

Design of Home Decoration Products from the Leftover Fishing Nets Coated with Latex: Vernacular-Inspired Product Designs Reflecting the Identity of the Southern Region in Thailand

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Abstract

This study reports an exercise that develops home decoration products using leftover fishing nets coated with natural latex. It employed the artistic skills of community members to add value to leftover materials in the region and create beautiful, contemporary, culturally-reflective home decor products that align with modern consumers' preferences, enhancing the ability of the community to continue developing in the future.

The physical characteristics of various types of leftover fishing nets after being coated with natural latex were analyzed. This data was subsequently used to design and develop prototype home decoration products. The cultural identities of southern communities in Thailand were integrated into the product design. Community members with expertise in art and painting skills contributed to the design process, using natural patterns inspired by fishing nets and employing color techniques that add depth and uniqueness to the home decor products,

The findings demonstrate that the formulated natural latex coating exhibit suitable material science properties for coating leftover fishing nets. It adheres well to the nets, has a smooth texture, and enhance the overall strength of the coated nets. Leveraging the distinctive physical characteristics of various types of coated fishing nets, the research leads to the creative development of prototype home decoration products.

Keywords: Latex-Coated Net, Community Identity in Southern of Thailand, Interior Decoration Product Development.

Introduction

Thailand is a significant global hub for the natural rubber industry, with both fresh latex and rubber sheets being major products (Oktora and Firdani, 2019; Simon et al., 2022). When processed, latex transitions from a liquid state to a solid form, presenting itself as a translucent, yellowish material with excellent physical properties such as high tensile strength, elasticity, and tear resistance at high and low temperatures (He et al., 2023). These attributes make natural rubber well-suited for producing various products, including automotive tires, medical equipment, footwear, and sports equipment.

The increasing demand for natural rubber within Thailand and globally has led to a significant push to form community enterprises among rubber growers in the southern region of Thailand, focusing on value-added applications of natural rubber within their communities. These enterprises leverage product design technologies and material science knowledge. For instance, they have created rubber pillows and coated raw yarn with natural rubber for water resistance (Kawkamsue and Kritsanaphan, 2022). However, community enterprises have faced challenges, such as high competition rates and limited target consumer groups, which have prompted them to explore ways to diversify their product offerings and add uniqueness to their locally made products. Some community enterprises have integrated the distinctive cultural elements of southern Thailand's batik craftsmanship into product designs, blending art with product design that connects with culture and traditions. Some have applied a mixture of natural rubber and dyes to create patterns on products to create unique and eco-friendly products (Kawkamsue and Kritsanaphan, 2022).

This study has investigated the technique of transforming rubber latex into a pond coated with latex rubber from community enterprises. It is observed that the main materials used in creating the pond coated with latex rubber are raw yarn and para-rubber latex. As the cost of raw yarn is approximately 35 – 80 Thai Baht per square meter, posing a high production cost, researchers and community enterprises have explored the use of leftover materials in the southern region of Thailand, such as leftover fishing nets, which exceed 640,000 tons annually. These materials support the Net Free Seas group, aiming to address the issue of ghost gear by recycling it into various products and sustainably solving the ghost gear problem in the seas around Thailand (The Environmental Justice Foundation (EJF), 2022). The selling price of leftover fishing nets is based on weight, ranging from 2 – 30 Thai Baht per kilogram, depending on their conditions. Apart from cost reduction to replace raw yarn, the use of leftover fishing nets also increases the strength of sheets coated with para rubber, adding value to leftover materials in the region. This serves as an example for communities in the southern region of Thailand or other areas with para rubber and leftover fishing nets, illustrating a strategy for creating added value by blending cultural identity and traditions with sustainable practices, contributing to global environmental conservation.

Nowadays, the utilization of cultural identities and traditions in product design is widespread, especially in creating added value and distinctiveness (Hiranteeyakul and Thungsaku, 2022; Yang, 2022). Current craftsmanship designs draw inspiration from various cultural elements, and their distinctiveness has become a significant selling point for handicrafts and product designs (Arumdee and Joneurairatana, 2022). The cultural heritage embedded in craftsmanship and design is a crucial part that reflects the culture and traditions of a particular region (Sugiyanto et al., 2023). Understanding artistic components allows for the selection of suitable materials and techniques to convey meaning to others (Yang et al., 2018; Duan et al., 2023; Suksikarn and Suksikarn, 2023). In the years 2020-2021, a study on consumer behaviors and trends during the COVID-19 pandemic revealed an increase in online shopping for consumer and home decor products. This shift in behavior was driven by consumers' emphasis on organizing and decorating their indoor spaces to make them more comfortable and suitable for both work and leisure (Morika and Ratum, 2021).

Building upon this context and recognizing its significance, this study emphasizes the design of home decoration products that authentically reflect the cultural heritage and traditions of Thailand's southern region, as shown in Fig. 1. The study aims to explore the cultural elements of traditional customs, including patterns, colors, and materials. Moreover, this study

seeks to explore product design approaches that blend traditional culture with a contemporary vintage style, allowing the application of this knowledge to create diverse and innovative designs that incorporate local culture into contemporary products (Halim et al. 2023). It provides new knowledge for community enterprise groups to transform latex into value-added products that can be exported worldwide. Its focus is on using local materials, latex, and materials causing marine pollution, such as microplastics, to create products in a new design under the principles of circular economy (reduce, reuse, recycle) for sustainable resource management. The objectives of this study are summarized as follows:

1. To study and develop leftover fishing nets to substitute raw yarn-coated para rubber sheets, aiming to create added value for leftover materials alongside para rubber in the southern region of Thailand, contributing to global environmental conservation.
2. To study local identities to apply in designing patterns on home decoration products made from recycled fishing nets coated with para rubber, such as tablecloths, dish mats, seat cushions, room dividers, lamps and accessories.

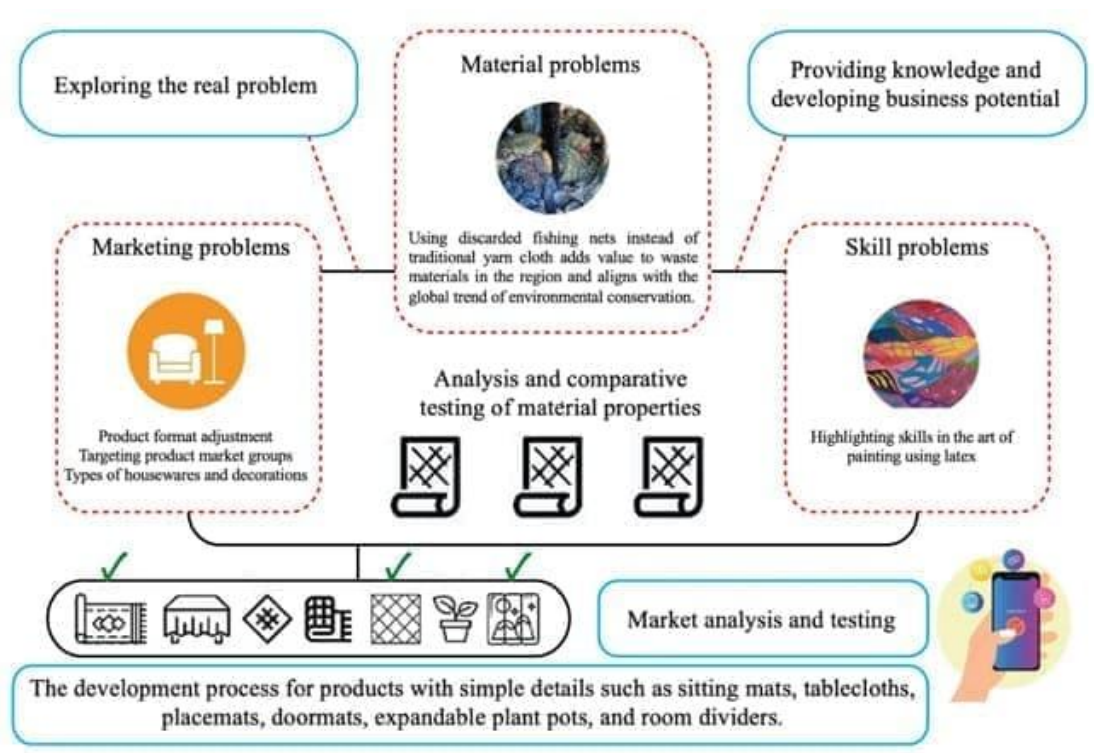


Fig. 1: Research workflow for designing and developing home decor products made from leftover fishing nets coated with natural latex.

Source: Author

Theoretical Framework

The framework used in this article aligns with the concept of creating product value from local identity. The use of distinctive local elements and ideas is crucial to preserving cultural identity and traditions (Kotradyova, 2019). This study incorporates the examination of artistic components and the application of local identity in design work (Srisopha, 2010), blending contemporary design concepts that prioritize environmental friendliness. It also explores the utilization of discarded materials to create new commercially viable products (Andrés et al., 2022).

Upcycled: The Way of Sustainability

Currently, upcycling is widely discussed in various fields, not limited to environmental concerns. Upcycling is a sustainable product design approach related to transforming waste

materials into new, valuable, and higher-quality products (McDonough and Braungart, 2022). It is a significant process for achieving a circular economy that requires redesigning product design, consumption, and waste management (Reichard and Martin, 2023). Upcycling differs from recycling because, after the process, the upcycled product is not the same as the original one (Hanna, 2022).

The upcycling process involves five thinking stages: empathize, define, ideate, prototype, and test (Parung and Enantiomery, 2022). This process integrates people, knowledge, ideas, needs, creativity, etc., resulting in unique products. The goal of upcycling is to study the potential of discarded materials and create new products using creative methods to transform waste into functional and aesthetically pleasing objects. Various upcycling studies in different design fields, such as furniture design (Ahmad et al., 2020), fashion design (Chen, 2020), and material development-focused design (Gumulya, 2019), emphasize techniques and methods like patchwork, bleaching and dyeing, and unthreading. These studies present possibilities for sustainable product design, prolonging material lifespan, reducing waste, and promoting resource potential. Additionally, by blending upcycling with product design, designers can contribute to environmental conservation and boost the circular economy (Andrés et al., 2022).

Therefore, upcycling or upcycled processes serve as crucial tools in design, enabling the development of environmentally friendly brands and products. This approach considers social and environmental responsibility (Paras et al., 2023). In Thailand, discarded materials are creatively used to produce environmentally friendly products. For example, the brand Saxtex creates fashion bags by coating old rice bags with para rubber, resulting in unique patterns, colors, and textures. Another brand, Mat Archer, retrieves old fishing nets and truck tires to incorporate them into their RETRIEVE bag series, demonstrating the upcycling process to add value to marine waste, creating interesting and innovative designs.

Ideas of Identity

Identity is a distinctive characteristic that serves as an indicator of the unique features of an individual, society, community, ethnicity, language, local culture, and religion (Friese, 2002). Community identity refers to the roots or social-cultural heritage, including customs, traditions, and culture, that have been molded and used to hold collective wisdom. It encompasses distinctive or differentiating aspects from norms, customs, and cultures in other societies, making it a unique characteristic of a community (Supriyatno et al., 2023).

According to Hall and Gay (1996), the definition of identity implies that identity is not inherent or naturally occurring but is established by culture at a specific period. It involves linking and integrating culture with society (social construct) and is not a static concept; rather, it is in constant motion and part of what is called the "circuit of culture," as shown in Fig. 2.

Panichsamai and Krutasaen (2018) say that the circuit of culture is never static, and is continuously moving with society without a fixed state. It evolves within a cultural period, being controlled, consumed, and producing cultural outcomes through various meanings. The circuit of culture can be utilized to create identity by representing local characteristics that indicate one's identity and unique significance. Examples include provincial emblems, various symbols, cultural practices and traditions, beliefs, occupations, regional attire, language, and distinctive local foods that are different and stand out from others.

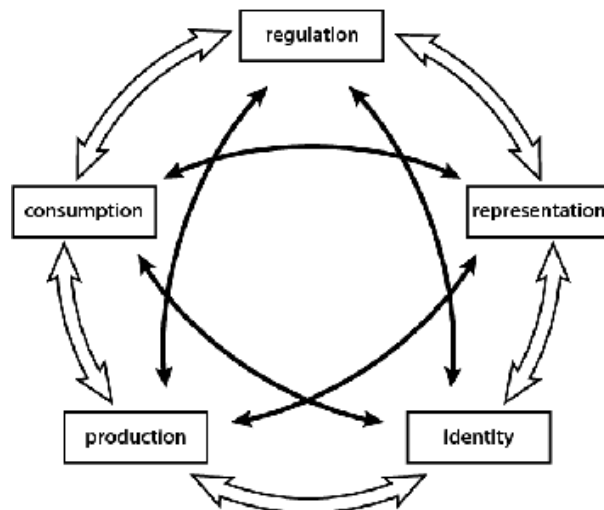


Fig. 2: The circuit of culture examines five key processes in the development cycle of an artifact, including production, consumption, regulation, representation, and identity.

Source: Schmidt, 2016

Imsamraan et al. (2021) emphasize that incorporating identity into design should consider psychological feelings and impacts, beliefs, and various prohibitions, aligning with the suggestions in the study of identity in design by Abidin et al. (2016). The latter recommended studying culture, ethnicity, cultural heritage, and cultural legacies to authentically represent the unique characteristics of a group of people.

In summary, according to various scholars, local identity refers to something created by humans through a continuous social process that is ever-present. It is a consciousness, opinion, and feeling regarding the local environment, possessing unique and distinctive characteristics. This concept involves a continuous process of creation and transmission across generations.

Therefore, the concept of identity plays a crucial role in product design, as it indicates the value and relationship of products with the target users, establishing a connection to the local context. This is essential for creating an identity in design. Additionally, blending traditional cultural elements and values with contemporary industrial design can lead to stronger relationships with users and evoke a sense of identity (Zdravkova, 2021). In the era of globalization, maintaining and utilizing local identity in design is challenging. Designers must access research in fields such as ethnology, anthropology, culture, history, and archaeology to understand and respect local identity. Preserving local identity is essential for social and cultural sustainability, allowing designers to incorporate it appropriately into their designs (Moalosi et al., 2010).

Chartsart: Traditions and Expressions in Objects

The Chartsart procession is a part of the Festival of the Tenth Lunar Month for the residents of Thung Yai district, Nakhon Si Thammarat province (see Fig. 3). This ceremony involves the preparation of Chartsart and necessary items before the day of receiving the deceased. The distinctive feature of the Tenth Lunar Month for the residents of Thung Yai district is the "trapping Chartsart (trapping materials)". This activity takes place from the 1st to the 14th night of the 10th lunar month, just before sending off the deceased to the ancestral realm. It is a collaborative activity within the village where people join together harmoniously to create the most beautiful and valuable Chartsart. This signifies the relationship between the living and the deceased, transmitted through the "preta" symbol, representing the characteristics of individuals who behaved admirably, and the Chartsart symbolizing the bond of love and respect between the descendants in Thung Yai district, Nakhon Si Thammarat province (Ruengmak, 2019).

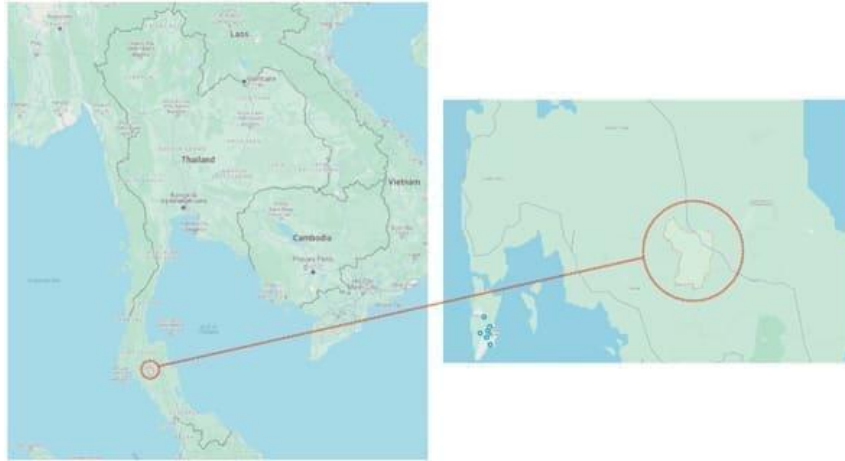


Fig. 3: Location of Thung Yai District, Nakhon Si Thammarat Province
Source: Author

The vibrancy of the festival of the Tenth Lunar Month is the presentation of offerings at the temple with meticulous beauty. The exquisite offerings from the residents of Thung Yai district, Nakhon Si Thammarat province, are known as "Chartsart" or the arrangement of Chartsart. This community-driven activity is organized using simple, locally sourced materials. The framework is constructed with lightweight materials such as bamboo or softwood, adorned with colorfully patterned paper strips interwoven with each other. Artificial flowers add a delightful touch. In addition to creating aesthetically pleasing Chartsart arrangements, colorful and beautiful pastries and various items are placed inside, carrying significant meanings related to the religious traditions of the people in Thung Yai district. Each Chartsart resembles a "house," adorned with vibrant and diverse colors, symbolizing the belief that departed spirits residing in the afterlife are in a place filled with darkness and suffering. The creation of Chartsart, resembling homes, is believed to bring comfort and joy to the spirits during the 15 days. The lively colors aim to create a serene and joyful atmosphere for the spirits to experience when in contact with the sincere intentions of their descendants, as depicted in Fig. 4.



Fig. 4: The Chartsart procession and artistic composition of the tenth lunar month offerings.
Source: Author

The intricate patterns on the Chartsart are filled with local cultural elements, such as shadow play and Manohra. The people of Thung Yai believe that by carving these patterns, their ancestors will appreciate and immerse themselves in the local culture, relieving stress and peacefully coexisting with their descendants for the entire 15-day period. It is noteworthy that the Chartsart of Thung Yai has a distinctive feature: being adorned with silver, offerings, and various ornaments on every layer, enhancing the beauty and value of each section of the Chartsart.

Literature Review

Researchers have explored various research topics addressing similar issues, such as the development of products from leftover fishing nets, the creation of value-added products from rubber latex, and utilizing local identities in the design of decorative products.

In the context of developing products from leftover fishing nets, Charter and Carruthers (2022) have designed a wide range of new products and services from waste, expired fishing nets, and fishing equipment. These include items like glasses, bracelets, rings, bags, mask chains, dog leashes, camera accessories, keychains, anklets, bicycle accessories, bird feeders, socks, travel bags, swimsuits, shoes, carpets, blankets, baskets, chairs, and hangers. Additionally, they have transformed materials into filaments and pellets for manufacturing purposes. Andrés et al. (2022) have created a business model from leftover fishing nets, resulting in products such as backpacks, winter jackets, and sunglasses. Furthermore, CleanTech in Denmark has developed recycling technology to convert used sea equipment, like fishing nets, into plastic and steel products (Storm, 2015). These examples illustrate the potential for transforming leftover fishing nets into new and environmentally valuable products.

Additionally, studies have examined the use of rubber latex to coat discarded materials. For example, Chukhin (2022) has creatively transformed used rice bags by blending them with rubber latex, resulting in fashionable products featuring unique patterns, colors, and textures, such as clothing, bags, shoes, surf skateboards, fabric bags, and various eco-friendly items. Kawkamsue and Kritsanaphan (2022) have applied rubber latex coating techniques to create expandable plant pots while also incorporating traditional cultural patterns into the design. Furthermore, researchers have explored the incorporation of cultural identities and traditions into product design. For instance, Zdravkova (2021) has studied the influence of culture and customs in creating products that reflect the cultural identity of Macedonia, using traditional elements in contemporary designs. Cheng and Shanat (2020) have emphasized the importance of understanding and applying cultural images and symbols in designing new products to create lively and sustainable works. This approach aims to preserve and promote cultural values internationally, contributing to societal and cultural sustainability (Kotradyová et al., 2019).

Moreover, studies in various regions of Thailand have incorporated cultural identities into product design. In Northern Thailand, Burapajatana (2016) has utilized the distinctive patterns of the "Mae Chaem Ten Jok" silk fabric to develop modern cultural home decor items, including stools, cushions, lamps, wall art, and mobiles. Similarly, Chemsripong and Petmee (2017) have reinterpreted traditional Thai fabric patterns from the Phu Phak Sai community into new designs, such as pillows, sofas with built-in iPads, and logos for new products. Pijukkana and Pijukkana (2021) have focused on developing furniture from handwoven "Ten Jok" fabric, blending Northern Thai cultural heritage with contemporary design trends for both local and global markets.

In the northeastern region of Thailand, Sowaphak and Simhong (2022) have incorporated the cultural identity of the Tharaprassat South Village community in Nakhon Ratchasima province into contemporary product designs. This includes archaeological artifacts, antiques, rituals, lifestyles, and local wisdom. They have created modern and culturally relevant products that cater to online markets and remain relevant today. Putri et al. (2023) have transformed patterns from the cultural heritage of Maha Sarakham Province, Mukdahan Province, and Nakhon Phanom Province, where weaving of Phraewa fabric and bamboo basketry are prominent, into the design of lamps. Such a study suggests that cultural fusion should consider developing representative products that showcase the diversity of cultures. Similarly, Cheuypoung (2023) has blended traditional weaving patterns and contemporary designs inspired by the simplicity of local flowers in the Sisaket province using the art nouveau technique, resulting in modern designs suitable for young people. An outstanding feature in the northeastern region is the Naga fireballs. Chaiprasert and Chotiratanapinun (2020) have studied and analyzed its compositions (e.g., point, line, plane, volume, shape, size, form, free space, color, and tactile surface) to design decorating homes for Western tourists in Bangkok.

In the central region of Thailand, Wanichakorn (2018) has integrated Thai architectural contexts from tourist destinations around Rattanakosin Island, such as the iconic landmarks of

Wat Phra Si Rattana Satsadaram (Wat Phra Kaew) and the Golden Mount (Wat Sra Ket Ratchaworamahawihan). These were used as inspiration for designing products for use and decoration on worktables, utilizing lead-free Nielloware. In contrast, Siripithalul et al. (2018) have used patterns from the weaving traditions of Thai Phuan fabric, representing Nakhon Nayok and Sukhothai provinces, to design furniture and home decor products, incorporating contemporary Thai art to enhance product uniqueness. Similarly, Cherdchoo (2020) has utilized the identity of the Thai Yuan ethnic group in the Ton Tan sub-district, Sao Hai district, Saraburi province, by extracting patterns and colors from local flowers. This approach helped in developing products that meet the lifestyle needs of tourists.

In the eastern region of Thailand, Prachong and Kanpai (2023) have incorporated local wisdom related to the weaving of Chanthaburi silk into unique patterns and colors, creating distinctive decorative products for homes. The study suggested that the government should assist in finding markets and promoting the integration of local identities into region-specific products.

Moving to the western region of Thailand, Phriwanrat (2023) has utilized patterns from the interior of the Vihara pavilion of Wat Yai Suwannaram, a significant landmark in Phetchaburi province, to design modular products for home decoration. These products include curtains, lamps, room dividers, and coasters.

Lastly, in the southern region of Thailand, Sirirot and Jinda (2022) have surveyed the perception of identity reflecting Nakhon Si Thammarat province among 150 individuals. Prominent landmarks such as the Phra Mahathat Woramahawihan temple were identified. The study also explored consumer preferences for home decoration products, and the findings were used to develop modern-designed lamp products reflecting the identity of Nakhon Si Thammarat province. Soonsan (2021) has designed fabric tie-dye patterns based on the unique identity of the tourism community in Phu Khao Thong sub-district, Sukhirin district, Narathiwat province. This area is the birthplace of the legend of the "Phra Um Mapa," which was developed into commemorative items for daily use. Wanichakorn (2014) has also emphasized the diversity of tangible and intangible Thai identity components, such as lines, shapes, and forms, that can be transformed and developed into contemporary products. These transformations add value and promote a sense of cultural well-being for users.

Research Methodology

This study employed a practical experimental approach to gain an in-depth understanding of the hands-on processes and to impart theoretical knowledge to the community of artisans. This approach focused on the potential of community enterprises in the southern region of Thailand to sustainably design handmade products and utilize locally available materials (Suksikarn and Suksikarn, 2021). The research aimed to utilize the desirable properties of latex to coat leftover fishing nets and design distinctive household decorative products that convey the skills, artistry, and culture of the southern region.

Based on the study on the properties of latex, the research had two main conceptual approaches. The first concept was coating locally available materials with latex to enhance their strength and durability. The second concept was creating small rubber units that could be assembled into larger three-dimensional shapes. Fig. 5 illustrates the process of designing and developing home decoration products from leftover fishing nets coated with latex, showcasing a product aesthetic that mirrors the cultural identity of communities in southern Thailand.

Preparation of Leftover Fishing Nets

The leftover fishing nets used in the study had characteristics of damage or deterioration from fishing activities. They were collected along the shores of the Gulf of Thailand. These leftover fishing nets were classified into seven types, including blue nylon net, krill net, minnow net, circle trawl, green net, bird trap net, and sea bass net. The mesh sizes of these nets ranged from 10.0 to 45.0 mm, depending on the types and sizes of animals they were intended to catch. Subsequently, trim the remaining 7 types of fishing net sheets to a specific width of 2.5 centimeters and a length of 10.0 centimeters (2.5 cm wide × 10.0 cm length).

Properties of Leftover Fishing Nets

This research examines leftover fishing nets in the fishing area of Tha Sala District, Nakhon Si Thammarat province. Samples of leftover fishing nets of seven different types were collected for a study of their physical properties (Chanrajakit, 2023). The summarized details for all seven types are as follows: (1) the blue nylon net, size 16 (1-inch mesh with 16 strands), discarded from fish farming cages, had a thread diameter of $\text{Ø}0.265 \pm 0.005$ mm and exhibited a high ultimate tensile strength. (2) the krill net, discarded from krill fishing activities, had a thread diameter of $\text{Ø}0.752 \pm 0.003$ mm and showed a high ultimate tensile strength. (3) the minnow net, abandoned from sea fishing, had a thread diameter of $\text{Ø}0.704 \pm 0.003$ mm and demonstrated a low ultimate tensile strength. (4) the circle trawl, left over from sea animal encircling, had a thread diameter of $\text{Ø}0.350 \pm 0.003$ mm with a low ultimate tensile strength. (5) The green net, discarded from sea animal capture, had a thread diameter of $\text{Ø}1.332 \pm 0.003$ mm and showed a moderate ultimate tensile strength. (6) the bird trap net, discarded from sea animal capture, had a thread diameter of $\text{Ø}0.963 \pm 0.003$ mm and exhibited the highest ultimate tensile strength. (7) The sea bass net, left over from sea bass fishing, had a thread diameter of $\text{Ø}1.498 \pm 0.003$ mm and demonstrated a moderate ultimate tensile strength.

It is important to note that the ultimate tensile strength varies depending on the condition and age of the abandoned fishing nets.

Preparation of Latex for Coating Leftover Fishing Nets

Formula F1 A was modified to prepare latex for coating leftover fishing nets (Kawkamsue and Kritsanaphan, 2022). This formula was used for coating raw fabric for building fish or aquatic animal ponds (Nakason et al., 2007). The latex and chemicals were weighed as specified in the formula shown in Table 1. The mixing of these components began by mixing potassium hydroxide and potassium laurate for about 5 min, followed by adding stearic acid and stirring for approximately 10 min to ensure a homogeneous mixture. Subsequently, calcium carbonate, ZDEC, Wingstay L, zinc oxide, sulfur, and titanium oxide were added in sequence. Then, the latex compound was cured for 24 h.

Table 1: Formula for latex-coated leftover fishing net sheets.

Source: Author

Compositions	Concentration (%)	Weight (g)	
		Dry weight	Wet weight
Latex	60%	100.00	167.00
Potassium hydroxide	10%	0.50	5.00
Potassium laurate	20%	0.50	2.50
Sulfur	50%	1.00	2.00
ZDEC	50%	1.75	3.50
Wingstay L	50%	1.50	3.00
Calcium carbonate	75%	20.00	33.40
Zinc oxide	50%	1.50	3.00
Titanium oxide	50%	5.00	8.35
Total weight (g)		131.75	227.75

Research Methodology

Study of physical properties of leftover fishing nets coated with latex

Forming fishing nets coated with latex

To form latex-coated net sheets, leftover fishing nets were stretched onto aluminum sheets. Subsequently, the latex compound cured for 24 hours was dropped onto the fishing nets in the first coating round, and a rubber brush was used to spread the latex compound throughout the sheet carefully so as not to create air bubbles. After the first coat of latex was dried, the latex compound was painted onto the fishing net layer by layer and waited until it dried. This process was repeated approximately 3–5 times, depending on the thickness of the fishing net and its dimensions (90.0–120.0 cm in width and up to 400.0 cm in length). Afterward, the

coated fishing net sheets were dried in the air in a well-ventilated area. When the leftover fishing nets coated with the latex compound changed from milky white to light brown, the fishing nets were peeled from the aluminum sheets to be tested for their physical properties.

Testing the Physical Properties and Performance of Leftover Fishing Nets Coated with Latex

All seven types of leftover fishing net sheets were cut to the same size (2.5 cm wide × 10.0 cm length). They were then coated with compounded latex. After that, their physical properties were tested to determine their tensile strength and stress.

The tensile strength and stress were determined following the ASTM D412-80 standard testing method. Compounded rubber sheets were cut into specimens using a test-cutting machine designed for tensile strength testing. The specimens were angular in shape. Their thicknesses were measured at three different positions, and the average thicknesses were used for calculating the tensile strength. The testing was conducted using a tensile testing machine at a rate of 500 mm/min, and the tensile strength (T) was calculated using the following equation:

$$T_s = F/t$$

T_s is the tensile strength (kN/m), F is the tensile force that causes the specimen to break (N), and t is the thickness of the specimen (mm).

Three specimens were used for testing, and the results were reported using the average value. If any experimental results deviate from the aforementioned value by more than 20%, two specimens are additionally tested, and the average value of all five specimens will be used to report the results.

Design thinking in prototype product development

The design concept in this study involves incorporating the artistic components of Chartsart for the Tenth Lunar Month into a gradation pattern painting style. It emphasizes a free-form approach while considering the practicality of product usage along with the product requirements for home decor. Additionally, the design considers the target group, linking it to purchase decision trends and ensuring product satisfaction in terms of design.

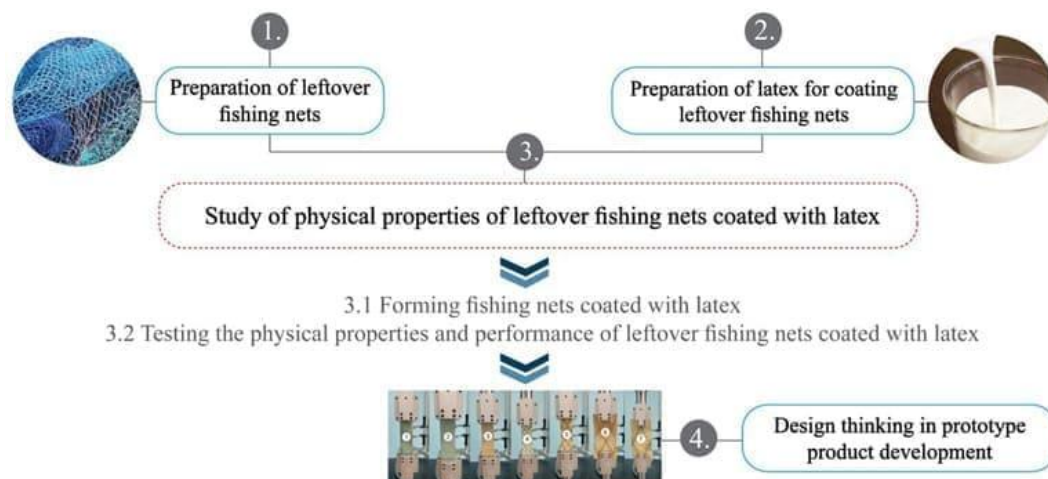


Fig. 5: The flowchart showing the process of designing and developing home decoration products using leftover fishing nets coated with latex.

Source: Author

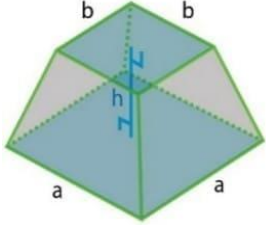
Findings

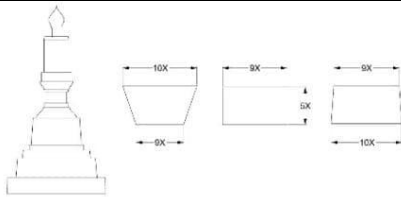
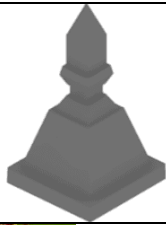
Design process of prototype for home decoration products made from leftover fishing nets coated with latex

The product designs were based on the identity extraction of coexistence between communities and local resources. Chartsart's identities were used to serve as a guideline for design, incorporating the principles of composition analysis. The analyzed compositions included point, line, plane, volume, shape, size, form, free space, color, and tactile surface. Chartsart is a part of the culture and tradition of the people in Nakhon Si Thammarat province, Thailand (Ruengmak, 2019). It is a symbol of the loving and respectful attachment of descendants to their deceased ancestors. The use of Chartsart as a guiding principle in the design process, which involves applying the principles of composition and combining them harmoniously to achieve perfect suitability, results in the highest value of the artwork. The compositions can be divided into two categories: conceptual elements and visual elements. Conceptual elements comprise point, line, plane, and volume. Visual elements encompass shape, size, form, free space, color, and tactile surfaces. These component analyses serve as the foundation for designing the shape, form, pattern, color, and tactile surface of the products made from leftover fishing nets coated with rubber, comprising five distinct designs as detailed in Table 2. (Chaiprasert and Chotiratanapinun, 2020).

Table 2: Chartsart's identities with art elements

Source: Author

Composition	Illustration	Analysis of Chartsart's identities
Point		Continuous points are employed to create the appearance of lines to decorate empty space, creating horizontal or diagonal connecting points along the empty space.
Line		The lines have square corners rather than rounded curves used to make segmentation clearer.
Plane		There are vertical planes for the most part, with the lower base being a vertical plane. Next, there will begin to be an inclined plane on all four sides so that they terminate at the apex.
Volume		The volume of a Chartsart is formed by combining the planes of its four sides. The volume will be the volume of a tetrahedron, with the base mostly being a square-based pyramid. It can be calculated in parts using the formula: $\frac{1}{3}(a^2+ab+b^2)h$
Shape		The shape of the pattern is a combination of natural shape and free shape, arranged together on each side to be balanced.

Composition	Illustration	Analysis of Chartsart's identities
Size		The actual size of the Chartsart is not fixed. Its size depends on the wealth of the Chartsart maker. The width and length of the base are in the range of 80–150 centimeters. The height is in the range of 120–250.
Form		A square-based pyramid has a base similar to a pagoda or stupa. It is symmetrical in all respects and has a denser base than the top. All its planes tilt towards the apex.
Free space		The free space in the shape is the space between the main structure and the side tiers. If the principle of contrast shape is applied, the gaps in the shape will become clearer.
Color		The vibrant and varied colors or the striking colors of the Chartsart are created from the stencil of paper decoration on the Chartsart itself as well as the colors of the utensils and dessert.
Tactile surface		The tactile texture of the shapes can be perceived through sight, touch, and light reflection. The tactile surface is smooth, with occasional subtle raised patterns and repeating designs. The edges and borders of the Chartsart are designed to provide a light and comfortable feel. Chartsart does not have a rough surface that would create a feeling of fear. However, it has sharp edges that make it unpleasant to the touch.

Development of Techniques for Painting Under Patterns

In the process of painting patterns, the researchers provided guidelines for a color gradient technique. The emphasis was placed on naturalness, not fixing colors. The creators could choose to drop colors as needed, but within the framework of the overall work and the pattern of the nets, using only 1-2 color tones. The gradient patterns were divided into 4 types: (a) without painted patterns, (b) from dark to light gradient, (c) from dark to light and back to dark gradient, and (d) a centered gradient from dark to light on the sides, as shown in Fig. 6.

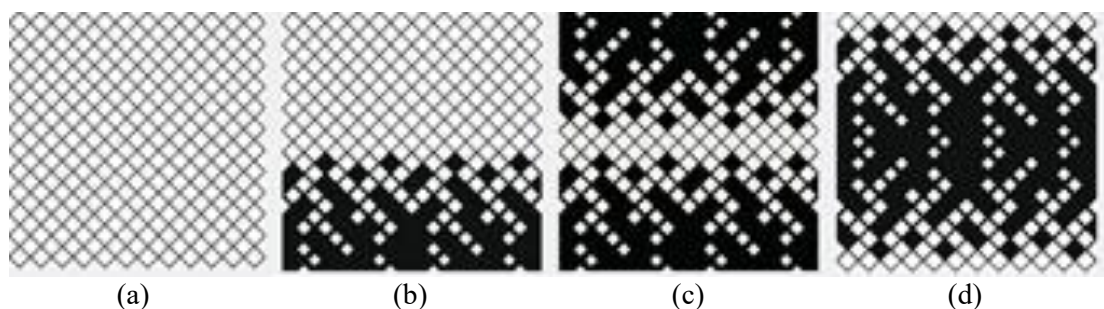


Fig. 6: Technique for painting under patterns created from leftover fishing net coated with latex
Source: Author

Design Thinking in Developing Prototype Products

Generating and summarizing design concepts in this study followed the framework of the design thinking process, combined with the use of the 5W1H design principles. It began with creating design concepts, which incorporated inspiration to shape the design ideas into another form. After that, it involved summarizing the requirements of entrepreneurs to understand the project's design direction before entering the design process, starting with drafting initial designs and selecting the design that aligned with the design concept before proceeding with the design. The design process may have multiple design options, providing entrepreneurs with choices to proceed to the development stage for the next prototypes. The details of each step are discussed in the following sections.

Defining the Product Scope

- 1) Seat cushion: Emphasis was placed on the design of the shape, pattern, and tactile surface. The product featured a free-form shape created by compressing rubber scraps into a cushion cover made from a latex-coated net sheet stitched into shape. The product dimensions were approximately 50–80 cm in width, length, and height. This design used latex-coated net type (2) (krill nets coated with latex).
- 2) Table mat: The focus was on the design of the shape and pattern. The product dimensions were approximately 60–120 cm in width and length. It can be either square or rectangular. This design utilized latex-coated net type (2), minnow nets (3), or circle trawls (4).
- 3) Plate mat: The emphasis was placed on the design of shape, pattern, and color. The product dimensions were approximately 30–50 cm in width and length. The shape can be circular, square, or rectangular. This design utilized latex-coated net type (2), minnow nets (3), or circle trawls (4).
- 4) Lampshade: The focus was on the design of the shape and pattern. The product featured a free-form shape created from a wooden structure or steel rod and used latex-coated net sheets stitched onto the frame. This shape was made by tightening (or fitting) latex-coated net sheets and then stitching them onto the frame structure. The latex-coated net sheets must have a width smaller than the frame structure, about 10–20%, to ensure a snug fit. The long sides were left hanging and cut into strips to create a pattern fluttering, resembling the Chartsart shape. The width, length, and height of the products were approximately 30–60 cm. This design utilized a latex-coated net sheet type (6), a bird trap net.
- 5) Room divider: The emphasis was placed on the design of the shape and pattern. The product featured a free-form shape created from a wooden structure or steel rod. This shape was made by tightening (or fitting) latex-coated net sheets and then stitching them onto the frame structure. The latex-coated net sheets must have a width smaller than the frame structure, about 10–20%, to ensure a snug fit. The width ranged from 50 to 80 cm, and the height ranged from 140 to 180 cm. This design employed latex-coated net sheet type (1), a blue nylon net.

Summary of Entrepreneurs' Requirements

Entrepreneurs wanted to produce products that could be made by their groups themselves without the need to outsource or buy finished products from elsewhere. They focused on marketing strategies targeting online product distribution and producing on demand. They emphasized art and craft processes suitable for community members. They sought to connect the tourism community in Thung Yai district and present the unique identity of Chartsart for the festival of the Tenth Lunar Month (Sat Duan Sip) to create value by telling the story of the community, producing within the community, and linking with community projects.

Results

The formula for preparing latex for coating leftover fishing nets was modified from formula F1A (Kawkamsue and Kritsanaphan, 2022) with the addition of zinc oxide and calcium carbonate to enhance the adhesive properties of the rubber as well as the stability and durability of the coated material (Raha and Ahmaruzzaman, 2022; Theptong, 2007). According to the results of testing the properties of the seven types of latex-coated leftover fishing net sheets using the ASTM D412 standard test method, as shown in Table 3, the ultimate tensile strength of the latex-coated bird trap net sheet (6) exhibited the highest value of 56.05 N. Following behind, there were three types of latex-coated leftover fishing net sheets with close values, which were the latex-coated blue nylon net sheet (1), latex-coated krill net sheet (2), and latex-coated green net sheet (5), with values of 22.68, 21.75, and 20.66 N, respectively. As for the latex-coated circle trawl net sheet (4), it had an ultimate tensile strength of 5.67 N.

Regarding the stress, the latex-coated krill net sheet (2) exhibited the highest maximum stress of 0.56 MPa, followed by the latex-coated green net sheet (5) with a maximum stress of 0.38 MPa and the latex-coated circle trawl net sheet (4) with a maximum stress of 0.37 MPa. The latex-coated bird trap net sheet (6) had a maximum stress of 0.05 MPa.

Table 3: Results of ultimate tensile strength and maximum stress testing using ASTM D412 standard test method for the seven types of rubber latex-coated leftover fishing net sheets

Source: Rubber Technology Transfer Center for the Community, Faculty of Engineering, Thaksin University in Phatthalung Campus, Thailand. No.CRTC-RP-TC026/2565

Test method	Measurement unit	Types of leftover nets coated with rubber						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ultimate tensile strength	N	22.68	21.75	10.20	5.67	20.66	56.05	18.24
Maximum stress	MPa	0.15	0.56	0.29	0.37	0.38	0.05	0.25

Note: (1), blue nylon net; (2), krill net; (3), minnow net; (4) circle trawl; (5), green net; (6) bird trap net; (7) sea bass net.

According to the literature review and preliminary data analysis regarding coating leftover fishing nets with concentrated latex, it was found that rubber composite exhibited high elasticity, a pale yellow color, resilience in temperatures ranging from -20 to -80°C, excellent electrical insulating properties, good flexibility, and resistance to tearing (Zheng et al., 2014; Lim and Sirisomboon, 2018; Burgaz, Gencoglu and Goksuzoglu, 2019; Kaliyathan et al., 2020).

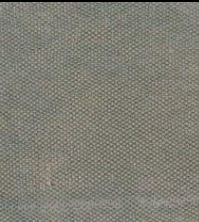
This study correlated the physical characteristics of the various types of latex-coated leftover fishing net sheets to the design concept for home decoration products, as shown in Table 4. The details are as follows:

- (1) Blue nylon net coated with latex exhibited a textured, non-smooth surface, hardness, opacity, low flexibility, and excellent tear resistance. This makes it ideal for producing products requiring structural attachment, such as room dividers.
- (2) Krill net coated with latex had a smooth texture, was soft, had high flexibility, and had good adhesion. It is suitable for crafting products that come into direct contact with skin, such as cushion covers, tablecloths, and coasters.
- (3) Minnow net coated with latex had a smooth mixed texture, was slightly soft, had good weight, adhered well, and was not slippery, making it suitable for crafting products requiring grips, such as table placemats and dish mats.
- (4) Circle trawl coated with latex had a smooth texture and was soft, highly flexible, and easy to sew, making it ideal for crafting products that come into direct contact with skin, such as cafe cushion covers, tablecloths, and coasters, as well as bags.
- (5) Green net coated with latex had a hardness, rough texture, large pores, and moderate flexibility. It is suitable for producing products requiring strength and a raw appearance.
- (6) The bird trap net coated with latex exhibited a smooth texture and excellent tear resistance and was flexible and easy to sew. It is suitable for attaching to products with important structures and varying transparency, such as lampshades.

- (7) Sea bass net coated with latex had a smooth texture and was flexible as well as fluttering. It is suitable for attaching to products with structures (e.g., room dividers) and varying transparency (e.g., lampshades).

Table 4: Physical characteristics of various types of leftover fishing nets and latex-coated leftover fishing nets

Source: Author

Types of leftover nets	Physical characteristics	Latex-coated net sheet	
		Front	Back
(1) Blue nylon net			
(2) Krill net			
(3) Minnow net			
(4) Circle trawl			
(5) Green net			
(6) Bird trap net			

Types of leftover nets	Physical characteristics	Latex-coated net sheet	
		Front	Back
(7) Sea bass net			

The development of painting techniques under patterns generated from latex-coated leftover fishing nets involved applying paint to latex-coated leftover fishing net sheets. This utilized the fishing net strands to create distinctive patterns through painting or dripping rubber latex into each mesh of the fishing net, generating the three-dimensional aspect of the fishing net patterns as if using the fishing net strands as frames to paint new patterns that have the net mesh as a frame. Moreover, the artistic skills of pattern painting by members of the community enterprise group were used. The creators of the work could choose to place the color in the desired position to create the identity of the products. According to the design process, considering the target user groups and the usability of the products, two collections of products could be designed and created, as shown in Fig. 7.

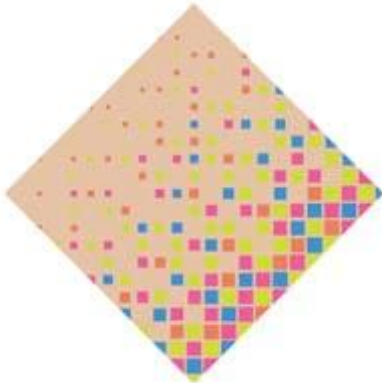
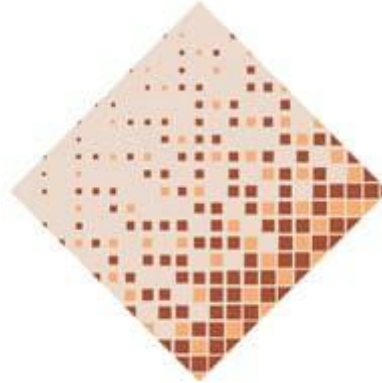
 C26 M3 Y91 K0  C7 M79 Y11 K0  C73 M37 Y5 K0	 C3 M38 Y59 K0  C27 M75 Y83 K18
 Collection 1 (graphity style)	 Collection 2 (vintage style)

Fig. 7: Determining colors and creating patterns for graphity and vintage styles.

Source: Author

Collection 1 targeted teenagers and working-age individuals residing in condominiums. The design concept blended art, craft, and vibrant graphity-style colors. It incorporated the identities of Chartsart for the Tenth Lunar Month (such as fluttering, color, recurring pattern, and geometric shape) to create products like tablecloths, coasters, seat cushions, lamps, and room dividers (see Fig. 8).

Collection 2 targeted working-age individuals and international customers. The design concept combined art, craft, and vintage-style colors. It drew from the identities of "Chartsart for the Tenth Lunar Month" to create vintage-style products such as tablecloths, coasters, seat cushions, lamps, and room dividers (see Fig. 8). The color emphasized pairing 1-2 colors with tones that blended with white and followed the same direction.



Graphity style

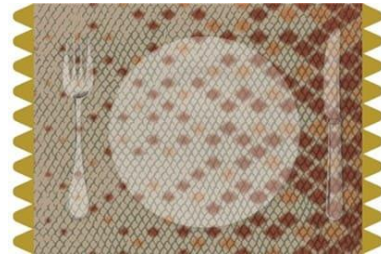


Vintage style

Tablecloths in graphity and vintage styles (width x length: 50x120-200 cm)



Graphity style



Vintage style

Placemats in graphity and vintage styles (width x length: 30x45 cm)

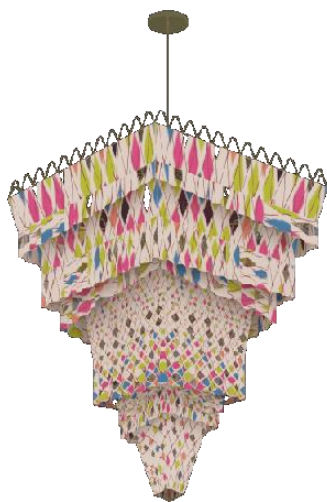


Graphity style



Vintage style

Seat cushions in graphity and vintage styles (width x length x height: 80x80x35 cm)

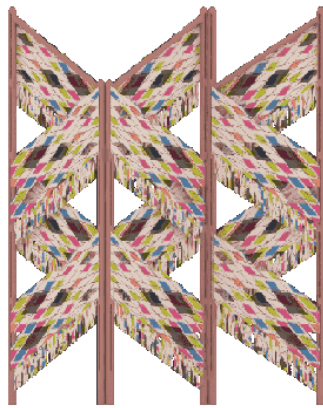


Graphity style

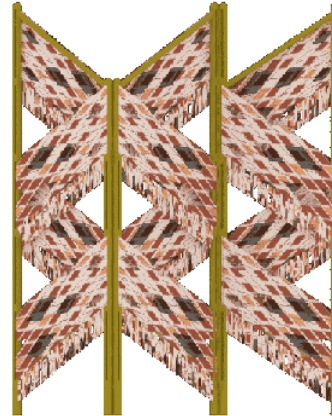


Vintage style

Lamps in graphity and vintage styles (width x length x height: 120x120x190 cm)



Graphity style



Vintage style

Room dividers in graphity and vintage styles (width/span x height: 50x175 cm)



Fig. 8: Design works and photos of prototype products

Source: Author

Conclusion

This study analyzed the design concepts of home and office decoration products reflecting the cultural traditions of southern Thailand. The analysis focused on product attributes such as shape, form, size, material, and color. The product shapes were analyzed in various forms, incorporating the concepts of tangible and intangible design, inspired by symbols of belief to create products that are attractive, aesthetically pleasing, and unique to capture the consumer's attention. The study applied latex for coating leftover fishing nets, which was adapted from the F1 A formula. The results showed that leftover fishing nets coated with latex exhibited a smooth surface without excessive shine, stability, and high durability. However, this research identified some challenges and obstacles. It was observed that certain types of latex-coated fishing net sheets, such as the minnow net sheet and the green net sheet, had a rough texture that could potentially cause irritation when in contact with skin. Therefore, there is a need to improve the texture of these sheets. To address this issue and create a smoother surface, the fishing net sheets should be rolled after being coated with rubber, utilizing a rubber sheet extruder, before being transformed into various types of home decoration products. Additionally, the strong odor of rubber could be a potential drawback, hindering its use in the production of home decoration items. It is recommended to develop a formula for odorless latex with excellent properties suitable for coating various materials.

To ensure the sustainability and ongoing benefits of this study, it is crucial to initiate a Phase II research project focusing on studying the target consumer group, product distribution channels, and buyer satisfaction. This initiative has the potential to diversify into various types of handicraft products by coating waste fishing nets with rubber, thereby reducing marine waste and enhancing the value of latex for future commercialization as an exportable product.

In this regard, incorporating cultural identity into future design concepts requires considering the emotions and psychological impacts, beliefs, and various taboos that may influence the utilization of such designs. It is essential to study and investigate these aspects from stakeholders. The researchers suggest extending the traditional identity to create awareness and promote local culture through products that serve as cultural reminders, making them more widely recognized.

Acknowledgments

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