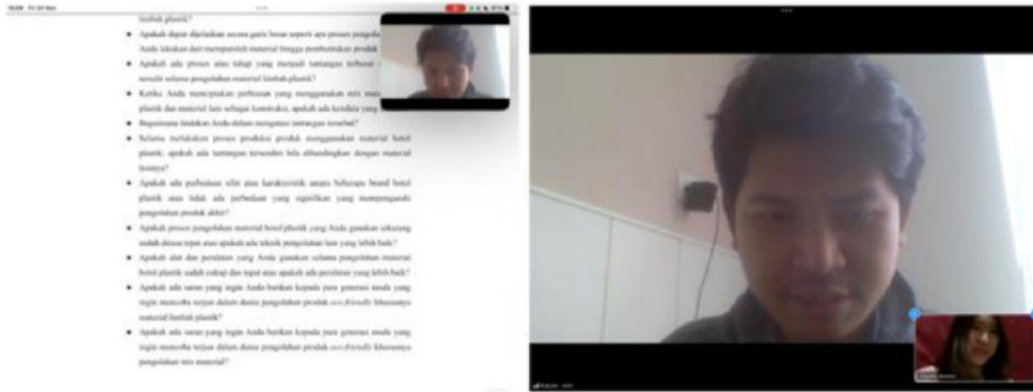


Image 7 Interview Documentation. (Source: Jessica, 2024)

Manifesting Material Experiences Pattern

Based on method, the final shape was the PP-based casting experiment because it has the best result for the final concept, using soft pastel as the color tools as it is the most eco-friendly material and hook modular system as it is the easiest and strongest modular mechanism. The keywords of final product were modular, recycle, interchangeable jewelry.

Eksperimen	1	2	3	4	5	6	7	8	9	10
Uji beban	3	4	5	2	4	4	1	3	4	5
Kekuatan setelah dijatuhkan	3	4	5	3	4	4	1	3	3	5
Ketersediaan bahan	3	3	3	3	3	2	3	3	3	4
Visual	1	1	2	1	3	4	1	3	4	5
TOTAL	10	12	15	9	14	14	6	12	14	19

Kriteria	1	2	3	4	5	6
Daya tahan terhadap tekanan	4	5	1	3	4	2
Durabilitas	4	5	1	4	4	4
Kemudahan penggunaan	1	5	3	3	2	4
Estetika	3	4	5	3	4	2
TOTAL	12	19	10	13	14	12

Image 8 Shape and Color Exploration QFD. (Source: Jessica, 2024)

Based on the 2024 jewelry trend results, it's known that retro and vintage design styles are popular, especially Art Deco.

Jewelry of medium to large size that gives a dramatic and trendy impression, featuring geometric shapes and bright, colorful tones, is in vogue. Additionally, the author utilizes the Art Deco design style, characterized by geometric shapes and a color palette consisting of orange, green, and blue.



Image 9 Jewelry Trend 2024. (Source: Jessica, 2024)

Designing material/product concepts

In this stage, the Author combining all the results to serve as a reference for the final product concept. The recommended solution is a modular interchangeable jewelry product from Polypropylene (PP) plastic cup waste using hook modular system.



Image 10 Final Product. (Source: Jessica, 2024)

The final product is a 3-in-1 modular jewelry made from recycled PP plastic cup materials utilizing a modular hook mechanism that can be transformed into three types of jewelry, there are necklace, bracelet, and earrings.

This jewelry is designed for individuals aged 15-35, regardless of gender, who are interested in recycled jewelry. It can be worn anytime, indoors or outdoors, but should avoid contact with water. There are 10 connected modular pieces on a steel ring and 5 detachable modular pieces made from recycled PP. Users can detach modules through slots located on each module.

A Focus Group Discussion was conducted with 5 users to obtain user studies and evaluate the product based on material, form, color, texture, and function aspects grounded on sensorial, interpretive, affective, and performative factors. The aim was to study user's product interaction and gather important input or feedback regarding the final product design. The FGD was conducted with two groups. In the sensorial stage, users liked the texture and color options of the material. In the interpretive stage, users associated the material with a jewelry or keychains. Users guessed that the material was made from PET plastic bottles. The expected products are jewelry such as necklaces, rings, earrings with a price range of Rp 50k Rp80k for small sizes and Rp 100k for large sizes.

In the affective stage, users were interested and closely observed the color patterns of the material. In the performative stage, users touched the texture and tried to assemble/disassemble modules.

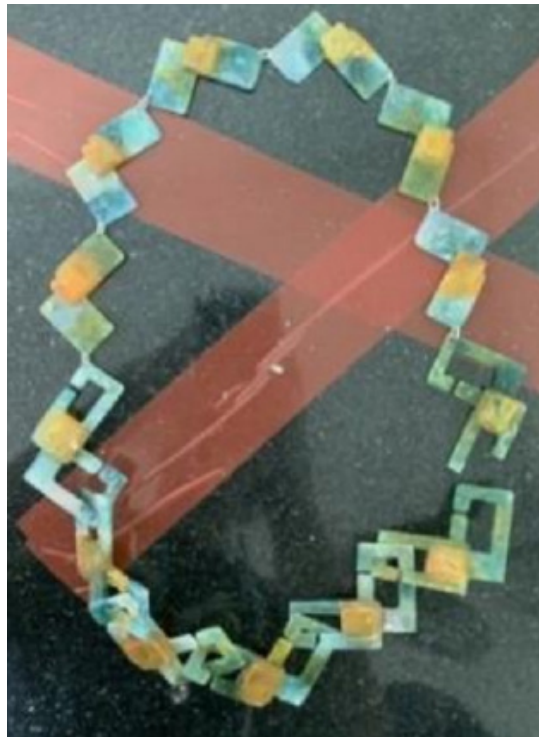


Image 11 Swatch Material. (Source: Jessica, 2024)



Image 12 FGD. (Source: Jessica, 2024)

The second group consists of two women, A and B. A is a 22-year-old student with knowledge of recycled materials. B is also a 22-year-old student who enjoys wearing plastic jewelry. In the sensorial stage, users liked the design and color of the material, considering the size to be just right. In the interpretive stage, users associated the material with jewelry (bracelets, necklaces, earrings). Users guessed that the material was made of PET plastic or natural stone. The expected product is a necklace with a price range of Rp 35 thousand per module and Rp 150 thousand per pack of 5 modules. In the performative stage, users touched and tried on the product, attempting to assemble and disassemble it. In the affective stage, users were interested and paid attention to the colors.

No.	Faktor	A	B	C	D	E	Rata-rata
1.	Desain Ide	4	5	4	5	5	4,6
2.	Keunikan material	5	5	4	4	3	4,2
3.	Motif	5	5	5	5	4	4,8
4.	Ukuran	4	5	4	4	5	4,4
5.	Warna	5	5	5	4	5	4,8
6.	Kemudahan penggunaan	4	5	4	5	5	4,6
Total nilai							4.56

Image 13 User Review QFD. (Source: Jessica, 2024)

A Quality Function Deployment (QFD) table was conducted for the five users with various factors such as design ideas, material uniqueness, patterns, size, color, and ease of use to determine the highest value on a scale of 1-5. The total result obtained was an overall score of 4.56 out of 5.

CONCLUSION

The conclusion of the design result is as follows. The design solution for plastic cup waste accumulation is a jewelry design utilizing PP plastic material entirely in

a modular system, resulting in a product composed of many modules using various waste materials. This product's attractiveness lies in its modularity, allowing it to be assembled and worn as three different types of jewelry, there are earrings, bracelets, and necklaces, thus widening the target user base. The strength of the product lies in its use of recycled plastic material, potentially aiding in reducing plastic waste accumulation. Additionally, it employs a modular hook system, eliminating the need for additional components and making it universally easy to use. With high durability, it lasts long due to being made from recycled material that is difficult to break down. The product consists of adjustable modules in size and length, allowing for customization according to needs, transforming into earrings, bracelets, or necklaces within a single product. Lightweight, easy to clean, and resistant to high temperatures.

REFERENCES

- Annur, C. M. (2023, July 5). Inilah Negara Penghasil Sampah Terbesar Dunia, Ada Indonesia? Databoks. <https://databoks.katadata.co.id/infografik/2023/07/05/inilah-negara-penghasil-sampah-terbesar-dunia-ada-indonesia>
- Awaja, Firas, Pavel, & Dumitru. (2005). Recycling Of PET, 41(7), 1453. https://www.researchgate.net/publication/222220710_Recycling_of_PET.
- Cavagnaro, E., & Curiel, G. (2012). The Three Levels of Sustainability (Greenleaf Production, Ed.). Greenleaf Company Limited.
- The Difference Between Fashion Jewelry vs Fine Jewelry | The Loupe. (2018, June 21). TrueFacet. Retrieved December 12, 2023, from <https://www.truefacet.com/guide/fashion-jewelry-vs-fine-jewelry/>
- Eco, U. (2023). Prinsip 3R (Reduce, Reuse, dan Recycle) Dalam Pengolahan Sampah. Universal Eco. Retrieved December 12, 2023, from <https://www.universaleco.id/blog/detail/prinsip-3r-reduce-reuse-dan-recycle/156>
- Versatile furniture system for children and adults alike - an easy-to-assemble, tool-free, modular furniture system that adapts to your needs and space.
- SIPSN. (2023). SIPSN - Sistem Informasi Pengelolaan Sampah Nasional. <https://sipsn.menlhk.go.id/sipsn/>
- Yu, J., Sun, L., Ma, C., Qiao, Y., & Yao, H. (2015, Desember 10). National Library of Medicine. Thermal degradation of PVC: A review. <https://pubmed.ncbi.nlm.nih.gov/26687228/>