

SIMULATION OF WEAVING DRAFT PATTERNS ON HAND EMBROIDERED CAPS (KUBE) USING COMPUTER AIDED DESIGN IN TEXTILES

Abdullahi M.¹, Bako G.W.¹, Abdullahi S.²

Department of Industrial Design, Ahmadu Bello University, Zaria

Department of Polymer and Textiles Engineering, Ahmadu Bello University, Zaria

Corresponding Author: Abdullahi Maryam

Abstract

This study explores the simulation of weaving draft patterns for hand-embroidered Hausa caps (kuba) using Computer-Aided Design (CAD), specifically CorelDraw. It emphasizes alphabetical coding (name drafting) as a structured alternative to conventional pattern drafting methods. The primary aim was to digitally simulate these weaving drafts to produce scalable embroidery designs. Adopting a practice-based research methodology, the study utilized the character string "AADIL SANI" to generate threading sequences for a four-shaft overshot weave. Three alphabetical coding methods were tested to assign letters to shaft numbers. These sequences were refined to meet structural weaving requirements—specifically the alternation between odd and even shafts—using incidentals to resolve conflicts. To enhance visual balance, the sequences were reflected to create symmetrical compositions. CorelDraw was employed to transform these theoretical drafts into embroidery-ready designs via a grid-based system. The software facilitated precise control over repetition, color variation, layout, and scaling, ensuring patterns could be adapted to various cap sizes with mathematical accuracy. The findings demonstrate that integrating name drafting with CAD offers a flexible, efficient, and highly accurate alternative to traditional kuba drafting. This approach significantly expands creative possibilities while preserving the cultural identity of Hausa cap embroidery. Ultimately, the study confirms that the intersection of traditional weaving logic and digital simulation supports both innovation and sustainability within the craft.

Keywords: Hausa Cap Embroidery (*Kuba*), Name Drafting, Alphabetical Coding, Computer-Aided Design (CAD), Textile Simulation.

Introduction

The Hausa ethnic group in Northern Nigeria is renowned for its mastery of diverse crafts, including blacksmithing, leatherwork, weaving, pottery, and textile decoration. In this tradition, hand embroidery holds a special cultural and economic significance. One of the most recognizable item of Hausa attire is the hand-embroidered cap (*Hula* or *Kuba*), which complements the traditional flowing gown known as *Babban Riga*. These caps are cultural artifacts that embody identity, prestige, craftsmanship, and aesthetics (Saidu, 2013). The introduction of Islam shaped aesthetic practices, encouraging the development of geometric and symmetrical designs (Bernard, Emmanuel, & Isaac, 2014). Over time, the embroidered cap evolved into a powerful symbol of cultural pride, fashion, and social status. In contemporary times, embroidery continues to thrive in Hausa societies, particularly in urban centres such as Zaria, Kano, and Maiduguri, though techniques remain largely manual. Computer-Aided Design (CAD) tools widely used in the global textile and fashion industries can simulate, manipulate, and scale weaving drafts with precision. Applying CAD to Hausa cap embroidery introduces possibilities for innovation, improved efficiency, and enhanced aesthetic quality.

This research therefore focuses on simulating weaving draft patterns using CAD as a means of enriching hand embroidered cap (*Kube*) design and production.

Background of the study

Embroidery in Nigeria is most prominent among the Hausa of the North and the Yoruba of the South-West, with its origin tied to trade and cultural interactions with Arab and North African merchants during the medieval period (Heathcote, 1976, as cited in Adiji, Ogunduyile & Ojo, 2016). Over centuries, the craft became indigenized and incorporated into local dress traditions. Among the Hausa's, embroidery is a central feature of men's attire, particularly on the *Babban Riga* and caps, with geometric, linear, and symmetrical designs reflecting Islamic influence. Beyond cultural importance, embroidery sustains livelihoods and has become a cottage industry in areas such as Yola and Maiduguri, where households participate in the production of embroidered caps (Adedokun, 1995). Traditionally, embroidery designs are drafted manually on graph paper (*Takarda*), scaled and transferred to fabric using ruler and pen, a time-consuming process requiring exceptional precision. With the advent of CAD, designs can now be simulated, manipulated, and scaled digitally, reducing error and saving time (Sadrehaghighi, 2022). Integrating CAD into Hausa cap embroidery (*Kube*) represents a significant step toward modernizing an ancient craft without eroding its cultural essence.

The main purpose of this study is to simulate weaving draft patterns with the aid of CAD software on hand embroidered caps (*kube*), using the name drafting method of pattern creation. The study explores cap pattern production using names in place of conventional patterns and drafts and prints patterns using Computer-Aided Design (CorelDraw) on fabric to be embroidered. Although many authors have written on Hausa cloth embroidery (Saidu, 2013), little scholarly attention has been paid to cap embroidery in Northern Nigeria, and even less to the integration of digital design tools. The application of CAD demonstrates advancement in embroidery research, encourages the integration of traditional craft with digital technology, and highlights creativity and innovation in pattern development.

Culture plays an integral role in sustaining development by preserving spiritual, material, intellectual, and emotional values such as arts, lifestyle, traditions, and beliefs. As a social dimension of sustainability, culture retains identity and guides change based on cultural values rather than economic efficiency alone (Kashim, Ologunwa, & Ogunlade, 2014). This study provides information on hand embroidered (*kube*) caps in northern Nigeria in terms of aesthetics, technical, cultural, economic, and academic significance.

- i. **Academically**, the study contributes to existing literature by documenting cap embroidery and expanding knowledge on the application of CAD in indigenous textile and craft practices.
- ii. **Aesthetically**, the study highlights the beauty, comfort, and fashion value of handmade cap embroidery through unique patterns created using the name drafting method and rich coloured threads.
- iii. **Technically**, the use of CAD enables easier drafting, scaling, and transfer of patterns onto fabric, saving time and supporting mass production compared to manual methods.
- iv. **Culturally**, the study contributes to conserving and promoting Hausa hand embroidered caps as a form of identity locally and internationally while integrating digital technology.
- v. **Economically**, the findings support the establishment of cottage and small-scale enterprises, creating employment opportunities.

Statement of the problem

Despite the cultural significance and economic value of Hausa hand-embroidered caps (*kube*), traditional methods of design and production remain highly manual, time-consuming, and labor-intensive. Embroiderers spend weeks drafting, scaling, and stitching a single cap, which limits productivity and restricts creative exploration. At the same time, globalization and modernization are reshaping consumer preferences, with increasing demand for innovative designs, quicker production cycles, and higher precision. Conventional embroidery methods often cannot keep pace with these expectations. While CAD has been widely applied in other areas of textile and fashion design, its integration into Hausa cap embroidery (*Kube*) is underexplored in scholarship and practice. The key problem addressed in this study, therefore, is the limited application of digital integration in Hausa cap embroidery (*Kube*) design, and simulating weaving draft patterns through CAD. This research seeks to bridge that gap by demonstrating how CAD can support the creation of innovative, efficient, and aesthetically appealing embroidery designs.

Aims of study

- i. The aim of this study is to simulate weaving draft patterns using CAD in the design of hand embroidered caps (*Kube*).

Research questions

- i. How can the alphabetical coding method of pattern drafting in weaving be explored as an alternative to conventional (*kube*) cap patterns?
- ii. In what ways can drafted patterns be manipulated with computer software (CorelDraw) to simulate scalable embroidery patterns for (*kube*) caps?

2. Review of related literature.

Conceptual Framework

Certain design effects in weaving may not be fully attainable through weaving alone, and integrating weaving with embroidery offers a complementary technique that enriches the fabric surface and facilitates more complex decorative outcomes. Embroidery is a decorative art that enhances fabric through needlework to improve aesthetics, cultural symbolism, and identity (Shahera & Ibrahim, 2017). This study is grounded in the concept of name drafting as discussed by Peter (1994) and Griswold (2004), a creative method used in weaving to generate threading sequences from text. The selected string may carry personal, cultural, or symbolic meaning, and the core of name drafting lies in coding, where each character is assigned a specific shaft number to produce patterned structures. Drafting is a fundamental tool for the weaver or designer and serves as the foundation for fabric design and originality (Carol, 1981). Weaving drafts are graphical notations of interlacing warp and weft threads. Embroidery is characterized by flexibility and originality and works well with weaving by allowing additions outside the regular weaving grid (Amanda, 2017). Building on these ideas, this research focuses on using alphabetical code drafting simulated through Computer-Aided Design (CAD) to create precise embroidery patterns, viewing Hausa embroidery as a progression toward CAD-assisted design innovation while retaining cultural essence. When a draft is completed, the embroidery produced reflects the same design indicated in the draft. A complete understanding of drafting cannot be achieved through reading alone; it is developed through continuous practice. With repeated drafting and interpretation of drafts, the relationship between the draft and the embroidered outcome becomes clearer.

Embroidery in Nigeria

Embroidery is the art of decorating fabric or other materials by stitching designs with thread or yarn using a needle. It is not a method of fabric construction but a decorative technique and is sometimes misinterpreted as appliqué (Isaac, 2012). Hand embroidery involves stitching designs by hand and, although time consuming and painstaking, produces unique and interesting results that has been valued since humans began decorating clothing. Embroidery is commonly used for decoration and beautification purposes in West Africa and is still practiced in almost all parts of the world, either by hand or machine. Although embroidery is not indigenous to Nigeria, it has formed an integral part of Nigerian clothing culture.

The art is dominantly practiced in Nigeria by the Hausa in the North and the Yoruba of South Western Nigeria. Heathcote (1976) in Adiji et al. (2016) attributed the emergence of embroidery in Nigeria to trading activities with Arabs during the reign of Queen Amina of Zazzau (Zaria), with Islam influencing practices between the 12th and 14th centuries. The Islamic religion extensively used embroidery in decorating items such as mosques, caps, bedspreads and houses, while dignity and power have been attached to embroidered works worn by Emirs and Obas Gostelow, 1979 in Adiji et al. (2016).

Embroidery provides means of livelihood through yarn preparation, dyeing, design drawing, embroidery, and merchandising of products. Embroidery designs in Northern Nigeria differ from those in South Western Nigeria due to Islamic influence, which discourages representational arts. This resulted in linear and symmetrical embroidery designs applied to Hausa caps, skull caps, leather goods and calabashes (Bernard et al., 2014). Among the Nupe and Hausa, embroidery is a long tradition used on farmers' clothes, ceremonial garments and riding robes, with intricately embroidered robes symbolizing prestige and rank.

In South Western Nigeria, embroidery was traditionally used on male clothing such as *Sokoto*, *Buba* and *Agbada*. Despite cultural and social challenges, people continue to embrace embroidery to maintain traditional identity. Adediran (1997) in Adiji et al. (2016) noted that embroidery in Yoruba land improves structural aesthetics and finishing, initially preserving garment necklines. Northern embroidery commonly uses chain stitch, buttonhole stitch and couching, with indigenous silk thread known as (*Tsami*) a highly valued. Other embroidered textiles serve as bedspreads, tablecloths and wall hangings, including Hausa bridal sheets. Hausa cap embroidery particularly employs these stitches stem, chain, satin, and French knots, enabling both geometric and stylized motifs (Adedokun, 1995).



Figures 1 and 2: Ready to wear Kube caps from Northern Nigeria

Photograph: Abdullahi (2025)

Process of making hand embroidered caps in Northern Nigeria.

Caps are integral to Hausa identity, complementing attire and symbolizing culture, status, and fashion (Sani, 2020). Borno, particularly Kangarmaka and Bama, is famous for glossy, intricate caps. In Yola and Zaria, embroidery is a household craft involving design, stitching, washing, and sales (Adedokun, 1995). The materials used include ball pen, ruler, and markers of different colours for preliminary design work; needles of different sizes; fabric as the ground on which the embroidery is carried out; threads of different colours; and other tools such as the thimble (*sa'afi*), wooden stand (*kori*), and the stick used for beating (*manji*). Starch is also required for application on the cap after washing and production includes these steps:

- i. **Paperwork:** Drafting designs on gridded paper.
- ii. **Scaling:** Marking cloth with horizontal (*sarka*) and vertical (*sanda*) lines to guide embroidery.
- iii. **Stitching:** Using techniques such as stem, chain, satin, French knots, and blanket stitches.
- iv. **Washing/Finishing:** Washing, starching, and sun-drying on a wooden frame (*kori*). Caps may take 10–30 days depending on complexity.

Concept of Computer Aided Design (CAD)

Before CAD, designers were forced to draw everything by hand, and any alteration required redrawing the entire design. CAD software allows designers to visualize their designs, test them against real-world variables, and easily alter the same file. Sadrehaghighi, (2022) defines Computer-Aided Design (CAD) as the use of computer systems to aid in the creation, modification, analysis, or optimization of a design. CAD is used to increase productivity, improve design quality, enhance communication through documentation, and create a database for manufacturing. CAD may be used in two-dimensional (2D) and three-dimensional (3D) space and is widely applied in industrial and architectural design. CAD replaced manual drafting, enabling precise design development, manipulation, and optimization. for Hausa caps, CAD can digitize traditional drafts, manipulate name-drafted patterns, scale motifs accurately, and introduce innovative yet culturally relevant designs while preserving cultural authenticity.

3. Research Method

Name Drafting; a method of creating patterns in weaving.

Name drafting enables hand weavers to move from copying existing drafts to creating personalized designs through simple alphabetical coding. Griswold (2004) states that name drafting involves selecting a string of characters, often a word, phrase, or sentence, to create a threading sequence. The string may be a name, motto, or epigram. Although various methods exist, only a few codings are commonly used in literature, particularly for four shafts, there are three (3) specific methods for assigning letters of the alphabet to a four-shaft loom system.

The 26 letters of the English alphabet are systematically grouped and assigned numerical codes that correspond to specific shafts. Each group of letters represents the characters that will be lifted by a particular shaft during weaving.

1. Method 1 organizes the alphabet into four sequential groups where the first seven letters (A–G) are assigned to the first shaft, the next seven (H–N) to the second, the subsequent seven (O–U) to the third, and the final five (V–Z) to the fourth.
2. Method 2 follows a similar sequential pattern but adjusts the group sizes, assigning the first three sets of six letters (A–F, G–L, and M–R) to shafts one, two, and three respectively, while the remaining eight letters (S–Z) are assigned to the fourth shaft.
3. Method 3 takes a slightly different and more flexible approach. Instead of assigning long, straight blocks of letters to one shaft, the alphabet is shared gradually starting from A to D, then E to H, I to L, and continuing this way until Z is reached. This overlapping arrangement allows the letters to flow more naturally when they are translated into weave drafts. Each shaft in this method carries **two possible codes** rather than one. This is done to follow an important technical rule in overshot weaving **odd and even shafts must alternate**. In simple terms, if one letter is placed on an even-numbered shaft, the next letter must move to an odd-numbered shaft. When two letters that follow each other belong to the same shared group, the drafting simply alternates between the two shaft numbers assigned to that group (for example, from shaft 1 to 2). This makes it unnecessary to introduce extra incidentals, which could lengthen the sequence and complicate the design. As a result, Method 3 keeps the draft simple, maintains the odd–even rule of overshot weave, and shorter sequence.

4. Findings according to Research Questions

Research Question One:

How can the alphabetical coding method of pattern drafting in weaving be explored as an alternative to conventional (*kube*) cap patterns?

Suppose the string chosen is AADIL SANI and method 1 is used, The resulting sequence is 1,1,1,2,2,3,1,2,2. If method 2 is used, the sequence is 1,1,1,2,2,4,1,3,2. And if method 3 is used, the sequence is 3 1,2,4,1,4,3,2,3,2. Note that the blank between Aadil and Sani is ignored. One problem in mapping characters to shaft numbers is underutilization of some shafts. Weavers using name drafting often test different tables to achieve the best results. Name drafts are usually woven in overshot, which combines plain weave and weft floats to create bold geometric designs. Overshot requires alternating odd and even shaft numbers (alternating parity). When this is not met, the sequence is modified by adding incidentals, increasing its length. In this example, an incidental is one more than the preceding value, with 4 wrapping to 1, ensuring the structural requirements of overshot weaving are met.

For method one 1,1,1,2,2,3,1,2,2 there are five places where incidentals are needed. They could be added as follows, where the incidentals are underlined:

$$\begin{array}{llll} 1\&1 = 2 & 2\&2 = 3 & 3\&3 = 4 & 4\&4 = 1 \\ 1\&3 = 2 & 2\&4 = 3 & 3\&1 = 4 & 4\&2 = 1 \end{array}$$

$$\begin{array}{ll} 1_2 1_2 1_2 2_3 2_3 4_1 2_3 2. & 1, 2, 1, 2, 1, 2, 3, 2, 3, 4, 1, 2, 3, 2. \\ 1, 2, 1, 2, 1, 2, 3, 2, 3, 4, 1, 2, 3, 2, 3, 2, 1, 4, 3, 2, 3, 2, 1, 2, 1, 2, 1. \end{array}$$

$$\begin{array}{ll} \text{For method Two: } 1, 1, 1, 2, 2, 4, 1, 3, 2. & \\ 1_2 1_2 1_2 2_3 2_3 4_1 2_3 2. & 1, 2, 1, 2, 1, 2, 3, 2, 3, 4, 1, 2, 3, 2. \end{array}$$

For method Three: 1,2,4,1,4,3,2,3,2.

Name drafts usually are reflected about the centers to add symmetry and increase the visual appeal. In overshot weaves, the tie-up usually is a twill.

Method One: 1,2,1,2,1,2,3,2,3,4,1,2,3,,2,,3,2,1,4,3,2,3,2,1,2,1,2,1.

Method Two: 1,2,1,2,1,2,3,2,3,4,1,2,3,,2,, 3,2,1,4,3,2,3,2,1,2,1,2,1.

Method Three: 3 1,2,4,1,4,3,2,3,,2,,3,2,3,4,1,4,2,1,3.

Research Question Two:

In what ways can drafted patterns be manipulated with computer software to simulate scalable embroidery for (kube) caps?

The exploration of how drafted patterns can be manipulated with computer software to simulate scalable embroidery for *kube* caps was also successfully carried out by the researcher, as detailed shown below.

Simulation using COREL DRAW.

CorelDraw was used to digitally simulate the name-drafted weaving patterns, transforming theoretical drafts into visual embroidery designs. The simulation process moved from simple drafts to advanced layouts, ensuring adherence to weaving principles such as symmetry, repetition, and balance while reflecting the aesthetic qualities of each name-derived pattern. A grid based on a 1.2 mm² unit block was created to map threading and treadling sequences, revealing distinctive motifs. Selected blocks were filled to reveal weave patterns and generate distinctive motifs.

The Drafts

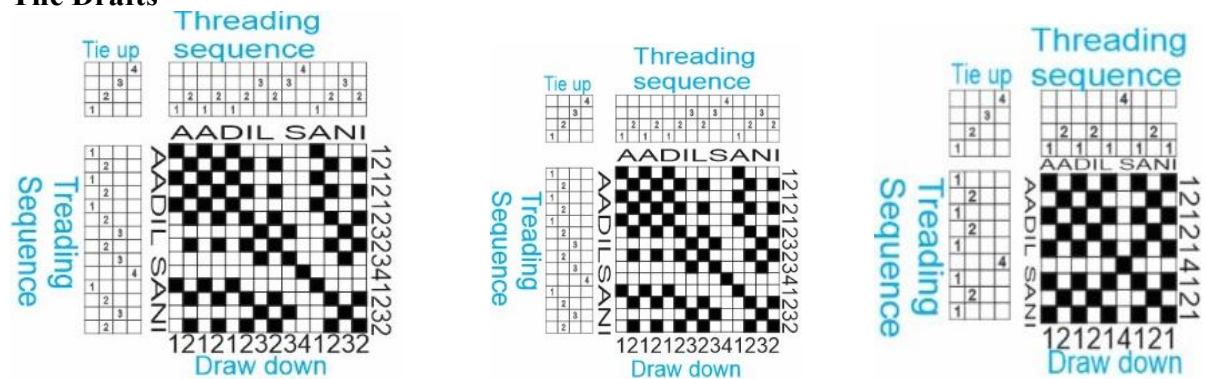


Figure 3: Aadil Sani method 1, 2 and 3
Source: Abdullahi (2025)

Designs.

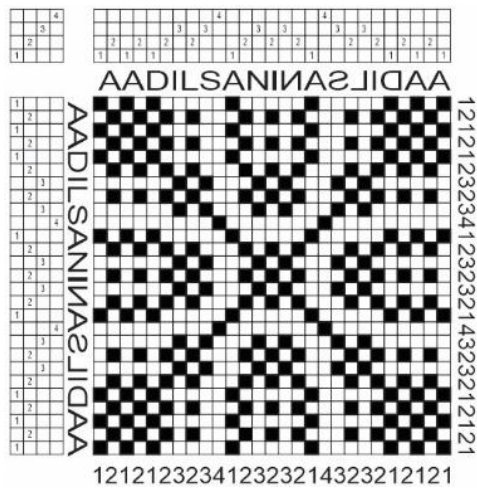


Figure 4: A unit of Aadil Sani method 1
Source: Abdullahi (2025)

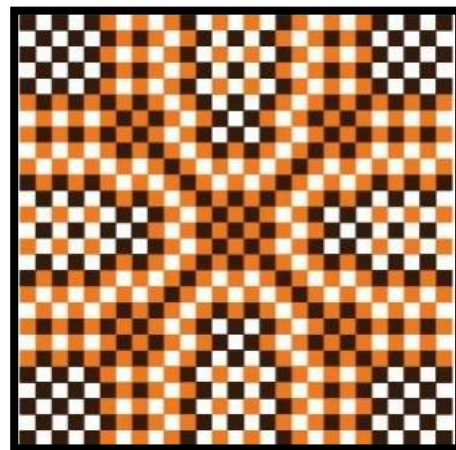


Figure 5: coloured unit for Aadil Sani method 1
Source: Abdullahi (2025)

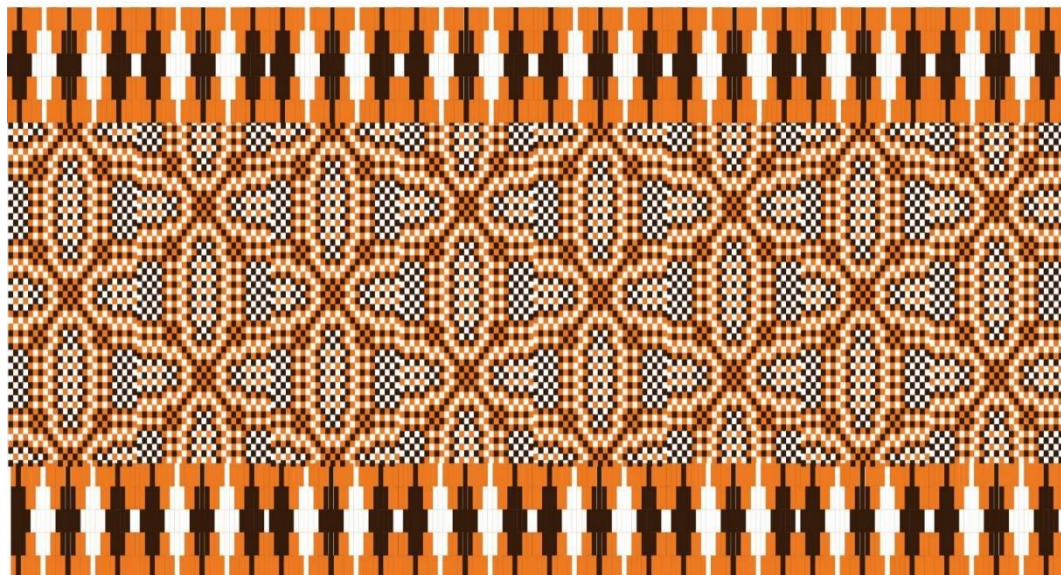


Figure 6: Design for body of cap, units placed using half drop presentation.
Source: Abdullahi (2025)

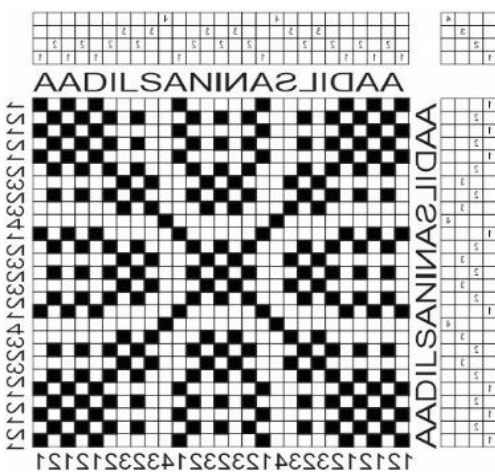


Figure 7: A unit of Aadil Sani method 2
Source: Abdullahi (2025)

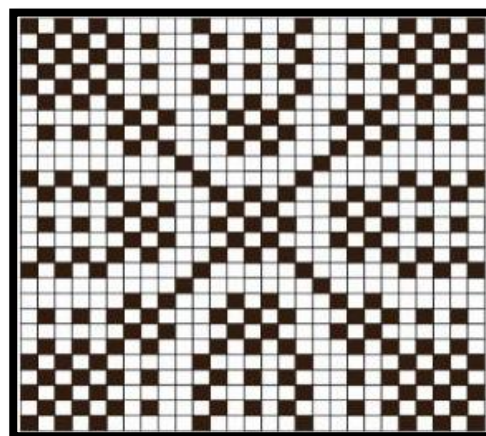


Figure 8: Coloured unit for Aadil Sani method 2
Source: Abdullahi (2025)

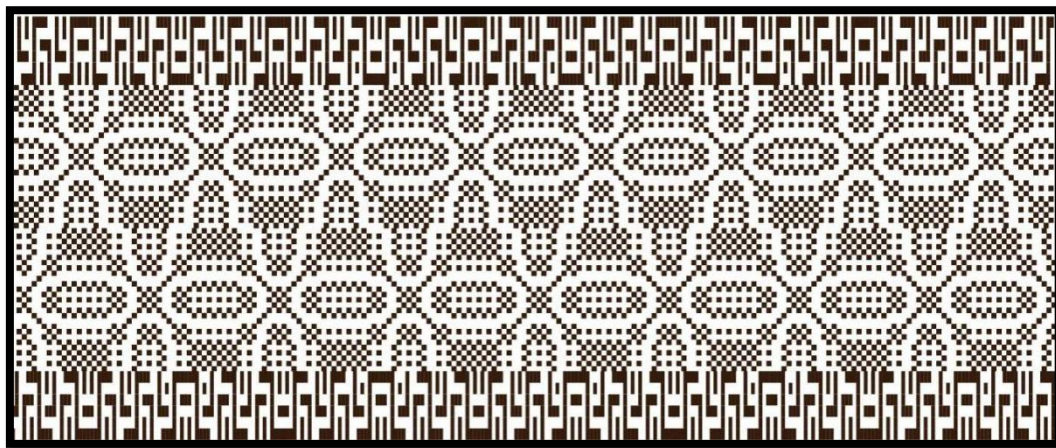


Figure 9: Design for body of cap, units placed in half slide presentation.

Source: Abdullahi (2025)

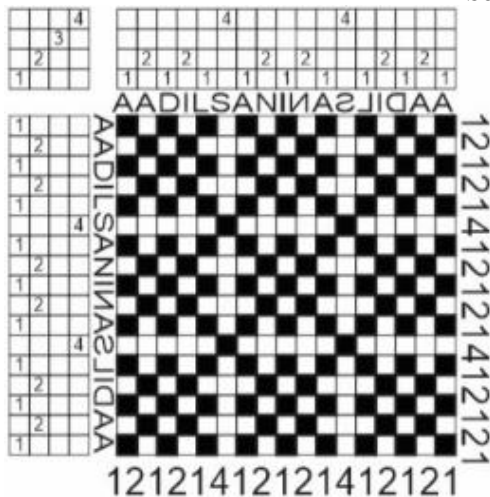


Figure 10: A unit of Aadil Sani method 3

Source: Abdullahi (2025)

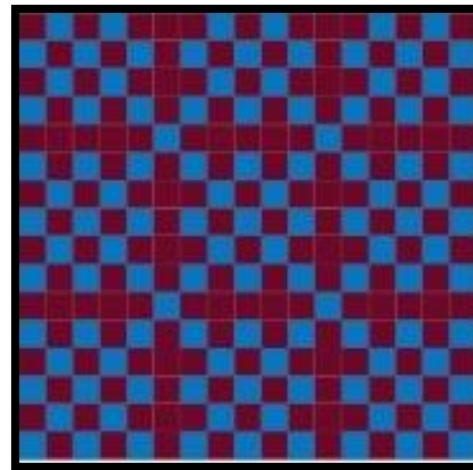


Figure 11: coloured unit for Aadil Sani method 3

Source: Abdullahi (2025)

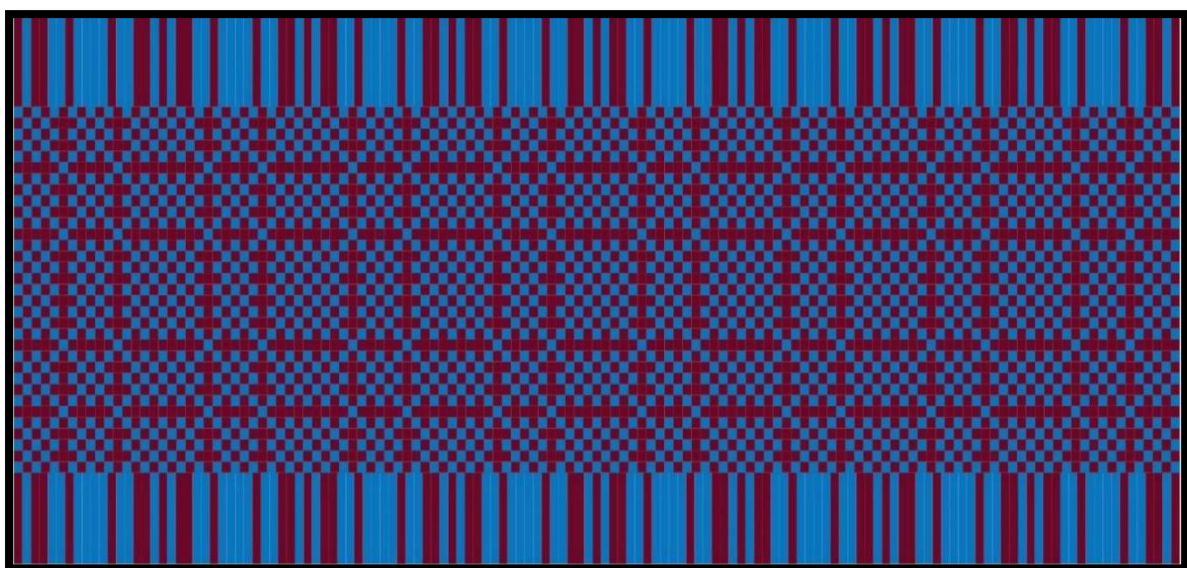


Figure 12: Design for body of cap units placed using simple repeat presentation.

Source: Abdullahi (2025)

Discussion

This study documented the processes involved in producing simulated name-draft hand-embroidered Hausa caps using Computer-Aided Design (CAD), contributing to the limited literature on indigenous embroidery production and finishing techniques (Gwari & Alesagba, 2024). Alphabetical coding method was meaningfully explored as an alternative to the traditional way of drafting kube cap patterns. The process showed that alphabetical coding can make pattern drafting more organized and easier to understand, especially for detailed and repetitive designs. Using the name AADIL SANI, three coding methods generated different shaft sequences, revealing that some mappings led to shaft underutilization and parity conflicts. These challenges were resolved by introducing incidentals to satisfy the alternating odd-even requirement of overshot weaving. Reflection of the sequences enhanced symmetry and visual balance, while a twill tie-up supported structural consistency.

The research also demonstrated clear ways in which computer software can effectively support and enhance the manipulation of drafted patterns. CorelDraw enabled the transformation of theoretical drafts into scalable embroidery designs through grid-based simulations. By applying repetition, symmetry, colour variation, and layout techniques, the software facilitated the development of diverse and adaptable cap designs. Through CAD tools, drafted patterns can be scaled up or down without losing their proportions, allowing artisans to adjust designs to different cap sizes with accuracy. The software also makes it possible to simulate the final embroidered appearance, giving users a preview of alignment, and overall balance before any physical work begins.

Summary

The study was motivated by the problem of limited scholarly documentation on Hausa cap embroidery and to integrate simulation of weaving draft and use of CAD, despite its cultural, social, and economic importance in Northern Nigeria. While Hausa embroidery has long been recognized as an integral craft tradition, the lack of comprehensive research on design processes created a gap in knowledge. The findings show that alphabetical coding (name drafting) can be effectively explored as an alternative to conventional *kube* cap patterns. Computer simulation with CorelDraw successfully transformed these drafts into scalable embroidery designs.

Conclusions

The study concludes that alphabetical coding (name drafting) is an effective alternative to conventional *kube* cap patterns, as it generates diverse and meaningful designs from personal names. Adjusting shaft sequences with incidentals ensures compliance with overshot weaving requirements while enhancing symmetry and visual balance. The use of CorelDraw successfully translated theoretical drafts into scalable embroidery patterns, allowing precise manipulation of repetition, colour, and layout. Overall, the integration of name drafting and computer-aided design expands creative possibilities and supports the modernization and sustainability of traditional Hausa cap embroidery. Grid-based digital mapping enabled experimentation with symmetry, repetition, colour, and layout, resulting in visually balanced and adaptable cap patterns suitable for embroidery production. With some training and support, artisans could use these tools to modernize traditional patterns, including alphabetical-drafted designs, making their work both faster and more accurate.

References

- Adedokun, B. A. (1995). *Cap embroidery in Yola* (Unpublished master's thesis). University of Ibadan.
- Adiji, B. E., S., R. O., & E., B. O. (2016). The documentation of embroidery types in South Western Nigeria. *Global Journal of Interdisciplinary Social Sciences*, 5(7), 7–14.
- Amanda, Z. (2017). *Crafting ourselves: Producing knowledge and constructing identities through contemporary handmade embroidery* (Master's thesis). Radboud University, Netherlands.
- Bernard, E. D., Emmanuel, R. A., & Isaac, K. A. (2014). Traditional hand embroidery and simple hand-woven structures as decorative crafts for garment manufacturing. *International Journal for Innovative Research and Development*, 3(1), 1–10.
- Carol, S. K. (1981). *A study guide for drafting, design and colour*. Hastings House Publishers.
- Griswold R. E. (2004) *Code Drafting, Part 1: Introduction*, Department of Computer Science. The University of Arizona Tucson, Arizona
http://www.cs.arizona.edu/patterns/weaving/webdocs/gre_cd1.pdf
- Gwari, B. W., & Alesagba, I. E. (2024). Revitalizing Okun traditional woven fabrics: A comprehensive study of socio-cultural and economic impacts in Southwestern Nigeria. *International Journal of Design and Fashion Studies*, 12(2), 55–72.
- Isaac, K. A. (2012). *Exploiting techniques in Ashante indigenous hand embroidery for Adinkra cloth production* (Unpublished master's thesis). Kwame Nkrumah University of Science and Technology
- Kashim, I., Ologunwa, T. P., & Ogunlade, B. A. (2014). Sustainable Hausa design, cultural and usability: A reflection on the art of Northern Nigeria. *Advances in Social Sciences Research Journal*, 1(5), 33–44.
- Peter, M. (1994). *Overshot: A manual for creative drafting and weaving*. Chesebro-Mitchell Associates.
- Sadrehaghighi, I. (2022, January). Computer aided design. *ResearchGate*.
<http://www.researchgate.net/publication/358140456>
- Saidu, A. (2013). *A historical survey of handmade cloth embroidery in Daura local government of Katsina State* (Unpublished Master's Thesis). Ahmadu Bello University, Zaria.
- Shahera, A., & Ibrahim, A. (2017). Creative approaches to the art of hand embroidery design: One outfit. *Current Science International*, 6(1), 145–166.