

The Design and Development of Community Textile Products from Banana Fiber Blends as Commercial Prototypes

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Abstract

This research is predicated on the imperative to enhance the economic value of indigenous materials, specifically banana fiber, through the integration and development of community-based textile products with potential for commercial scalability. The objective of this research was to develop community textile products from banana fiber blends as commercial prototypes. The creation was divided into two parts: the creation of textile designs and the development of textile product prototypes from the needs of 400 working-age consumers aged between 25 and 45 years. The findings revealed that the yarn blend with banana fiber using a blend ratio of cotton, banana fiber, and Eri silk (70:20:10), spun in OE Spinning, yarn size 10/1, when used to create woven fabric patterns using the Kite technique resulted in new designs inspired by parts of a banana tree, which included designs based on banana blossom tops, banana fibrous layers, and banana blossoms. These developed designs could be applied to create textile fabrics with other techniques at the community level. When the developed textile was made into 10 daily wearable prototypes, the acceptance of the products by the consumers was at a good level. The overall mean acceptance score of 4.70, which was higher than the predetermined criterion of 4.00. Therefore, developing a prototype community textile product from banana fiber blend to commercial scale is the new body of knowledge that the community can use, develop, and expand its textile product in the future.

Keywords: Banana fiber, Products from banana fiber, Commercial textile prototypes, Hand woven fabric, Development of community textile

Introduction

The consumption of textiles and clothing has currently become fashionable rather than utility for body covering. The needs of textile products of consumers, both in quantity and in style, have changed rapidly, resulting in the expansion of the textile industry to meet the increasing demand of both domestic and global consumers (Sarkar, 2015). Fibers for producing textiles and clothing are synthetic and natural, and cotton is a globally popular natural fiber due to its good quality for cooling and sweat absorption. In Thailand, nevertheless, cotton fiber is insufficient in quantity for textile and clothing production and the import of cotton fiber could cost US\$ 113.7 million (Thai Textile Institute, 2024). This problem has been partly due to a lack of serious promotion to grow cotton from the state sector. Thus, studies and investigations about natural fibers from other plants as a substitute are interesting, especially from those with abundant fibers and locally available materials like banana fibers.

Abaca (*Musa textilis*) is also known as Manila hemp. It is a member of the Musaceae (banana) family of plants (Franch, 2005). Banana is a type of herbaceous plant in Asia. It is easy to cultivate, grows well, and provides good yields. In 2022, the banana export from Thailand ranked 20 in the world with a cultivation area of approximately 418,639 rai and an export of 1,075,251 tons per year. (TNN Online, 2023) Banana is therefore a promising prospect for the development of agro-based fibers. Normally, banana trunks after harvest are cut down without being exploited for other benefits. In fact, the trunks can be used to produce natural fibers. The part for fiber segregation is the pseudo-stem of the banana plant, which is a waste. Banana fibers are natural plant fibers derived from waste and they are biodegradable, ecologically friendly, sustainable, renewable, and natural plant fiber extracted from agricultural waste (Unal et al., 2011). The fibers have great potential as a natural fiber among the agro-based, natural, and cellulosic fibers (Pappu et al., 2015). Banana fibers are shiny, highly strong, tough, and durable, but coarse. Consequently, to use the fibers in textiles to produce clothing, it is imperative to blend them with other types of fibers to increase softness and reduce coarseness. The banana plant has long been an abundant source of fiber production for high-quality textiles. Banana fiber-based fabrics have been regarded as eco-friendly apparel with the potential for commercial success in the creation of job prospects in rural areas (Sodhi et al., 2012). In Thailand, commercial products based on banana fibers are few, especially textile products, due to limitations in the production process, such as labor, machinery as well as delivery of raw materials. Thus, patterns of banana fiber-based textile development have only been product prototypes proposed as a production guideline that could not be produced commercially.

Regarding textile products at the community level in Thailand, they have been developed from local wisdom of particular communities which are folk handicrafts passed down from generation to generation through analyses and syntheses from ancestral knowledge. Each community is unique in consistency with geographical conditions, raw materials, customs, traditions, and local cultures. Nowadays, there are about 40,000 textile entrepreneurs registered with OTOP (Community Development Department, 2024). The textile producers have encountered problems of yarn prices varying according to marketing mechanisms and it is thus difficult to control production costs. If other types of yarns could be used commercially, it would provide communities with more alternatives to use them to produce more products which could lead to the creation of community products that could be suitably applied to their contexts creatively. Consequently, it is interesting to use banana fibers to develop and create community products. Therefore, this research aims to design woven fabric patterns and develop prototypes of community textile products. This will create commercial opportunities for textile craft groups. Ultimately, the goal is to expand local knowledge and wisdom for commercial benefit.

Methodology

The development of community products from fiber blends for commercial purposes was based on banana fibers from the wild *balbisiana* variety as product prototypes. The bananas were sourced from the variety cultivated in Chiang Mai province, Thailand, where villagers primarily grew them for leaf sales. When banana trees aged and their leaves no longer sold well, they were cut down and the trunks were left to rot without being exploited for other benefits. The yarn was derived from the open-ended spinning process with a blend ratio of 70:20:10 between cotton, banana fiber, and Eri silk. The combination of banana fibers, Eri silk, and cotton was at the ratio of 20:10:70. (Reference to the appropriate banana fiber mixing ratio based on the process by Piyaporn Kampeerapappun). The size of the yarn was 10/1. The research methodology was divided into two steps as follows.

Step 1: The creation of textile designs

1. Specified the designs with the entire continuous supplementary weft technique by designing the heddles for the local looms. The designs reflected the story of the banana tree and thus were inspired from parts of a banana tree which included its fibrous layers and blossom. Using the color trends of 2022, including shades of brown, blue, and cream. The designs were created with the participation of the involved community members, textile specialists, academics, and textile entrepreneurs to share their opinions and collectively provide suggestions to develop banana fiber-based textiles consistence with consumer needs.

2. Calculated the number of heddles for weavers' knots and the results were 10 heddles for the first design, fibrous layer design; 16 heddles for the second design, banana blossom top design; and 36 heddles for the third design, banana blossom design.

3. Designated the designs in the form of alternate weft threads of different colors by using the tie-and-dye technique for the threads with natural dyes extracted from leftover banana fibers after having undergone the segregation process (brown and indigo). The warp threads were blended with white banana fibers with a size of 10/1. Two-ply thread was used for each heddle so that the threads were strong, and the fabric was thick.

Step 2: The development of the textile product prototypes

1. Surveyed the needs of consumers who were visitors at the Chiang Mai Design Week in 2021 to realize the development guidelines and product patterns consumers needed.

2. Selected a community where banana fibers would be handwoven into the fabric. The selection criteria were that the community had production potential, received a four to five-star OTOP award, and needed new materials for textile production. The purposive sampling method was applied to select one community where banana fibers were actually exploited.

3. Drafted 40 product prototypes, consisting of 20 for women's clothing and 20 for men's clothing.

4. Selected the 10 prototypes by community representatives, cloth designers, and the researcher to collectively find out and define directions of the products suitable for consumers, so that they would be further produced commercially.

5. Cut and tailored the selected prototypes and improved them to suit commercial production.

6. Exhibited the finished products at a product exhibition in Chiang Mai province and asked for the acceptance of the consumers. The questions focused on three product aspects, namely, design, beauty, and utility. The acceptance mean of each product must be 4.00 and over to measure and infer that the product was accepted by consumers and could be produced commercially.

Results

The development of these community textile products from banana fiber blends was based on Guilford's creation theory about flexibility, originality, and elaboration. Methods of improving fiber quality for use in various fields were not under the same principles or conventions, and the main result was that there was a new creation leading to banana fiber innovation from an environmentally friendly process so that they could be used to produce or develop creative community textile products. This undertaking was divided into two parts: woven fabric design creations and product prototype development leading to creating innovations.

Woven fabric design creation

The design creation was channeled for use with traditional looms of the community and the continuous supplementary weft technique was employed as this technique has been used in the community nowadays. The designs were inspired by parts of a banana tree: fibrous layers and blossoms. The outer frame structures of the parts were applied for the designs superimposed with the materials to derive unique and innovative shapes, as shown in the following figures.

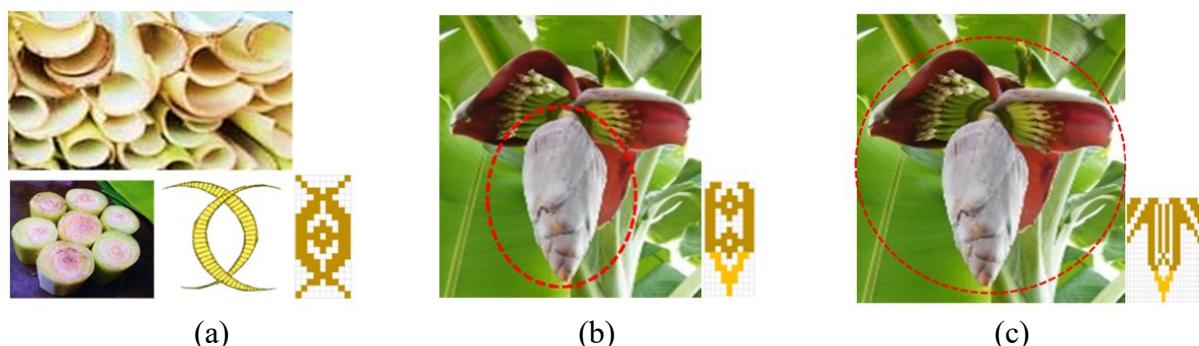


Figure 1 Inspiration for the fabric designs (a) fibrous layer (b) blossom top and (c) blossom (Researcher, 2024)

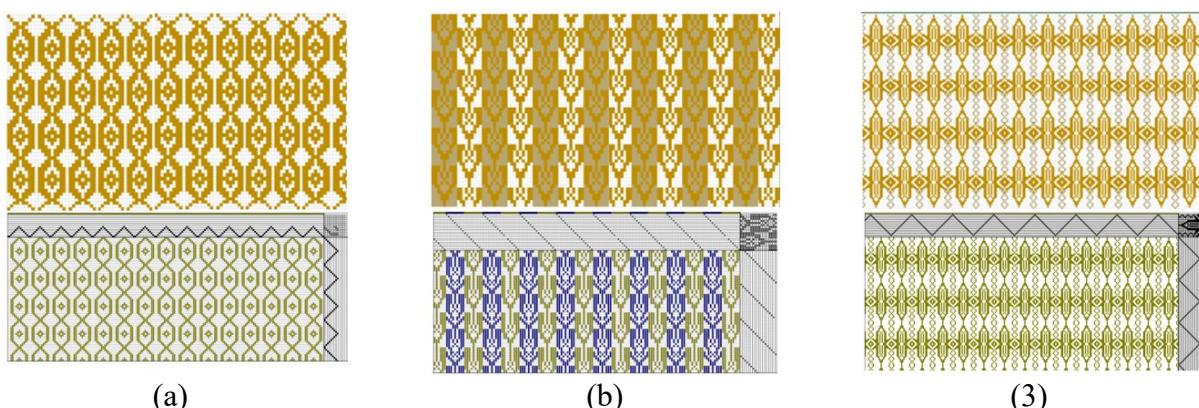


Figure 2 Drafts of the fabric designs (a) Fibrous layer design (b) Blossom top design (c) Blossom design (Researcher, 2024)

From the three design drafts, they were created using a packaged computer program to plan for weaving and calculate the number of heddles of each design, so that their names were easy to apply and memorize by weavers as well as to implement commercially. It was revealed that the first design required the 10 heddles, the second required 16 heddles, and the third required 38 heddles. The community weavers also participated in naming these designs. The designs in Thai contained the word "*Khrua*" or "cluster", indicating the passing down of the weaving wisdom.

For the color shades used for this development, the 2022 trend was applied, comprising brown, blue, and cream shades. When color use was analyzed to rank its importance, the results were shown in Figure 3.

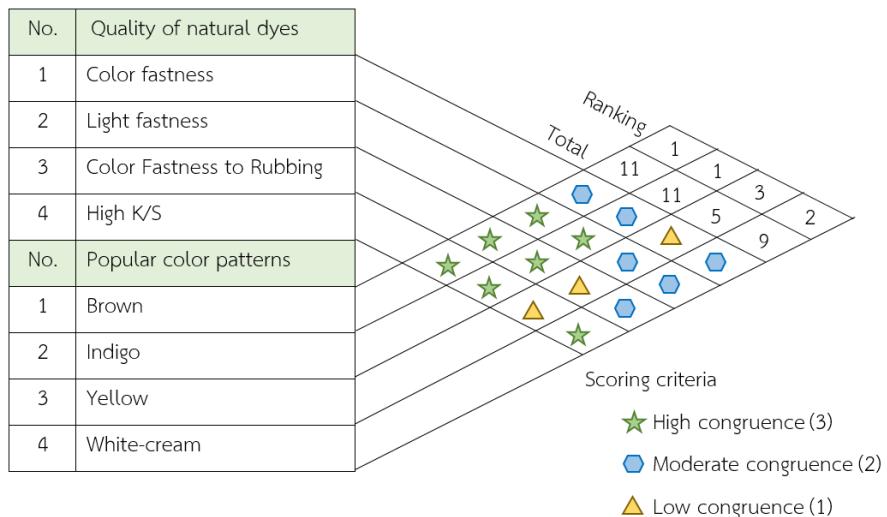


Figure 3 Analysis results of color used to develop community textile products
(Researcher, 2024)

The above figure revealed that the brown and blue shades had the highest scores. Therefore, the blended threads with the sizes 10/1 and 16 were dyed with natural dyes extracted from leftover banana fibers after the segregation process. Tamarind juice was used as the mordant due to its good fastness qualities (from previous test results), and the cold dyeing method was used to reduce carbon dioxide being released into the atmosphere. In this development, white warp threads (without dyeing) were used to brighten the woven fabric and heighten the designs. The dimensions of the designs were created by tying and dyeing weft threads two times to create three shades in one skin. The first time was for brown and it was repeated five times for stronger color fastness and darker shade. The second time was for indigo and it was repeated once to prevent the color from becoming too dark.

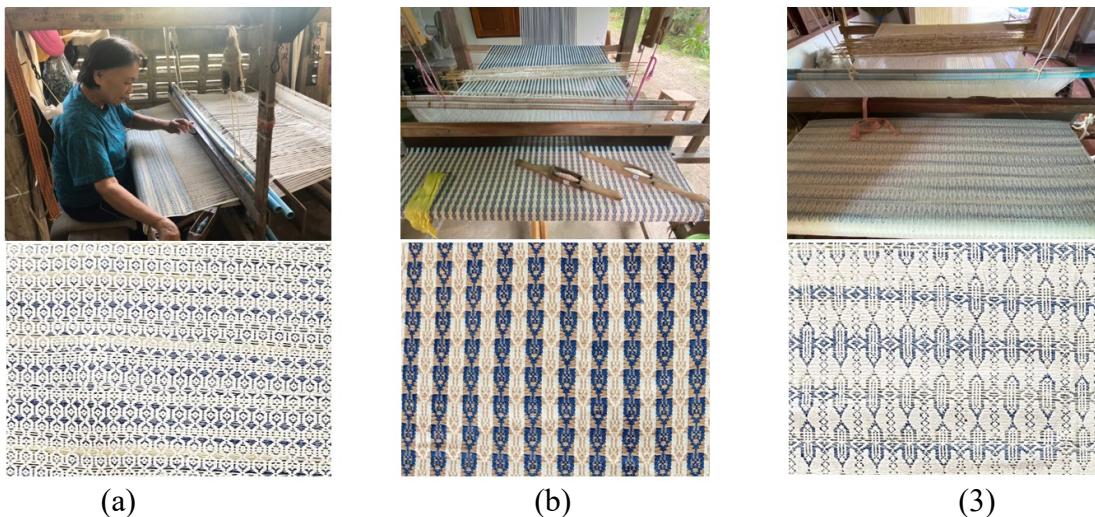


Figure 4 The fabric using the continuous supplementary weft technique (a) Fibrous layer design (b) Blossom top design (c) Blossom design (Researcher, 2024)

The development of community textile product prototypes

For the development of the prototypes, documentary research was conducted, and existing community products as well as the target group to use the developed products were analyzed for the prototypes to be produced commercially at the community level. The target group was 400 working-age individuals between 25 and 45 years old who were visitors at the Chiang Mai Design Week 2021. The collected data were concerned with consumers' needs. It was revealed that 17.36% wanted fashionable clothing and 55.25% wanted contemporary traditional styles. After the data of the target customers were obtained, they were analyzed and synthesized to formulate the product design plan as follows.

1. Inspiration: The inspiration was from valuable Lanna traditions, arts, and culture passed down from generation to generation through their beliefs and faith via natural sacrificial objects with structures and lines that express strength and stability. These cultural traits inspired the designs of contemporary clothing suitable for working-age consumers. This was because their lifestyles were relatively predictable with the purchasing power to buy community products. Furthermore, they also appreciated wisdom-based and cultural products.

2. Concept design: The focus was on the exploitation of wasted banana fibers for textile benefits, which could be tailored to produce ready-to-wear clothing for daily use. The fashion mood was with a loose structure and basic cutting and shapes. The patterns were simple, symmetrical, and asymmetrical without much superimposition. The emphasis was on wearability daily. The colors were natural dyes extracted from leftover banana fibers that produced brown, yellow, and indigo shades. For the form and silhouette, the shapes of the clothing were simple, and the clothes could be worn on both sides. Details of the fabric were weaving banana fibers in alternation with cotton using continuous supplementary weft technique to create designs on the fabric. For the design techniques, this fashionable clothing could be worn on both sides and the materials were banana fibers blended with cotton dyed with the dyes extracted from leftover banana fibers after the fiber segregation process.

3. Sketch design: The designs of the products were conducted under the notion that the community had the potential to carry them out commercially. Consequently, 40 design drafts were carried out consistent with the survey results of consumer needs. The drafts were collectively selected and analyzed for production feasibility and directions of product styles suitable for consumers.

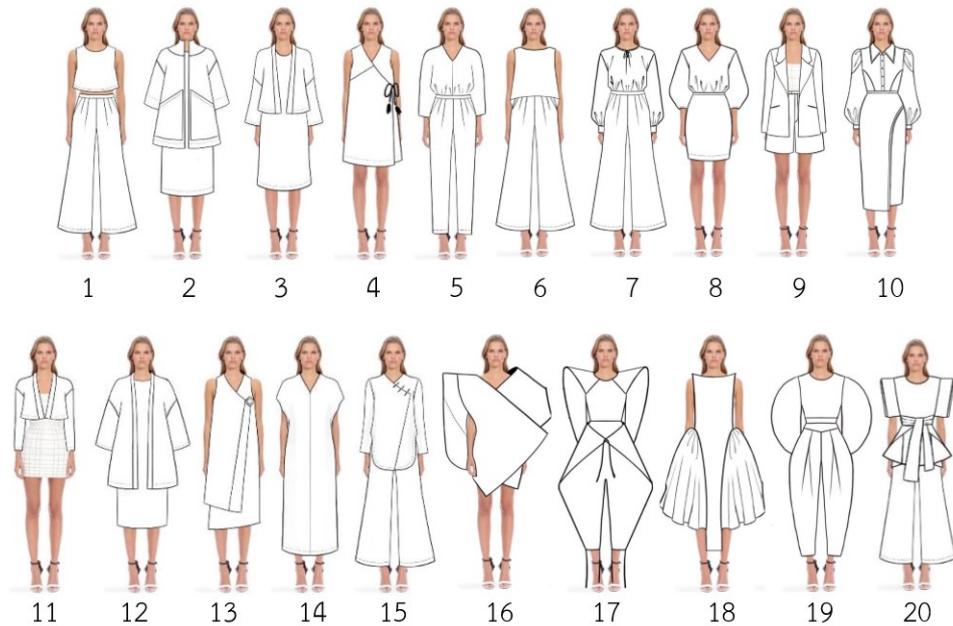


Figure 5 Women's clothing design drafts (Researcher, 2024)

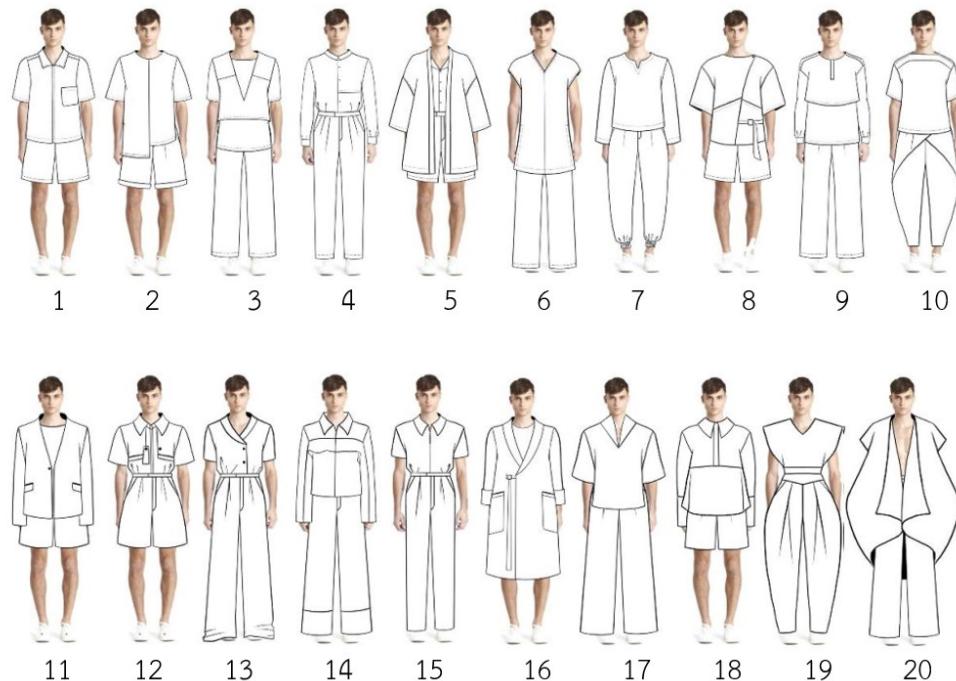


Figure 6 Men's clothing design drafts (Researcher, 2024)

4. Collection: The community representatives, the specialists, and the researcher together selected 10 drafts and slightly revised the clothing patterns to suit the utility and commercial production.

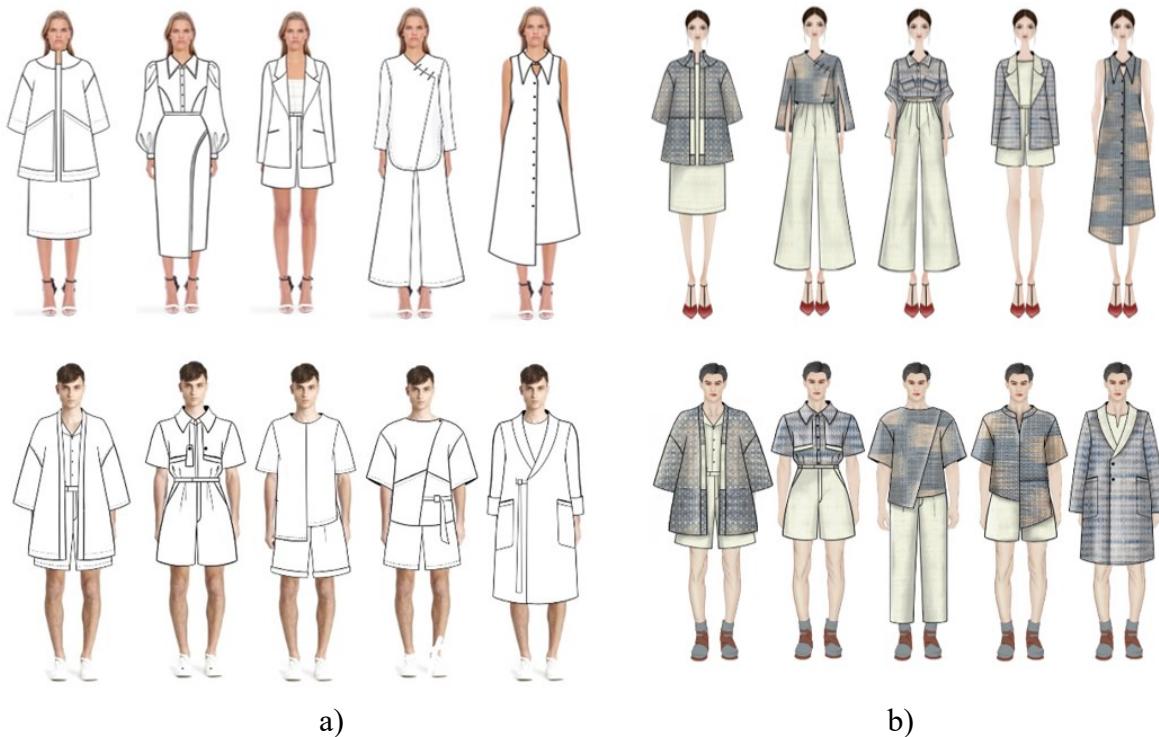


Figure 7 Drafts for prototype production a) Selected drafts b) Revised drafts
(Researcher, 2024)

5. Prototypes of the selected prototypes: They were experimentally tailored by using calico to assess their patterns and techniques. The patterns were in both symmetrical and asymmetrical forms, as shown in the following figure.



Figure 8 The 10 prototypes made from calico (Researcher, 2024)

After the revision and correction, the creation of the prototypes was made into the final stage, as shown in the following figure.



Figure 9 The final prototypes of women's wear (a) Blazer and dress (b) Blouse and long pants (c) Blouse and long pants (d) Suit and shorts (e) Dress (Researcher, 2024)

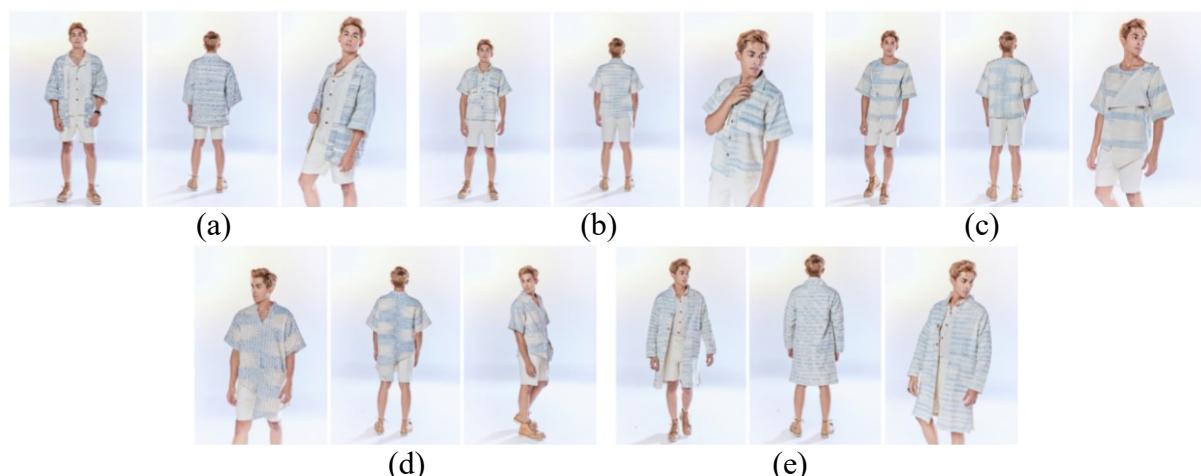


Figure 10 The final prototypes of men's wear (a) Yukata style (b) Collar shirt (c) Overlap top shirt (d) Chinese collar shirt (e) Overcoat (Researcher, 2024)

6. Correction of the prototype products: The products were examined and corrected in small details so that they would look better with better quality and beauty in consistency with the production at the community level.

7. Publicity of the prototype products: The 10 sets of the products were exhibited at a fashion show at the Lanna Expo 2022 on July 1, 2022, held at the Chiang Mai International Exhibition and Convention Center in Chiang Mai province, Thailand, where many tourists and entrepreneurs attended.



Figure 10 The fashion show exhibition (Researcher, 2024)

8. Product acceptance testing: The test was conducted at the 7th Chiang Mai Craft 2023. For this test, 200 consumer acceptance tests were conducted and observing consumer behaviors toward clothing patterns. It was found that they were interested in the banana fiber fabric because the products were innovative, using a fiber different from what is found in the general market. Moreover, such fibers could be tailored into wearable clothes. The overall acceptance mean was 4.70, higher than the predetermined criterion of 4.00. The result indicated that the prototypes could be

Product testing was conducted to find out the acceptance of 200 domestic and customers the target areas and having an interest of textile products made from naturally dyed banana fiber blends. Specifically, those who participated in the product and watched the performance that the researcher presented. From the questionnaire, it is revealed that 74.50 % of the respondents were females, 30.50 % were in the age range between 41 and 45 years, and 45.00% were self-employed. Additionally, 59.00% held an undergraduate degree and 21% had a monthly income between 15,001 and 20,000 baht. The acceptance of the respondents on each product is shown in Table 1.

Table 1 Product testing results on the products of the respondents

Description	$\bar{X} \pm S.D.$	Level
Aesthetics part		
1. The products are novel.	4.70±0.53	highest
2. The products are aesthetics and attractive.	4.67±0.54	highest
3. The arrangement of the patterns is appropriate.	4.79±0.49	highest
4. The colors used are appropriate for current trends.	4.76±0.51	highest
5. The aesthetics of the overall product composition	4.83±0.46	highest
Total	4.75±0.51	highest
Products part		
1. The products are modern.	4.76±0.51	highest
2. The products are diverse.	4.69±0.59	highest
3. The product can be repeated.	4.75±0.57	highest
4. The size of products is appropriate.	4.83±0.46	highest
5. The texture of the fabric is suitable for the product.	4.69±0.60	highest
6. Products can promote the transfer and extension of local wisdom creatively.	4.72±0.59	highest
7. The products are an innovation that can be made to the community level.	4.79±0.55	highest
8. The product is a cost-effective use of local materials.	4.69±0.59	highest
9. The materials used are suitable for developing new alternative textile products.	4.72±0.64	highest
10. The product is an extension of local wisdom and art for commercial benefit.	4.76±0.57	highest
Total	4.74±0.57	highest
Functionality part		
1. The products are easy to maintain.	4.35±0.76	high
2. The products are safety	4.76±0.51	highest
3. The products are easy to use.	4.62±0.72	highest
4. The products are convenient for transportation/transportation.	4.65±0.66	highest
5. The products are strong and durable in use	4.72±0.64	highest
6. The products are easily repairable if there has been a damage	4.58±0.77	highest
7. The product responds to the usage needs of the target consumer group.	4.72±0.59	highest
Total	4.63±0.66	highest

From the table, it can be summarized that the overall mean of the products is 4.71 ± 0.58 , indicating that the target consumers accepted the textile products made from naturally dyed banana fiber blends. This is because the overall mean scores are higher than the predetermined scores of 4.00. Aesthetics part have the highest average score is 4.75 ± 0.51 . In addition, the respondents also suggested that the format of the work presented was creative. The style of the set is beautiful, and the quality is very well-crafted. There should be further development of products in various other formats. And there should be a market test in the form of actual distribution as well, that would be great. However, the development of textile product prototypes this time was carried out according to the theory and process of textile product design. To evaluate the product format that has been created. If the results are positive, they will be considered for transitioning these products into commercial production.

Leveraging the analysis and synthesis of community textile needs, we have developed successful prototypes of woven fabric mixed with banana fibers. These 10 prototypes will serve as a knowledge transfer tool for the community, teaching pattern making and color selection for textile design. This empowers the community to apply these skills in their own textile business and careers.

Discussions

The research results revealed that the creative development of community textile product prototypes from banana fibers dyed with natural dyes was done in the middle and final stages (woven fabric and processing). It was the integration between science and arts, resulting in an innovation based on local wisdom that was significant to the socio-economic conditions of community members. Constructive creation was derived from regular integration and combination. When an entity was constructed, the consideration and analysis must be executed on a regular and continuous basis to obtain innovative and different ideas. Such creativity would lead to unexpected concurrences that would emerge when the concept of creative potential was critically taken into consideration in its various forms and dimensions (Corazza et al., 2020). From this integration, new fabric designs were derived with the inspiration from parts of a banana tree for creating the product prototypes. Creative thinking was a process of creating new things for suitable and wearable benefits to the community and consumers alike. Creative achievement must be considered as a blend of attitudinal and cognitive abilities, and both elements were required to be measured accordingly (Agnoli et al., 2016). Creative thinking plays a crucial role in socio-economic development to elevate Thailand as a creativity-based center of high-valued production and services. Communities should be encouraged to add more value to their products and services to internationally accepted qualities and standards. For the development of these product prototypes, suitable techniques, methods, and materials were deliberately selected consistent with their utility attributes to produce the products according to consumer and marketing needs. A survey on consumer needs was conducted before the production and the data were used to plan for the development through analyses, syntheses, and assessments so that the developed prototypes were beautiful with quality and truly responded to consumer needs. Nowadays, banana fiber-based fabric has been used more widely in producing clothes, paper, shoes, handbags, and household furniture. This is because consumers are more aware of the sustainable and ecologically friendly values of products (Sodhi et al., 2022). These products in this study were regarded as new products and were at the 5th level of creativity, which had incorporated technology, local wisdom, and culture to create unique, meaningful, and valuable stories for products to become more value-added (Soodsang, 2015). Ulrich & Eppinger (2012) stated that the product development process is a sequence of steps that transforms a set of inputs into a set of outputs. A clear process contains quality assurance, coordination, planning, management, and improvement. The conclusion of the product development process is the product launch, and subsequently the product becomes available for purchase in the market. This is in line with the acceptance theory of Hambling (2013) in that user acceptance requires formal testing and the tests should be designed and conducted in a structured way that provides objective evidence of the acceptability of the system. The test for this investigation was formulated according to the aspects of the products, namely beauty, product, and functionality, in an attempt to derive the overall information in accordance with market needs. In addition, the research results of Inpakdee et al. (2022) it was found that they had developed a prototype product from naturally dyed banana fibers for wicker. Consumers accept the product at a very good level. As a consequence, not only does exploiting the fibers use for wicker production, but they can also be applied to developing other products by using other methods like weaving and embroidery. This attempt had empowered fashion designs or arts to become sustainable by incorporating conventional cultures with new technology so that designing could be more widespread and expanding (Zou et al., 2022). Therefore, the creation of these textile products was based on an interdisciplinary integration, resulting in the production becoming commercial as well as creating more jobs and incomes for community members, which could turn the community economy sustainable.

Conclusion and suggestions

The commercial development of the banana fiber-based textile product prototypes was to exploit banana fibers for textile benefits with an emphasis on ecological friendliness. The creation of the textile designs in this research was innovative with the inspiration from the parts of a banana tree, namely, the fibrous layers and blossom. The designs were created by using the continuous supplementary weft technique. Furthermore, the designs could be developed in handwoven fabrics using other techniques, e.g., brocade, raised wafting, or tie-and-die. This was to further local wisdom based on culture. For this commercial development, it is necessary to understand the nature of the fibers to create strengths and reduce weaknesses, which would lead to the creation of sustainable community development.

New knowledge and the effects on society and communities

Developing a prototype community textile product from a banana fiber blend to commercial scale is the use of fiber from banana tree to add value to community textile product by spinning it into open-end spinning yarn using a mixture ratio of cotton, banana fiber, and Eri silk (70:20:10) with a yarn size of 10/1. Such yarn can also be used in weaving by local loom. Because the size of the yarn is the same size that the community has ever used. Therefore, it does not affect changes in the production process. When woven into fabric, the woven fabric has a texture different from other woven fabrics in the market. Because banana fiber has shiny characteristics like silk fiber. New knowledge and effects on society and communities are as follows:

1. Woven fabric patterns inspired by banana tree components were developed using the Khit weaving technique. These patterns create a cohesive narrative that can be used for marketing to engage consumers.
2. Prototype textile products have been developed into lifestyle fashion clothing, which the community can replicate for commercial production.
3. The research has successfully demonstrated the potential of banana fiber, an agricultural waste material, to be transformed into higher-value products using locally sourced resources.
4. Innovative textile products made from banana fibers have been developed to cater to the growing demand for environmentally friendly options. These products represent a novel offering in the market.

Therefore, developing a prototype community textile product from banana fiber blend to commercial scale is the new body of knowledge that the community can use, develop, and expand its textile product in the future. There is a high possibility that the community produces it for commercial distribution because the target consumer group accepts the prototype textile product with an average acceptance score of the consumer group of 4.00 which is higher than the specified criteria.

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