THE UTILIZATION OF SEA GLASS AS AN ATTRACTIVE MATERIAL IN JEWELRY WITH A KINTSUGI APPROACH

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Abstract

One of the significant contributors to environmental pollution is waste from glass bottles. A potential solution to this problem is transforming glass into sea glass, consisting of glass shards that are naturally recycled by the ocean over 5 to 50 years, smoothing sharp edges. Unlike plastic, which breaks down into microplastics, the sea can recycle glass due to its high pH and the presence of sand and rocks that aid in the smoothing process. Sea glass has a positive environmental impact as a recycled material that can replace new raw materials. This study aims to develop jewelry from sea glass using the kintsugi technique, which combines glass fragments with precious metals to create aesthetic and economic value products. The research identifies market needs for attractive and sustainable jewelry through in-depth interviews with respondents. The analysis results indicate that the jewelry developed will comprise a necklace, ear cuff, and bracelet set. Therefore, developing sea glass-based jewelry using the kintsugi technique is expected to contribute to environmental preservation while enhancing the competitiveness of domestic jewelry products in the global market.

Key words: waste, Sea Glass, Jewelry, Kintsugi, culture, exploration

INTRODUCTION

Cindy Mutia Annur (2023) noted that glass waste is one of the highest contributors to environmental pollution, reaching up to 304,330 units. In single-stream recycling systems, glass increasingly becomes a contaminant, as glass shards can pollute other recyclable materials. One effort to recycle glass shards

without causing contamination and ensuring greater safety is by transforming them into sea glass. Sea glass is a naturally recycled form of glass that is shaped by the ocean over many years into beautiful stones. This process can take about 5 to 50 years, smoothing the sharp edges of glass shards due to the high pH of seawater, which can naturally recycle glass. The presence of coarse sand and numerous rocks aids in transforming sharp-edged glass fragments into smooth surfaces. The smaller and smoother the sea glass found on the beach, the longer the recycling process has taken, which also increases its market value. (Anwar & Hasan, 2021)

There is an effort to create sea glass using a machine. This process utilizes a rock tumbler, which serves as an alternative method for producing sea glass by significantly shortening the natural weathering process that typically takes a long time when done through seawater. This method is more efficient, and the potential for developing sea glass using a rock tumbler also contributes to environmental preservation, as it is part of the effort to recycle glass bottle waste. (*What is the Environmental Impact of Sea Glass?*, n.d.) The recycled sea glass will be approached using the kintsugi technique, which represents cultural value in relation to the philosophy of kintsugi. This will also enhance the aesthetic value of sea glass as an attractive material in jewelry. (Simanungkalit, 2018)

This research is conducted to address three main research questions: 1) Designing sea glass as the primary material for jewelry products using a rock tumbler with the kintsugi technique. 2) Designing sea glass jewelry products to ensure environmental value and promote sustainability. 3) Designing sea glass into jewelry products that reflect distinctive features of Indonesian culture. The research is limited by: 1) The dimensions of the resulting sea glass will vary and not be identical. 2) The color of the sea glass will be limited. 3) The target users for this design are female jewelry consumers in Indonesia, aged 25 to 33 years.

1. Standardization of Glass Bottles and Jars

According to the Indonesian National Standard (SNI) 8229:201X, regarding glass bottles and jars, it establishes

quality requirements for glass bottles with narrow-necked containers that must meet the following quality criteria: (National Standardization Agency of Indonesia, n.d.)

a. The visible quality
   The visible quality of glass bottles and jars, when tested for use by the general public as food or beverage packaging, must not have any defects, including critical defects, severe functional defects, or minor functional defects.
b. Dimensions and Tolerances
   Dimension and tolerance testing is conducted on five test specimens. If there are dimensions for the glass jars being tested, they must meet tolerance requirements for capacity, nominal height, nominal diameter, verticality, and the lack of parallelism of the ends, referring to the base of the container.
c. Temperature shock
   Temperature shock testing is conducted on five test specimens. Glass bottles and jars intended for food and beverages must not crack or break. The requirement for the temperature difference of the beverage is 42 degrees Celsius, with a low temperature of approximately 22 degrees Celsius, allowing for a variation of about 5 degrees Celsius.
d. Internal Pressure
   Pressure glass bottles must meet the quality requirements for pressure as specified in the table below.

Table 1 – Internal Pressure
Source: National Standardization Agency of Indonesia, 2024

Type of Bottle	Single-Use (kgf/cm^2)	Reusable (kgf/cm^2)
Carbonated Non-Alcoholic Beverages	12,3	14,1
Carbonated Alcoholic Beverages	12,3	14,1
Fermented Beverages	14,1	-

e. Vertical Load Resistance
   The quality standards for glass bottles and jars for food and beverages must meet a vertical load resistance of at least 3000 N.

f. Alkali Migration
The limit for alkali migration in glass bottles and jars, when tested, must meet the following requirements.

Tabel 2 – Maximum Alkali Migration Limits
Source: National Standardization Agency of Indonesia, 2024

No.	Substance	Maximum Migration Limit in Glass Containers (x 10^{-6} mg/L)
1.	Alkali (Na/K)	8,50
2.	Lead (Pb)	0,50
3.	Cadmium (Cd)	0,50

g. Annealing Stress
The annealing stress requirement for glass bottles and jars for food and beverages must not exceed a maximum of 4 standard stress pieces.
h. Impact Resistance
The minimum impact resistance requirement for glass bottles and jars for food and beverages is 3.5 kgf/cm^2.

2. Characteristics of *Sea Glass*

Sea glass generally has a smooth and hard surface, and it becomes more opaque over time. Sea glass that undergoes the weathering process will experience a reduction in dimensions from the original glass shards before weathering. In terms of color, the most common sea glass colors are white, brown, and green, as these colors are typically derived from milk bottles, syrup bottles, or beer bottles. Other colors are relatively rare because their usage is less common compared to these three colors. (*Sea Glass*, n.d.)

3. Kintsugi *Technique*

Kintsugi originating from *Kin* (金) is gold, whereas *tsugi* (継ぎ) is a method of repairing ceramics or fragile items using a special adhesive mixed with gold, silver, or platinum. It is based on an appreciation of the object's history, acceptance of flaws, imperfections, and the aging process.

Figure 1. Kintsugi
Source: Risner, 2022

This technique, which originated in Japan, emerged when a ceramic item was accidentally broken and then repaired in a more elegant and aesthetic manner using molten gold powder to fill each crack. The process of creating kintsugi ceramics involves using a special ceramic adhesive, which is then enhanced with authentic gold powder for aesthetic appeal. Generally, objects that undergo kintsugi treatment end up as decorative home items. (Simanungkalit, 2018)

RESEARCH METHODS

This research method involves analyzing the study subjects, specifically targeting users who have an enthusiasm for fashion jewelry that embraces the concept of sustainable jewelry and belong to the upper-middle class. The research is conducted through material exploration of sea glass, incorporating the additional technique of Kintsugi.

The research flow is as follows: 1) Analyzing the problems identified by the researcher. 2) Collecting data using literature review methods, in-depth interviews with two study subjects, and a questionnaire distributed to respondents who meet the study specifications. 3) Exploring materials related to the research.

1. Jewelry

   In general terms, jewelry can be defined as an item worn to enhance one's appearance, whether for special occasions or everyday use. Jewelry is not just an accessory for users to look more beautiful or stylish; it can also signify the social

status of the person wearing it. This is evidenced by the discovery of jewelry in ancient times, which was not only used to adorn the body or clothing but also held significant functions and meanings for specific groups or tribes. The experimentation process occurs after analyzing data related to jewelry users. The experiments are conducted based on key points that are important considerations for this design. (Arumsari, n.d.)

2. Processing of Sea Glass Materials

The primary material is the central element of a product. It serves as the focal point that highlights the product. In this research, sea glass is the main material. Generally, sea glass has a smooth and hard surface, and it becomes more opaque over time. Sea glass that undergoes the weathering process will inevitably experience a reduction in dimensions from the original glass shards.

In terms of color, the most common sea glass colors are white, brown, and green, as these colors are typically derived from milk bottles, syrup bottles, or beer bottles. Other colors are relatively rare because their usage is less common compared to these three. (*How to Make Sea Glass with a Rock Tumbler*, n.d.) The process of processing sea glass is a manufacturing analysis study conducted through direct research.

a. Collection of glass bottle waste: The process begins with the collection of glass bottle waste from collectors. The gathered shards consist of various shapes, colors, and sizes.
b. Breaking glass bottle waste: This process involves cleaning the bottles to remove any labels still attached to the surface. The cleaned used glass bottles are then inspected and sorted by thickness and color. After that, the glass bottles are broken using a hammer and thick cloth.
c. Grinding process using a rock tumbler: This process involves mixing materials such as sandpaper powder, polishing powder, and water into the rock tumbler along with the previous glass shards. One rock tumbler can accommodate the volume of shards from one large glass

bottle. This process can take several days to achieve the perfect sea glass results.

d. Checking the sea glass: This process is carried out multiple times to ensure the sea glass reaches perfection. If the sea glass is not yet fully formed—meaning the surface is not smooth and the color has not changed—the grinding process can be repeated until the desired results are achieved.
e. Washing the sea glass: The formed sea glass is then cleaned of any remaining material residues.
f. Selecting the sea glass: This process aims to sort the sea glass shards based on dimensions, ensuring they are suitable for use in necklaces, bracelets, rings, or other types of jewelry.

Figure 2. Processing Sea Glass with a tumbler rock glass
Source: Author's Processing, 2024.

3. User Study

The study on jewelry users employs in-depth interviews and user preferences. The research aims to understand tastes in jewelry products, which will later be implemented in the study. The study focuses on potential users aged approximately 25 to 35 years. Participants were selected based on their relevance to the research, specifically targeting those living in urban areas. The chosen demographic consists of women aged 25 to 33 who wear jewelry in their daily activities and have an income above 4,000,000, placing them in the upper-middle class. All participants expressed interest in a feminine look, as this style aligns with their attendance at significant events. However, they

prefer a design that combines traditional elements with modern adaptations. The participants agreed to select floral motifs as supporting designs for this research product, with the chosen flower being the frangipani.

4. *Kintsugi* Analysis

   In this Kintsugi experiment, the author focuses on the appearance of the sea glass jewelry to enhance its appeal to users, thereby increasing the value of the jewelry product. During this experiment, several color combination processes were conducted to support the successful treatment of sea glass using the Kintsugi technique.

Table 3 - Results of Sea Glass Type Collaboration Using Kintsugi
Source: Author's processing, 2024

No.	Parameter	Type of Sea Glass Kintsugi Combination	Difficulty Level	Neatness Level
1.	Ease and neatness of applying the kintsugi technique on sea glass with different .	 2 colors and 2 thicknesses	Difficult Reason: The difference in glass thickness prolongs the glass joining process.	Low Reason: The difference in glass thickness makes it difficult to create a level surface.
2.	Ease and neatness of applying the kintsugi technique on sea glass with different.	 3 colors and 2 thicknesses	Very Difficult Reason: The difference in glass thickness and types prolongs the glass joining process.	Low Reason: The difference in glass thickness makes it difficult to create a level surface.
3.	Ease and neatness of applying the kintsugi technique on sea glass with the same.	 1 color and 1 thickness (thin)	Easy Reason: The same thickness and type of glass (thin) speeds up the glass joining process.	Neat Reason: The same thickness of glass (thin) makes it easy to create a level surface.
4.	Ease and neatness of applying the kintsugi technique on sea glass with the same	 1 color and 1 thickness (thick)	Very Easy Reason: The same thickness and type of glass (thick) further speeds up the glass joining process.	Very Neat Reason: The same thickness of glass (thick) makes it easier to create a level surface.

The author obtained data from the analysis of color combinations and thickness, as shown in the table above. It was found that different thickness combinations present a higher level of difficulty; however, the color combinations resulted in an appealing visual value when paired together. Thus, the author concludes that while combining colors, if there is variation in thickness, additional layers need to be applied to the sea glass to enhance its neatness, allowing it to be processed into the design product in the next stage.

5. Material Exploration

   In the initial manufacturing process of kintsugi sea glass, the sea glass is bonded using epoxy glue, which serves as the primary material in the kintsugi process. The adhesion process must be carried out quickly by mixing the epoxy glue in a 1:1 ratio with the hardener, which is then applied to each piece of sea glass individually.

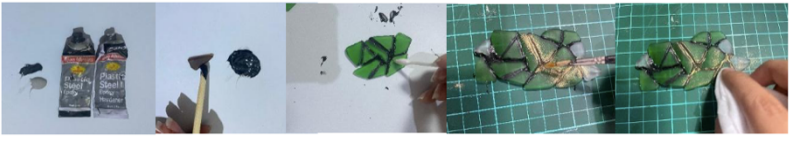

Figure 3. Kintsugi Sea Glass Stone Assembly Process
Source: Author's processing, 2024.

After the adhesive is applied, while it is still partially wet, gold powder is sprinkled on it and left to dry. Once dry, the area with the gold powder is tidied up using a damp tissue. Below are the results of the sea glass that has undergone the kintsugi process; this glass will eventually be assembled as the main stone in the jewelry product using a bezel setting.

Figure 4 – Sea Glass Kintsugi
Source: Author's processing, 2024.

RESULT

The final stage involves selecting the final design for a set of jewelry that will move on to the manufacturing phase. Each design in this set has its own concept, derived from the overarching concept of the Nusantara Series established earlier. The Nusantara Series draws inspiration from the rich natural resources found in Indonesia.

Osa Series, This jewelry series features green sea glass combined with black and white sea glass. It is named “Osa,” which means “growth” in Sanskrit, representing the natural growth of plants. This reflects the predominant green color of the sea glass, which embodies the personalization of botanical elements.

Figure 5. Visualization of the sea glass kintsugi jewelry set
Source: Author’s Processing, 2024.

DISCUSSION

1. The shape of the jewelry is important because it affects the weight; asymmetrical jewelry is very susceptible to weight imbalance, which can cause it to feel heavy on one side when worn. This results in a look that is not as intended and may make the user feel uncomfortable.
2. Kintsugi adhesion is performed with safety in mind, as it uses a strong adhesive, epoxy glue. Based on the author's experience, it is necessary to wear a mask to avoid the unpleasant odor of the epoxy during the adhesion process, which also requires a lengthy duration to set properly.
3. The sea glass pieces to be bonded must have the same thickness, as differing weights can affect the balance of the kintsugi sea glass.

CONCLUSION

Sea glass is a naturally recycled form of glass that has been shaped by the ocean over many years into beautiful stones. This process can take between 5 to 50 years, smoothing the edges and corners of glass shards. Unlike plastic waste, which breaks down into microplastics, seawater can "recycle" glass shards into stunning glass stones. The smaller and smoother the sea glass found on the beach, the longer the recycling process has taken, which also increases its market value. Seawater has a high pH level, enabling the natural recycling of glass, while coarse sand and numerous rocks aid in transforming sharp glass fragments into smooth surfaces. In this study, material exploration of sea glass is conducted with a focus on the appearance of the jewelry pieces to enhance their appeal, thereby increasing the value of the jewelry products.

The research includes several processes of color combination exploration that support success in terms of appearance. This results in sea glass being transformed into gemstones by incorporating the kintsugi technique, which uses a special adhesive mixed with gold. Additionally, the limited exploration of design in this area presents a significant opportunity for developing jewelry with sea glass materials, allowing for further exploration into other products that cater to the preferences of future generations.

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