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Bolsa Cross-body Bag: Agarwood-Inspired Product by Exploring Agarwood Material as an Alternative Material on Wearable Products

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Abstract
BOLSA is a cross-body bag developed to include simplicity, portability, flexibility, easy-to-carry, parametric wood textures, and compatibility with users of all ages. The industry's current challenge is to improve and innovate the uses of Agarwood. Currently, agarwood products available in the market are just the "tip of the iceberg" and only focus on being used in incense and perfume, and are very limited in small carvings. The solution to this problem is to explore the durability and flexibility of Agarwood and a possible way to commercialise agarwood material as an alternative material for wearable products.

Keywords: Agarwood; sustainable; product design; product development

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1.0 Introduction

Agarwood, a highly prized non-timber forest product used in perfumes, incense, medicines, aromatherapy, and religious rituals, is obtained from the heartwood of Aquilaria trees. This heartwood is affected by a type of mould known as phialophora parasitica. According to Tan et al. (2019), the most expensive wood in the world is Agar's heartwood, which has been infected. Due to its extensive use in medicine, fragrance, and religion, Agarwood is known as the "wood of the gods." Over $1.2 billion is the estimated annual value of Agarwood exported from Singapore (Elias, Ibrahim, & Mahamod, 2017; Tan et al., 2019). The only places where agarwood-producing species can be found are southern China, Indonesia, and Malaysia. Notably, Indonesia and Malaysia are the leading countries from which Agarwood is originally sourced. The industry's current challenge is to improve and innovate the uses of Agarwood (Tan et al. 2019). Only a small fraction of the potential uses for Agarwood are being exploited by the industry, with most of the existing items relegated to incense, perfume, and trinkets made from tiny blocks of wood (López-Sampson & Page, 2018). The inducing method, which aids in producing high-quality Agarwood, is the procedure upon which the carving is based for its quality and distinctive shape of non-resinous wood. The problem arises because of the wide use of carving; it has been identified in carving, artwork, and sculpting. This is because Agarwood is too light and fibrous to be used in substantial buildings (Mamat et al., 2010; Persoon & Beek, 2008).

Today, agarwood products have expanded to include a variety of alternatives, but few people acknowledge the waste of sawdust and wood chips generated during the carving process (Mamat et al., 2010). Every part of the Agarwood has commercial value, from the oud chips and oil to the excess dust and discarded wood. Agarwood leaves were used to make tea; agarwood dust was burned as aromatic, and agarwood chips were used for incense and perfumes. So, it still costs a lot to get the agarwood material, even if it is unused and left over from the production process (Elias, Ibrahim, & Mahamod, 2017; Tan et al., 2019).

Currently, agarwood items on the market are only the "tip of the iceberg," with an emphasis on incense and perfume, and are quite limited in terms of little sculptures. The carving is based on the quality and distinctive shape of non-resinous wood obtained through the

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induction technique, which aids in developing high-quality Agarwood. Due to this context, the issue has been found in carving limits in several areas, such as carving, artwork, and sculptures. This is because the characteristics of Agarwood, known as being light and fibrous, disallow its use in heavy construction. The solution to this problem lies in identifying Agarwood's durability and flexibility. Addressing these identified problems through thorough research, strategic planning, and innovative solutions will contribute to the success and sustainability of the agarwood-inspired product.

By addressing these identified problems, this project aims to commercialise Agarwood as an alternative material for wearable products, thereby contributing to the success and sustainability of the agarwood-inspired product on a global scale. The objective of this project is to promote Agarwood as an alternative material for wearable products, seeking to enhance its global value. The project focuses on integrating innovative approaches to sustainability into the product and aims to optimise the use of waste agarwood material in creating an alternative wearable cross-body bag. The wearable cross-body bag has Agarwood as its primary material to achieve sustainable development goals (SDGs). Using waste materials as sustainable materials in the development of new products, in other words, would benefit the environment and help the world save a lot of resources. Using a sustainable context in design also aids in understanding and spreading awareness of the importance of preserving the environment, ecological health, and human health by utilising renewable resources. Because the research aimed to develop zero-waste agarwood products, this study had to include an experiment on the form's flexibility and explore the innovative use of agarwood material in offering a unique and distinct product in the wearable accessories market.

2.0 Methodology

The researchers used a mixed approach throughout the study to gather data from experiments and observations to look into how Agarwood can form both positive and harmful forms of flexibility. In these studies, the researcher used an observation approach, a data collection strategy used in experimental, action, and practical research (Rosenbaum, 2018; Creswell, 1999; Johnson & Onwuegbuzie, 2004). This research consisted of three phases: (i) Phase 1: Case Study; (ii) Phase 2: Experiment on Agarwood Material; and (iii) Phase 3: Concept Generation. However, case studies, experiments, and concept generation are often context-specific. Findings from such studies may not be readily generalisable to broader populations or different contexts. The specific conditions of the study may limit the applicability of the results.

2.1 First phase: Case Study at Agarwood Plantation

Ral Plantation Sdn Bhd, an agarwood plantation in Kuala Kangsar, Perak, was visited on a field trip. This company is an agarwood business that sells agarwood-based items. The case study was conducted between July 5 and July 10, 2022. The case study intends to get first-hand knowledge of Agarwood processes and business-related studies (Wright, Greenwood, & Boden, 2011). We were given briefings about the agarwood process, a tour of the plantation and research and development areas, and a demonstration of several agarwood extraction procedures by the company's management and working employees during the trip.

2.2 Second phase: Experimentation on Agarwood Materials Formation of Form on Human Body Parts

Throughout the study, the experiment was conducted using two types of experimentation: (i) study on Agarwood wood flexibility to build up basic form and parametric design in relation to the geometrical form; (ii) study on the suitable form on specific of human body parts and figures (Seh et al. 2017). The following human body parts were subjected to form testing: head, neck, chest, shoulder, arm, arm-wist, waist, and thigh. The researcher selected this part of anatomy because it is probably suitable for wearing the wearable product that will be developed in this study.

2.3 Third phase: Concept Generation

The production of ideas began with establishing a list of parameters based on the needs and specifications of the customer. The requirements are used as a basis for the concept generation in this study, which helps focus on several potential solutions and concepts that meet those requirements (Ali & Liem, 2014; Ali et al., 2020). The researcher used : (i) brainstorming technique and mind-mapping technique for generating initial ideas; (ii) market segmentation to study design trends and branding; and (iii) semiotic analysis and design language for design inspiration (Gretzel & Collier de Mendonça, 2019; Wang et al. 2021).

3.0 Results & Findings

3.1 Case Study

RAL Plantation stated that their type of Agarwood is made by wounding the Aquilaria tree and infecting it with mould. A defence mechanism activates a secondary metabolite biosynthesis pathway that produces a fragrant resin. Putting the tree under physical stress will make aloe resin heal itself. That is how the Agarwood at RAL Plantation is formed. For Agarwood to develop naturally, it will take ten years. So, to speed up the process, the Ral Plantation makes an inoculation serum injected into the Aquilaria tree. RAL Plantation created the inoculum PROVE-N1 using a combination of infusion and direct induction. They used hoses and hose joints, chemjet tree injectors, pointed 140-ml bottles, and 10-mm drill bits for the inoculum process. They then explained how they did the wood carving of the Agarwood to get the resin. The carving must be done accurately without damaging the wood's infected part. After that, the designer

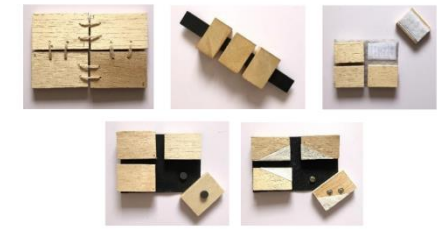
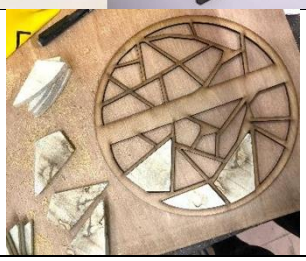
was given a tour around the plantation to show the agarwood oil distillation machine and the agarwood fields. The Agarwood in the areas was marked and recorded to determine which tree had been injected and which had already been formed. (see figure 1)

Fig. 1. The use of PROVE-N1 inoculum agarwood super inducer at RAL Plantations

3.2 Experimental on Agarwood Plank.

Experimenting with different shapes, joints, and finishes on the agarwood plank resulted in the conclusion that agarwood planks are unsuitable for use as solid or stand-alone materials to create products. As a result of the experiment, an agarwood plank is not a solid wood plank. To create a solid wood material, another process will need to be involved and will be expensive. Alternatively, the researcher must combine resin and carbon to create a new solid-state material. Table 1 shows the experiment for the study.

Table 1. Experimental of agarwood plank toward flexibility of shape and finishing.

	Experimental on jointing: ● Agarwood is not a solid plank and must be a solid material if jointing is to be added. ● It is weak, prone to dents and scratches, and cannot withstand pressure.
	Experimental on finishing: ● Agarwood surfaces absorb liquid and resin. ● They have an open cell shape that permits them to absorb huge volumes of stain, which can result in undesirable outcomes after staining.
	Experimental on shape: ● Agarwood, combined with other materials, adds aesthetic value to the design. ● Agarwood can be sculpted into various forms and is simple to combine with other materials.

3.2 Experimental on Agarwood Material for Geometrical Shape

The experimental method is to explore the flexibility of the agarwood plank material. A geometric shape consists of parametric and geometric shapes used in the experiment. The main objective of this experiment is to assess the flexibility and suitability of the Agarwood form in geometrical and parametric shapes for the human body. The human body parts tested are the head, neck, shoulder, chest, arm, wrist, waist, and thighs. Three geometric shapes were experimented: (i) triangles, (ii) arrows, and (iii) honeycombs. Three levels of colour are used as result indicators based on the experiment and observations: (i) Red denotes extremely low flexibility, (ii) Yellow denotes average flexibility, and (iii) Green denotes maximum flexibility and suitability (see Figure 2)

Figure 3 below shows the flexibility of the agarwood geometrical shape toward human body parts with the existing wearable product. The primary purpose of this finding is to explore what material, features, colour, and measurements are used on existing products. There are two types of wearable products on the market: handmade and mass-produced. To find potential wearable products for this study, the researcher also conducted persona analysis to learn about people's backgrounds, body types, brands, sense of style, and other traits. At this point, the researcher interviewed them to get all the facts, including the names of the brands and products they used. The results also show that most personas used a cross-body bag in their daily activities, contributing to the highest flexibility on the Agarwood form in terms of a parametric shape.

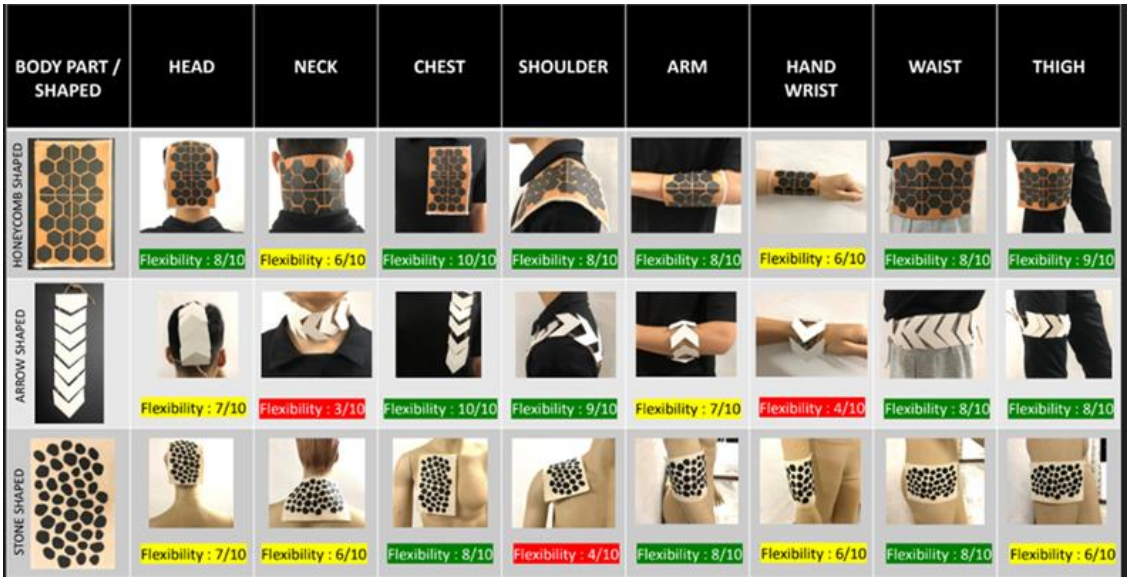


Fig. 2. Experiments on geometrical shape for human body parts.

Fig. 3. Mapping geometrical shape to the wearable product and human body parts

3.6 Design Research and Generative Process using ROI Analysis

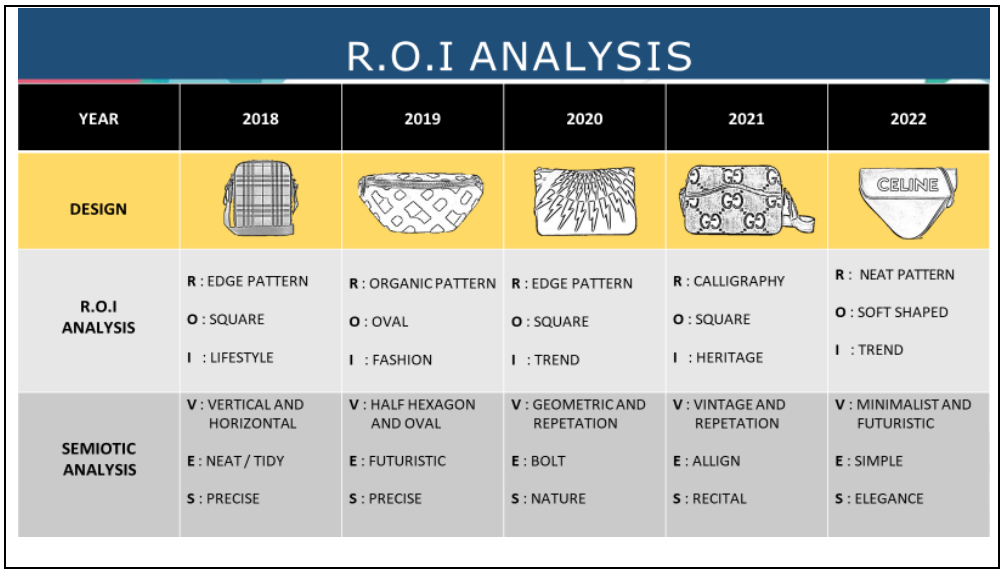


Fig. 4. ROI and Semiotic Analysis on several brands of cross-body bags from 2018 until 2022.

3.7 Final Design Development

A design concept inspired by Malaysian culture was chosen through the generative process to add cultural value to the design. Culture influences the styles and preferences of a specific group of people. These two factors require special features in items that appeal to people. This is the underlying idea behind the design and development of this study. A Malay iconic traditional kite, "Wau," was selected as an inspiration to create iconic elements in the design. Figure 5 explains concept sketches that contain geometric and iconographic components.

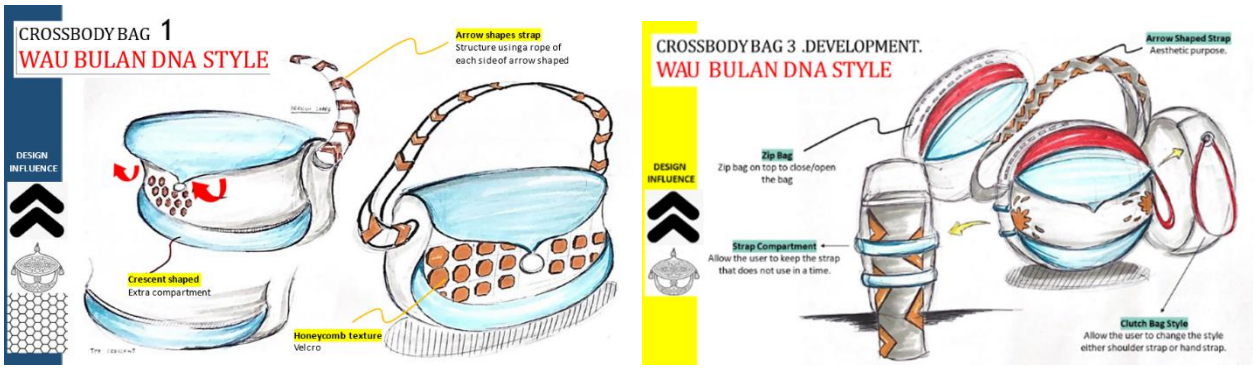


Fig. 5. The concept development inspired by "Wau Bulan"

After design development, this study created a few mock-ups to evaluate the shape and size and to test the final design. A few experts criticised and assessed mock-ups for the final 3D design proposal. Then, the researcher develops the final prototype, as shown in Figure 6, for further testing with users.

Fig. 6. The mock-up development (Left). Final prototypes (Right)

4.0 Discussions

Agarwood can be used for wearable merchandise, medical devices, and other purposes, such as making agarwood resin coaster sets, utensils, etc. Every part of Agarwood has its purpose and function. The only thing left is applying it to products and designing them to function correctly. Agarwood can be much more than just a popular and in-demand fragrance. This study covered everything there was to know about Agarwood's flexibility. The research goals are to use agarwood waste to create a product that can be used as a wearable merchandise item and to design an agarwood-based product that can compete in the global/modern market—an eco-friendly handmade bag from a combination of Agarwood and sustainable materials. The design of this product emphasises the use of discarded Agarwood. It is made from a suitable variety of materials such as leather, canvas, or plastic to be combined into a bag with aesthetic value. The use of Agarwood in product design is uncommon, and the creation of this product emphasises the use of discarded Agarwood. BOLSA is a cross-body bag developed to include simplicity, portability, flexibility, easy-to-carry, parametric wood textures, and compatibility with users of all ages. This study focuses on GOAL 8 (Decent Work and Economic Growth), GOAL 9 (Industry, Innovation, and Infrastructure), and GOAL 12, adopted from the United Nations (UN) Sustainable Development Goals. To attain "Goal 9," "Goal 8," and "Goal 12," we study current developments, trends, and prospects of Agarwood as the primary material for a proposed product in Malaysia. This study considers the technology, material, and productivity issues of agarwood materials. This product follows the current market trends to satisfy a demanding and highly selective consumer—collectors of experiences that create new emotional and indulgent experiences. The contribution of this product toward social benefit will support entrepreneurship initiatives for local artisans to create unique agarwood-based products. These initiatives hope to benefit the consumer and Agarwood, create responsible production and motivate companies to develop technology-driven products. Companies can help the agarwood plantation business by managing crops, harvesting them, transporting them, and influencing the final manufacturing of products that meet market needs and potential.

5.0 Conclusion & Recommendations

In conclusion, the product design industry may be impacted by investigating Agarwood material in wearables, ranging from customer tastes and design to environmental policies and cross-cultural fusion. Future implications might help create a product design scene that is more varied, sustainable, and socially conscious. The broader sustainable product design movement can benefit from using Agarwood, an eco-friendly and sustainable material, in wearable products. It might serve as a model for the product design industry to investigate more environmentally friendly, ethically sourced, and renewable materials.

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Paper Contribution to Related Field of Study

This project significantly adds to the body of knowledge in Agarwood research, product design, and industrial design. The research aims to create a wearable product out of discarded Agarwood and an internationally appealing, competitive agarwood product. The use of Agarwood as a substitute material is in line with the subject of the eco-product conference, emphasising a sustainable and eco-friendly approach to design. This aligns with the conference's focus on sustainable material selection by highlighting Agarwood's potential as a sustainably managed renewable resource.

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