Design and Development of a Small-Scale Jacquard Weaving Machine to Enhance the Efficiency of Thai Song Dam Woven Fabrics

Wachirasak Kainwong[1] Janyawan Janyatham[2*], Areeya Juichamlong[3],

Saowalak Srisuwan[4], Wittawat Sooksaket[5], Kwannapa Watchanarat[6]

[1,2] Department of Product Design and Development, Faculty of Engineering Science and Industrial Technology, Bansomdejchaopraya Rajabhat University

[3]Department of Digital Content Communication, Faculty of Engineering Science and Industrial Technology, Bansomdejchaopraya Rajabhat University

[4]Department of Broadcasting and Streaming Media, Faculty of Engineering Science and Industrial Technology, Bansomdejchaopraya Rajabhat University

[5]Department of Animation, Game, and Digital Media, Faculty of Science and Technology, Bansomdejchaopraya Rajabhat University

[6]Department of English, Faculty of Humanities and Social Sciences, Bansomdejchaopraya Rajabhat University

[*]Corresponding author email: janyawan.ja@bsru.ac.th

Received 31 May 2025 **Revised** 25 Aug 2025 **Accepted** 04 Sep 2025

Abstract

This research used a mixed-method approach. The objectives of this study were 1) to study the identity of woven fabric patterns of the Thai Song Dam ethnic group at the Traditional Thai Dam Cultural Center, Moo 1, Ban Don Sub-district, U-thong District, Suphan Buri 2) to design and develop a small-scale Jacquard weaving machine to preserve traditional patterns and consistently improve production efficiency and 3) to determine the efficiency of the small-scale Jacquard weaving machine. The population and samples in this study were divided into two groups: 1) community leaders, folk philosophers, and villagers at the Traditional Thai Dam Cultural Center, Moo 1, Ban Don Sub-district, U-thong District, Suphan Buri and 2) a target group of about 30 people interested in Thai Song Dam woven fabric products, who participated in product testing. The research instruments included interview forms, product evaluation forms, and product testing. Data were analyzed using frequency, percentage, mean, standard deviation, and user satisfaction level analysis. The findings revealed the following: 1) The study of the identity of woven fabric patterns of the Thai Song Dam ethnic group at the Traditional Thai Dam Cultural Center showed that the technique of creating patterns involved folding fabrics of various colors and stitching them together, as well as the use of “eua saew” embroidery with different motifs on black fabric. Black is particularly significant, as it represents the original name of the ethnic group. 2) The results of designing and developing the small-scale Jacquard weaving machine to preserve the traditional patterns of the Thai Song Dam ethnic group demonstrated that the machine could be installed on existing looms and operated according to traditional weaving plans. 3) The evaluation revealed that all five dimensions were rated at high to very high levels, with “structural strength” receiving the highest score ($\bar{X}$ = 4.70, SD = 0.44). This indicates that durability, safety, and

functionality are the most valued attributes of the product. Overall, the small-scale Jacquard loom was assessed as efficient, reliable, and well-suited for user needs. Although the punch-card technique allowed for the creation of patterns, there were limitations, as the studied motifs were embroidered. Consequently, the patterns could not be fully replicated through weaving alone. To achieve completeness, it is necessary to combine Jacquard weaving with the coiling process.

Keywords : jacquard, loom, small jacquard

Introduction

Fabric is a basic fundamental necessity to human life. This is because fabric makes up one of the four essential factors. In addition to needing food, housing and medicine, agrarian societies ever since the past have had to weave fabrics for use in their families. Their weaving techniques have been accumulated and passed on over time by female family members, since weaving is an art which requires diligence, patience, perseverance, meticulousness and delicateness. Mothers or grandmothers take charge of teaching and passing on their techniques and experiences in weaving to their daughters or granddaughters. Thus, their skills became intellectual heritage passed on from one generation to the next in the same manner as cultural heritage. Fabrics have long been produced in every region of Thailand. The methods involved in their production are meticulous. There are techniques for creating various complex and uncomplex patterns such as by dyeing to create patterns, adding warp and weft lines to create patterns and twisting two strands of silk into one. The patterns woven on attractive fabrics result from the wisdom of the weavers and the natural environment. Thai woven fabric patterns began from things observed in nature, followed by various combinations of geometric patterns (Phetnil & Kularb, 2022).

Fabric weaving is a part of the human way of life. (Sinthuchai & Yodmalee, 2021). This is because it is the production of clothing, which is part of the four essential factors for human life. Furthermore, fabric weaving is an art in itself. The weaving cone by each ethnic group has its own shapes patterns, and these shapes and patterns indicate identity and culture as well as the beliefs and backgrounds of each ethnic group. Some of these patterns and symbols have been passed on across many generations. Some patterns are

named in local languages and not understood by Thai people in other regions, such as the Ia pattern, Bak Chan pattern, etc. Meanwhile, some other names have been known widely without any knowledge on their backgrounds such as the spider pattern and squid pattern. Furthermore, some patterns are given new names such as the "Kho Phra Thep" pattern, etc. Some symbols and patterns are connected to the attitudes and beliefs of the local Thai people, who have passed them on through many generations, and many are connected to patterns apparent in other arts such as reliefs and architectural works. Sometimes they are even mentioned in local myths and literatures. Finally, some patterns are attitudes shared with contemporary beliefs and appear in the arts of many countries such as hook patterns and spiral patterns (Chanpla, J., et al. ,2011).

At present, fabric weaving is still taking place in many localities to produce the same traditional patterns. This is particularly true for certain ethnic communities dispersed across various regions of Thailand. For weaving in the lower central region (UthaiThani, Chai Nat, Suphan Buri, Saraburi, Lopburi, Nakhon Pathom, Ratchaburi, Phetchaburi, etc.), Thai Yuan and Thai Lao settled in these places over various time periods in Thai history, especially in the case of Thai Lao ethnic groups such as the Puan, Song, Phu Thai, Krang, etc., who settled there. (Kongkaew & Chanthong, 2021). These Thai Lao peoples have retained their distinct cultures and identities, especially the patterns they weave into their fabrics, which have various different colors and characteristics. That being said, the Thai Song Dam of Lao Song people who settled in the country established homes which were similar to their own backgrounds. First, they settled in Phetchaburi, but then they moved to various adjacent provinces such as Suphan Buri, Nakhon Pathom, Chai Nat, Nakhon Sawan, Phitsanulok and

Phichit. Ever since the past, the Thai Song Dam preferred to manufacture their own tools and furniture, and a handicraft of theirs which stands out is their fabrics. Since the past, they grew their own silk worms for producing threads and for weaving fabrics. Fabric weaving is intimately connected with the unique culture of the Thai Song people. Their fabrics are unique and stand out for their distinct patterns, embroideries and stitch work. They largely preferred to use black fabrics and have preserved their traditions and customers. As a result, Thai Song Dam fabrics are valuable works which were developed by their ancestors and passed on to the later generations. Thai Song Dam groups are dispersed through the country but particularly in the central region. Suphan Buri is a particular province in which large numbers of Thai Song Dam have settled. They are spread across different areas, especially in Ban Don Sub-District. The woven fabrics and apparels of the Thai Song Dam represent their cultures and traditions and attitudes and beliefs in their daily lives. They stand out in that both men and women wear black clothing. Women, in particular, wear a skirt known as the watermelon skirt, which is made by weaving blue-dyed cotton together with red silk and covered with white patterns. At present, blue is the preferred color along with double threaded patterns and single threaded patterns. The people say that the fabric will sparkle in red when exposed to sunlight. Thus, it is a way for Thai Song Dam women to reminisce about their men when they go out to work in different areas for a long time. It is a way to send a message from the heart without direct communication. The watermelon skirt is worn with a sleeveless shirt. (Phetnil, 2023) . However, the Hee shirt is worn during ceremonies. Men wear black pants known as Suang Hee pants, also worn with sleeveless shirts and Hee shirts. Most Thai Song Dam products are apparels and other handicrafts. These products are often bought by the Thai Song Dam

themselves, although a small number is purchased by tourists as souvenirs. These products clearly represent the culture of the Thai Song Dam people, as apparent from the colors and patterns in weaving and stitching such as red, orange, green, yellow and white colors, and distinctive patterns such as the Dok Chan pattern, Kho Kud pattern, Dok Paed pattern, etc. (Thongthai, 2022).

However, fabric weaving by the Thai Song Dam at Ban Don in Suphan Buri is beginning to disappear, since society is changing economically and socially, within increasing influences of education and communication, compounded by the increasing availability of cheap clothing made by industrial factories. Furthermore, modern Thai Song Dam people began taking interest in engaging in various occupations aside from farming, leading to a change in the lifestyles and culture of the Thai Song Dam of Suphan Buri. Weaving, in particularly, is no longer as common, and the people are dressing themselves differently. Villagers are replacing hand-woven fabrics with machine-woven fabrics. Consequently, their Thai handicrafts have practically vanished from some communities.

The design and development of a small-scale Jacquard loom for producing Tai Song Dam woven fabrics is highly significant in preserving and transmitting traditional patterns of this ethnic group. The weaving patterns of the Tai Song Dam are distinctive, reflecting a long-standing cultural identity and history. Traditionally, the creation of these intricate patterns relied on craftsmanship and individual expertise. Manual labor alone presents limitations in terms of time, precision, and production volume, making it difficult to meet contemporary demands (Department of Cultural Promotion, 2020). The small-scale Jacquard loom has thus been designed to address the challenges of reproducing traditional motifs. Its key feature is the ability to program complex

and diverse heddle-lifting sequences, enabling ancient patterns of high delicacy to be reproduced with accuracy, while reducing the risk of loss or distortion (Sureeporn, 2021). Moreover, it saves labor, shortens production time, and provides opportunities for designers and new weavers to learn and create contemporary patterns based on traditional designs more effectively (Supachai et al., 2021). Therefore, the small-scale Jacquard loom plays an essential role in safeguarding the cultural heritage of the Tai Song Dam. It not only preserves their unique motifs but also facilitates transmission, continuity, and the extension of indigenous knowledge into innovative contemporary creations in a sustainable manner (UNESCO, 2021).

Thus, in order to preserve and conserve Thai Song Dam fabric weaving at Ban Don in Suphan Buri and save it from vanishing due to social conditions and time, the researchers, which belong to an academic agency responsible for taking actions related to various academic services in order to strengthen communities and society and other activities related to establishing research networks to meet community and social needs, became interested in conducting a study to design and develop a small jacquard to enhance the quality of Thai Song Dam woven fabrics and to preserve their weaving patterns in order to reduce the need for memorization, weaving time, cost, time, and labor cost from the traditional weaving techniques to develop new Thai Song Dam products that will increase value in line with creative economy guidelines and preserve the identities and meanings of Thai Song Dam woven fabrics in order to ensure that Thai Song Dam fabrics can be developed into various products that can meet the needs of modern customers whose ways of living have changed in many ways. This effort is one way to preserve and pass on the fabric weaving of the Thai Song Dam people at Ban Don, Suphan Buri, and

prevent it from vanishing. The objectives has 3 topics: 1) To study the identity of woven fabric pattern of Thai Song Dam ethnic group in Traditional Thai Dam Cultural Center at Moo 1, Ban Don sub-district, U-thong district, Suphan Buri 2) To design and develop small-scale jacquard weaving machine to preserve traditional patterns and constantly increase production efficiency; 3) To determine the efficiency of the small jacquard weaving machines.

Material and methods

This research was a research with mixed methods that utilized a research and development process. This research was divided into four main phases as follows: Phase 1 – study of relevant knowledge and survey of basic data; Phase 2 – design and development of the jacquard; Phase 3 – testing of the developed design; and Phase 4 – refinement of the developed design.

1.2.1 Target Group

The target group consisted of community leaders, local sages, and villagers of at Moo 1, Ban Don, U-Thong, Suphan Buri, along with other people interested in Thai Song Dam woven fabrics. In all, there were 30 people.

1.2.2 Research Instrumentation

The instruments used in the research consisted of a structured in-depth interview form used for in-depth interviews of Thai Song Dam people at Ban Don, Suphan Buri, and a small jacquard product evaluation form. Product testing was supervised by 3 experts in testing jacquard design for weaving Thai Song Dam fabrics. The selection criteria were as follows: (1) One expert in the Thai Song Dam ethnic group; (2) One Thai Song Dam fabric manufacturer and distributor; and (3) One academic in weaving technologies.

1.2.3 Evaluation Form for Product Development and Design for Experts in Small Jacquard Product Design

- Data Analysis and Statistics Used in Data Analysis

(1) Quantitative data analysis was performed with data obtained from questionnaires analyzed as follows:

- Analysis by descriptive statistics covered frequencies, percentages, mean values, and standard deviations. Data were analyzed in five-level scales. The researcher used the concept by Best (Best, 1981) to interpret results as follows:

Mean from 4.50 - 5.00 means the highest

Mean from 3.50 – 4.49 means high

Mean from 2.50 – 3.49 means medium

Mean from 1.50 – 2.49 means low

Mean from 1.00 – 1.49 means the least

(2) Qualitative data analysis was conducted by using data obtained from the qualitative data collection instruments, namely, in- depth interviews and observation. Prior to analysis, data accuracy was verified. The data were then analyzed using the following techniques:

- Content analysis.

- Typology and taxonomy

- Cause and effect analysis

Results

1)Study of the uniqueness and identity of the woven patterns of Thai Song Dam fabrics at the Traditional Tai Dam Cultural Center, Moo 1, Ban Don Sub-District, U-Thong District, Suphan Buri

For the findings on the uniqueness and identity of the woven fabric patterns of the Thai Song Dam ethnic group at the Traditional Tai Dam Cultural Center, Moo 1, Ban Don Sub- District, U- Thong District, Suphan Buri, the researcher ordered the unique characteristics of woven fabric patterns according to pattern creation techniques and colors identifying the ethnic group. The findings were as follows:

A variety of folding and pulling techniques using various colored fabrics were used to create patterns. The Ua Saew was also used, which is a method to stitch lines into various patterns on a black fabric. The black color is a color which identifies the Thai Song Dam identity and is an origin of the ethnic group's name. The characteristics and styles of pattern adaptation of the Tai Song Dam are applied as follows:

1) Application through the use of five primary colors (red, orange, green, white, and black) applied as decorative elements on a black background.
2) Application of patterns using triangular and square shapes, combined to form motifs by folding edges or corners and stitching them together.
3) Application by adding details to the patterns, such as framing the motif with rectangular borders.
4) Application by retaining the original design but altering the colors, making it more suitable for contemporary use.
5) Application by rearranging shapes and colors on a black background, creating newly designed motifs that emphasize beauty and appropriateness for intended uses, particularly in the technique of patchwork pattern-making.

Figure 1. Floral stitching patterns of the Thai Song Dam textiles from Ban Don; Picture Taken by the Research Team on 20 July 2023

2) Design and development of a small jacquard to preserve traditional patterns and increase production effectiveness

For the findings on the design and development of a small jacquard to preserve traditional patterns of the Thai Song Dam people at the Traditional Tai Dam Cultural Center, Moo 1, Ban Don Sub-District, U-Thong District, Suphan Buri, the study in the design and development of the small jacquard by the research committee produced the following findings:

In regards to design, the small jacquard is mainly composed of 1) a lifting box part of the system for lifting control of standing threads, whereby as 160 cards in the machine come into contact with needles, patterns are created; and 2) a structure attached to the lifting box responsible for weaving fabrics.

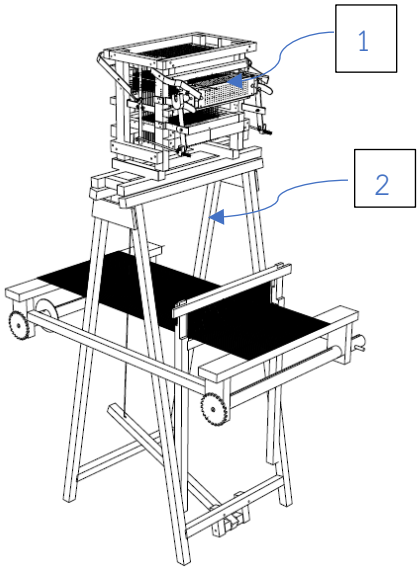

Figure 2. Small loom fitted with the 160 needle Jacquard system

In regards to techniques, the process to create patterns by using cards takes place by using punched cards to create patterns. Each card controls the lifting of standing threads in rows and columns, whereby 160 threads are lifted through a hive with ends attached to hooks in a box set. In the system, the code 0 means not punched or no lifting, while 1 means punctured or lifting. Thus, they make it possible to create desired patterns. Warp and weft lines are created by using spindles to weave threads through lifted threads which are impacted by beaters to firmly secure threads to produce the desired fabrics.

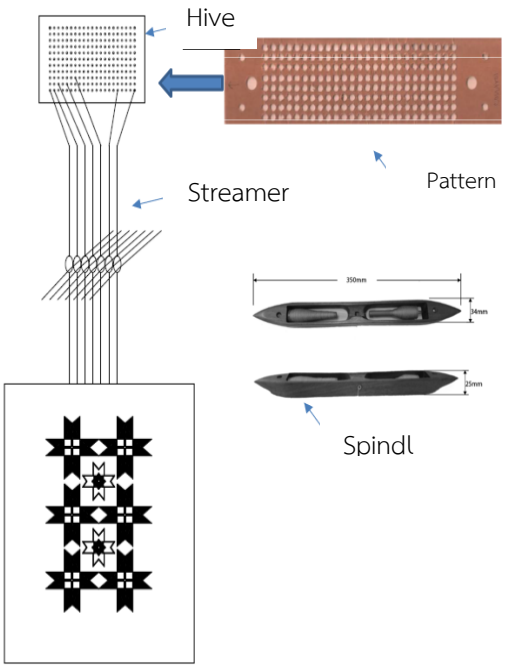

Figure 3. Mechanism for pattern generation using Jacquard punch cards

Figure 4. Prototype of a small semi-automatic weaving machine with a single treadle system

3) determine the efficiency of the small-scale Jacquard weaving machine

Evaluation Dimension	Item with Highest Mean	Mean ($\overline{X}$)	SD	Interpretation
Functionality	Value for money	4.60	0.52	The highest
Aesthetics	Modern and appealing design	4.45	0.48	high
Price	10,000–15,000 Baht	4.20	0.65	high
Safety & Maintenance	Safe design during use	4.55	0.50	The highest
Materials	Structural strength	4.70	0.44	The highest

The results indicated that in terms of Functionality, the highest mean score was found in the item "Value for money" ($\overline{X}$ = 4.60, SD = 0.52), which was interpreted as very high. For Aesthetics, the item with the highest score was "Modern and appealing design" ($\overline{X}$ = 4.45, SD = 0.48), interpreted as high. In the Price category, the most preferred option was "10,000–15,000 Baht" ($\overline{X}$= 4.20, SD = 0.65), also at a high level. Regarding Safety and Maintenance, "Safe design during use" achieved the highest score ($\overline{X}$ = 4.55, SD = 0.50), at a very high level. Finally, for Materials, the highest mean score was "Structural strength" ($\overline{X}$ = 4.70, SD = 0.44), which was at a very high level. Overall, the evaluation showed that structural strength of materials (5.3) had the highest mean score among all items, highlighting durability and reliability as the most valued attribute of the product.

Research Products

1) A loom installed with a small jacquard sized 160 needles.
2) A model for creating and recording community woven patterns for preserving Thai Song Dam woven fabrics through pattern cards.

Research Outcomes

1) Increased recognition of the importance of the Thai Song Dam culture and joint learning involving the community and Traditional Tai Dam Cultural Center.
2) Development of the small jacquard innovation for preserving Thai Song Dam woven fabric patterns.

Application of the Research Findings

Academics – Apply the findings to resolve problems or in other academic uses to provide new knowledge, for reference or for teaching students in a classroom setting, or to publish the research findings in a national- level periodical. (Khanthong & Praphan, 2021).

Policy – Use the findings as data to accompany the creation of measures and regulations by government organizations or agencies or in creating policies for managing local knowledge heritage. (Srisuk & Boonruang, 2022).

Communities – Use the small jacquard innovation created by the research in communities. (Wongruang & Chokthanasakun, 2023).

Commercial – Develop local woven fabric products or textile products to generate revenue or increase local fabric weaving effectiveness. (Kamonrat & Lertsakul, 2020).

Conclusions and Discussion

This research created results that can be used in academics, policies, communities and commerce. Local communities or other interested parties can apply the model for the design and development of the small jacquard in making appropriate improvements to local knowledge and technologies and increasing local fabric weaving effectiveness or in increasing production volume, reducing learning time, reducing skills, reducing shortages of knowledgeable people in passing on their knowledge, and increasing access in every age group as well as preserving the local woven fabric patterns of communities long in to the future. (Sookwong, 2021; Jantarasiri & Meethong, (2023). The model also has the potential to contribute to inclusive innovation at the community level, linking cultural sustainability with economic development. With appropriate adaptation, this innovation can be implemented in other weaving communities to empower local artisans and strengthen local identity through creative industries (Manopwisedkul & Chaiyasuk, 2022).

Acknowledgements

This work was fully supported by The Thailand Research Fund (TRF) (contract No. RDG61A0037)

References

Chanpla, J., et al. (2011). Development of Thai Song Dam woven fabric product styles to add value through the creative economy approach. *Bangkok: Department of Cultural Promotion.*

Department of Cultural Promotion. (2020). *Report on the transmission of wisdom and identity of the Tai Song Dam ethnic group.* Bangkok: Ministry of Culture.

Jantarasiri, T., & Meethong, S. (2023). Technological adaptation and heritage preservation in community textile industries: A case study of central Thailand weaving clusters. *Southeast Asian Cultural Innovation Journal, 5*(2), 71–88.

Kamonrat, N., & Lertsakul, J. (2020). Creative commercial development of ethnic woven products in central Thailand. *Journal of Local Economic Innovation, 3*(1), 55–70.

Khanthong, S., & Praphan, P. (2021). Integrating traditional textile knowledge into modern education: A case study of applied Jacquard weaving innovation in Thai universities. *Journal of Arts and Cultural Studies, 4*(2), 48–63.

Kongkaew, K., & Chanthong, A. (2021). Ethnic weaving heritage in lower central Thailand: Cultural continuity and adaptation among Thai Lao subgroups. *Journal of Cultural Identity and Heritage, 2*(1), 65–81.

Manopwisedkul, P., & Chaiyasuk, C. (2022). Integrating small loom innovations into rural creative economies: Lessons from northern Thailand. *Journal of Community-Based Design and Development, 4*(1), 35–52.

Phetnil, K., & Kularb, N. (2022). Designing contemporary products from traditional Thai woven textiles: A case study of northeastern weaving patterns. *Journal of Textile and Fashion Design, 4*(1) , 12– 28. doi:10.5555/jtfd.2022.04102

Phetnil, K. (2023). Women's roles and emotional expressions in Thai Song Dam textile symbolism: A study on the watermelon skirt tradition. *Journal of Ethnic Art and Design, 6*(1), 22–38.

Sinthuchai, S., & Yodmalee, P. (2021). The cultural transmission of traditional weaving practices in rural Thai communities. *Journal of Cultural Heritage Studies, 3*(2), 45–59.

Sookwong, P. (2021). Development of a small-scale Jacquard loom for enhancing local weaving innovation. *Journal of Thai Craft and Design, 3*(1), 14–29.

Srisuk, K., & Boonruang, W. (2022). Policy mechanisms for preserving community knowledge through textile heritage in Thailand. *Thai Journal of Social Development and Policy, 5*(1), 17–34.

Supachai, K., et al. (2021). Textile technology and contemporary design for cultural heritage preservation. *Journal of Design Research, 9*(1), 33–49.

Sureeporn, C. (2021). Preservation and development of Tai Song Dam woven patterns through loom innovation. *Journal of Art and Design, 15*(2), 45–58.

Thongthai, N. (2022). The visual identity of Thai Song Dam textiles: Patterns, symbolism, and continuity in central Thailand. *Textile Heritage Review, 5*(2), 33–49.

UNESCO. (2021). *Traditional weaving knowledge and intangible cultural heritage safeguarding.* Paris: UNESCO Publishing.

Wongruang, T., & Chokthanasakun, R. (2023). Community adaptation of small-scale weaving machines: Access, skills transfer, and intergenerational learning. *Community Technology and Innovation Review, 6*(1), 25–42.