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Generating Weaving Codes of Abel Iloko

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ABSTRACT

The study described the weave patterns used in abel products like slippers, face masks, and pouch bags and developed weaving codes in designing these products. The coding theory, an application of number theory and the use of the binary decimal codes, was used and applied to describe and develop the codes of the designs in the Abel Iloko Products in Ilocos Sur. The result guided the researchers in generating weaving codes for the designs of slippers, face masks, pouches, and bags. The study employed descriptive and developmental research designs. It explored the different weave patterns found in the Abel Iloko products. It is developmental because the study aims to generate weaving codes based on the patterns used in the production of Abel Iloko. Moreover, the results provide new research directions and ideas for innovation. Based on the findings, the following are recommended: Instructional medium may be used as a medium of learning for students in Ilocos Sur, where learning could be made more varied, and students get to know their culture and preserve the culture of Abel Iloko products. Researchers may use the results as a basis for future research to develop a warp-weighted loom simulation so that historical weaving processes may be explored and shared to generate new fabrication possibilities.

Keywords: *Generate, weaving, code, abel, binary*

INTRODUCTION

The weaving culture in the Philippines dates back to the 13th century. The tradition makes use of raw materials like local cotton, abaca, fibers, and pineapples. Many Filipinos are very spiritual people; in fact, our traditions are rooted in beliefs that were passed on by our ancestors. Through the years, as we can observe in our country, the number of weavers and pocket communities that uphold the tradition of weaving has become smaller and smaller, and consequently, more women are losing their source of livelihood. With this, the production and the usage of traditionally woven cloths were also rapidly declining, and inabel cloth weaving has no exemption from this. Inabel weaving is one of the prides of the Ilocos region in the Philippines. "Abel" is the Ilocano word for weave, and "inabel" can be interpreted to mean any kind of woven fabric that may mirror the culture of the weaver. However, to the Ilocanos, the inabel is particularly used to refer to textiles that are distinctly Ilocano in origin.

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Debeli and Jiu (2013) mentioned that textile designers put their sentiments into the design process. These sentiments and original ideas are sourced from the cultural background of designers.

Weaving is culturally significant to NERI women, as women who weave contribute to the household income and hold a higher social status as compared to women who do not weave (Dias et al., 2020). Twill weaves are made by interlacing the yarns in a manner that produces diagonal ribs, ridges, or wales across the fabric. Wales may run from the upper right to the lower left of the fabric or the reverse. The herringbone weave has Wales running both ways. Knitting is a folk practice connected to society. As educators, we do not mathematize the procedure, but the mathematical content and skills embedded in the process of weaving include estimation, making relations, communicating counting, patterns, transformations, and symmetry. Taban and Cadorna (2019) stated that some features of teaching approaches improve the communication skills of students, they learn to express all they can say related to the given problem. It may not be in verbal form, but at least they can translate their thinking into visual presentations.

In the Jacquard loom, each distinct pattern to be woven is defined by a specific encoding of the pattern in a closed-loop series for punched cards. The loom reads this pattern and weaves the cloth accordingly. By changing the batch of punched cards, the loom weaves a different pattern. The same loom, a finite device, has the capability for, potentially, an infinity of weaving patterns. In the Analytical Engine, the computation of each distinct mathematical function is determined by an ordered sequence of (arithmetic) operations on the values of variables. These sequences of operation (in present-centered language programs) can be encoded as patterns of holes on punched cards. The machine reads a particular set of punched cards, and a different sequence of operations corresponding to a different mathematical computation is performed. In the evocative words of Lovelace, the three analytical engines would weave 'algebraic patterns' much as the Jacquard loom wove flowers and leaves. The matrix relates to the practice of weaving because, as Sabine Eckmann (scholar, director, and chief curator of the Mildred Kemper Art Museum in St Louis, Missouri) describes matrices, weaving makes "the invisible visible," it produces an object that is dependent on links and connections. The matrix is identified with the computer, and the computer creates matrices that use grids, but these grids change, move, and shift. In this way, the matrix expands the idea of the grid as a way of hinting at the possibility of what we cannot see and includes the many possibilities of what we cannot see or experience in many overlapping dimensions (Krauss, 1978). They have not considered women weavers' connections to the indigenous art of weaving. However, understanding these connections may be valuable, as textile traditions may be intimately bound with the development of individual and community attitudes and beliefs and cultural identity (Dias et al., 2020).

In the Philippines, the Ilocos Region has areas of land for farming compared to other regions. To survive, Ilocanos have taken full advantage of the use of the small space available to them for planting. The Ilocanos are naturally cautious, resourceful, practical, and thrifty. The Ilocano families engage in other profitable work to increase their income. Some dye and spin yarns. They weave clothes, jackets, blankets, towels, bags, napkins, and tablecloths (Malicdem & Perilla, 2019).

Off the southern part of Vigan City lies the town of Caoayan. Weavers witness how locals turn colorful strands of cloth into something beautiful. Painstakingly, they weave these by hand, turning simple yarns into something intricately beautiful to an abel, Ilocos province's traditional woven product. Every Ilocano worth his salt has an abel somewhere in their house, the fabric being an intrinsic part of their lives. From birth, Ilocanos are wrapped in an abel blanket. During their weddings, they wear dresses made from abel. Even in death, they are again wrapped in a blanket made of the same material. The abel, however, goes back to the Pre-Colonial Era when ladies were once required to know how to weave looms. Believe it or not, these products were even bartered for gold and were sometimes used to pay taxes. Its quality was so good that it managed to threaten Spain's textile industry.

Weaving is the process of knitting a piece of cloth by interlacing two sets of threads (warp and weft) on a loom. Every weave displays a two-dimensional arrangement of warp and weft intersections that may be mathematically represented by a binary matrix: 1 represents warp on a weft, 0 represents weft on the warp, and vice versa. Weaving is an old method of producing textiles to manufacture cloth, with thousands of years of history. With the advancement of materials, machinery, and information, the functions of fabrics and garments are no longer limited to weather protection or aesthetic requirements; multifunctional garments have been developed for a variety of purposes, including bulletproofing, fireproofing, health care, wearable computing, and so on. The coding function of woven fabric, on the other hand, has never been identified or used to produce high-tech smart textile devices.

Each cross point of woven fabric could be considered as a binary element with two states: warp on weft and weft on warp (refer to Figure 3). A set of parallel warp yarns is driven and controlled by a loom to form an open or closed shed sequentially for the filling of weft yarns through the shed, as shown in Figure 4. Information in a binary format could represent the sequences of yarn interlacing along the warp and weft directions. For ease of mathematical description, a 2D matrix, whose elements are either 1 or 0, is used to record the data contained in the weave code, as depicted in Figure 5. An additional column and row containing color information of each yarn could be added to describe the color weave code mathematically (Baciu et al., 2016).

A textile design may have different levels of brightness depending on the local density of the crossing points as well as the colors of yarn that are shown on the top. Inappropriate

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designs result in uneven grid points and partial fabric tightness as a consequence of the pattern being used. Textile designs have been carefully created since antiquity, taking into consideration a variety of factors and learning through trial and error. In recent years, techniques for developing textile patterns with the assistance of computers have been developed, making it feasible to generate patterns that are more complicated in their design and construction. The study of Marfo and Marley (2015) aimed at generating textile patterns and innovative artistic and constructional designs for artists and architects by the development of programming procedures based on the codes obtained from the analysis of patterns used.

The southern part of Vigan City lies the town of Caoayan. Here, people witnessed how locals turned colorful strands of cloth into something beautiful. Painstakingly, the workers weave these by hand, turning simple yarns into something intricately beautiful to an abel, Ilocos province’s traditional woven product. Abel Weaving in Ilocos Every Ilocano worth his salt has an abel somewhere in his house, the fabric being an intrinsic part of their lives. From birth, they are wrapped in an abel blanket. During their weddings, they wear dresses made from abel. Even in death, they are again wrapped in a blanket made of the same material. Spools for Abel Weaving in Ilocos Loom weaving is not unique in the Ilocos Region, but what separates it from the rest of the country is the nature of the material they use in producing it. The yarns are made from cotton and dyed from the sap of a plum called sagut. These are abundant on the lands north of Luzon.

One of the many concerns of the textile industry is the sustainable development of textiles. There are issues in the connection between the cultural needs of increasing consumers and the development of the designs of the textiles that are produced. Moreover, the rise of 3D printing has allowed designers to create customized designs. This study aims to explore how binary codes and algorithms could be used to promote the sustainability of textile designs and to give a better understanding of cultural sustainability in the textile industry.

Objectives of the Study

This study aimed to describe the weave patterns used in Abel Iloko products, such as slippers, face masks, and pouch bags, and to develop weaving codes for these designs using coding theory and binary decimal codes. Additionally, the study aimed to propose future research directions, including the development of a warp-weighted loom simulation to explore historical weaving processes and innovations in fabrication techniques.

METHODOLOGY

This section presents the research design, population and sample, data gathering procedure, ethical consideration, and statistical treatment of data.

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Research Design

The study employed descriptive and developmental research designs. It explored the different weave patterns that are found in the Abel Iloko products. Moreover, it is developmental because the study aims to generate weaving codes based on the patterns used in the production of the Abel Iloko.

Conceptual Framework of Weaving Codes

The basic computer language made of 0s and 1s originated in the automation of looms. Weaving code connects hand-weaving to 3D printing. While a piece of textile is produced on the loom, an object is generated by the computer using the same binary code. By turning weaving patterns into a programming language, weaving code will be able to explore how traditional crafts and digital tools can enhance each other and offer an alternative interpretation of technology at large.

Weaving Code sits at the intersection of hand weaving, programming, and 3D printing. The binary language, using only 0 and 1, traces back to the Industrial Revolution, originating from the automation of looms. Punch cards are used to generate patterns containing digital data represented by the presence or absence of holes in specific positions. By translating woven patterns into a programming language, Weaving Code explores how traditional craftsmanship and digital tools can enhance one another, offering a new perspective on technology. These textiles are created as follows: each time a piece comes off the loom, the computer generates an object in binary code, which is then 3D printed and integrated into the handwoven textile.

In mathematics and digital electronics, a binary number is expressed using only two symbols, 0 and 1, a system simple to implement and used by nearly all computing devices.

The idea of using a binary code to represent information is not a new one; it's been used in many different cultures throughout history in the art of weaving. Weaving involves the interlacing of threads in a specific pattern to create a textile. In weaving, binary code was used to represent the interlacing of threads in a specific pattern. Each thread in a weave can be thought of as either "on" or "off" depending on its position in the pattern. For example, in a basic plain weave, the weft thread alternates over and under the warp threads, creating a pattern of 1s and 0s. This pattern could be extended to more complex weaves, where different combinations of over and under create more intricate designs.

The Baudot code is a binary code that uses 5 bits per symbol. It was developed by Emile Baudot in the 1870s for telegraphy. This code represents 32 different characters ($2^5 = 32$), allowing for the transmission of letters, numbers, and control characters. Digital encoding system and weaving process share the same principle as both rely on binary logic, the presence or absence of a hole, and the sequence of 0s and 1s, which is the Baudot Code. While

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the Baudot code was not directly used in weaving, its principles echo the binary data representation.

Sources of Data

The main sources of data for this study are the Abel Iloko products in Caoayan, Ilocos Sur. These Abel products may be in different forms such as facemasks, bags, slippers, and pouches. The products were limited to one shop only which limits also the presentation of a distinctive quality of a particular culture. Commercializing traditional weaving techniques may not be easy due to the conflict between preserving cultural heritage, adapting to market demands, and competing with modern production methods. Strategic approaches should be employed to ensure meaningful analysis and be able to come up with reliable models. The ideas or design must be given thoughtful strategies while respecting and preserving cultural essence.

Data Gathering Instruments

The binary code decimal was used in the study to generate weaving codes for each of the Abel Iloko products. The figure below is the binary code decimal used to generate the weaving textile codes.

BINARY	DECIMAL
00000	0
00001	1
00010	2
00011	3
00100	4
00101	5
00110	6
00111	7
01000	8
01001	9
01010	10
01011	11
01100	12
01101	13
01110	14
01111	15
10000	16
10001	17
10010	18
10011	19
10100	20
10101	21
10110	22
10111	23
11000	24
11001	25
11010	26
11011	27
11100	28
11101	29
11110	30
11111	31

Figure 1

Binary Code Decimal for Weaving Textile Codes (https://stanford.io/3x7JsvE)

Data Gathering Procedure

Figure 2 guided the researchers in gathering the needed data. They gathered designs from the weavers of Abel Iloko, created a model on the products' patterns, and constructed a matrix to be applied in the given weave code decimal. After this, the outcomes of Abel Iloko

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products were analyzed when binary codes were applied. Lastly, researchers decoded the final result of the products' patterns.

Image analysis was used to identify the internal weaving structure of fabrics and determine the traditional procedures. As described in coding theory, it is conventional to represent information as being in one of two possible states: a switch up or down, on or off, a hole punched or not, and so on. Each cross point of woven fabric could be considered as a binary element with two states: warp on weft and weft on warp.

Weaving codes can be applied practically in teaching weaving techniques or software skills, as students can use the codes to understand weaving structures, experiment with patterns, and learn textile technology. This is also advantageous to textile production as weaving codes translate creative patterns into precise instruction, thus making production more innovative.

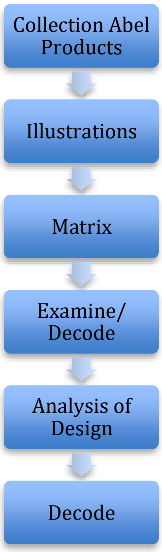

Figure 2

Steps in Gathering Data

There are several challenges in interpreting binary codes for non-traditional products. One is since binary codes are abstract representations, a precise mapping of binary sequences to material properties is a requirement. Another is on the material constraints which may not behave predictably during the production. In the use of machines, one limitation could be that the production machinery may not support the complexity or precision required for non-traditional products

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Data Analysis

The following illustrations served as guides for the researchers in analyzing the weave patterns, generating the specific weaving code, and determining the process of Abel Iloko.

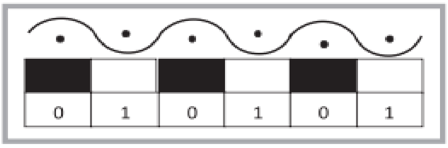

Figure 3
Binary status of yarn interlacing (Vector format)

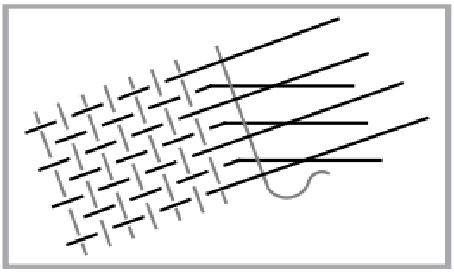

Figure 4
Formation of a weave pattern

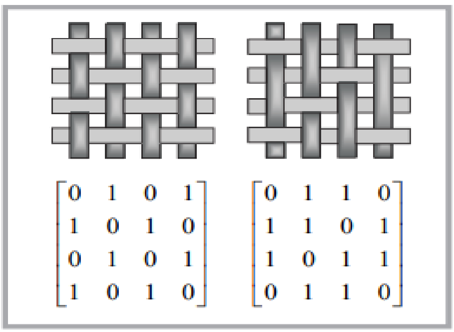

Figure 5
Mathematical description of a weave code (Matrix format)

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RESULTS AND DISCUSSIONS

This part presents the results and discussions to answer the objectives raised in this study. The results are presented with figures about the different Abel Iloko products.

Weave patterns used in the design of the Abel Iloko products

Weave patterns in the design of the selected Abel Iloko products were investigated by the researchers by looking into how the patterns were generated. The Abel Iloko products that are generated in Figures 6, 7, 8, and 9 are slippers, facemasks, pouches, and bags.

Figure 6
Slippers

Figure 6 shows different patterns. The slipper upper part has a satin weave pattern and the lower part has a twill weave pattern. This is the same as what Taban and Cadorna (2022) found in the geometric designs of Ilocano wood carving, patterns used, such as symmetry, parallelism, transformation, and proportionality, on the furniture products.

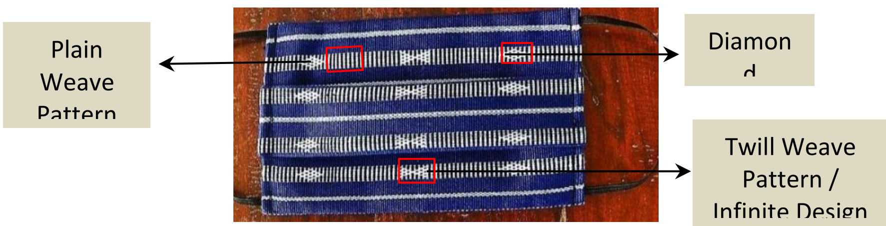

Figure 7
Face mask

Figure 7 shows that the facemask was made using different outlines which are plain and twill weave patterns. In the vertical middle part, it is like an infinite design, and on both sides, it has a diamond design.

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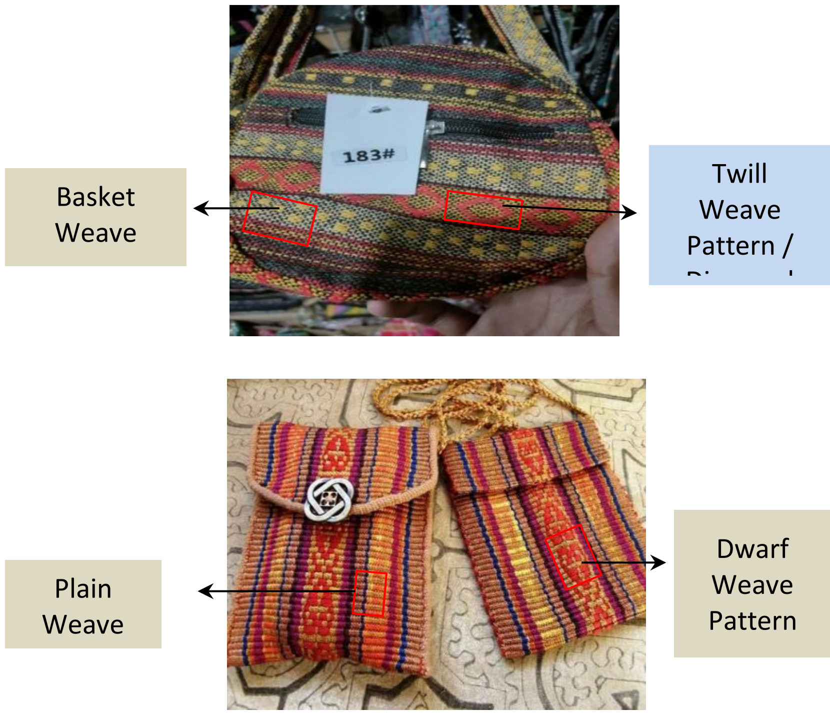

Figure 8

Pouch

It is evident from Figure 8 that the Abel Iloko products used different forms. The upper pouch has a combination of diamond design, twill weave, and basket weave patterns. Whereas the lower pouch used plain weave and the mid part has a dwarf pattern.

Figure 9

Bag

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Figure 9 reflects that the Abel Iloko products have diverse designs. The bag has a combination of plain weave and unbalanced twill to five harness satin weave patterns.

Weaving codes in the design of the Abel Iloko Products

The following figures show the weaving codes of slippers used in this study.

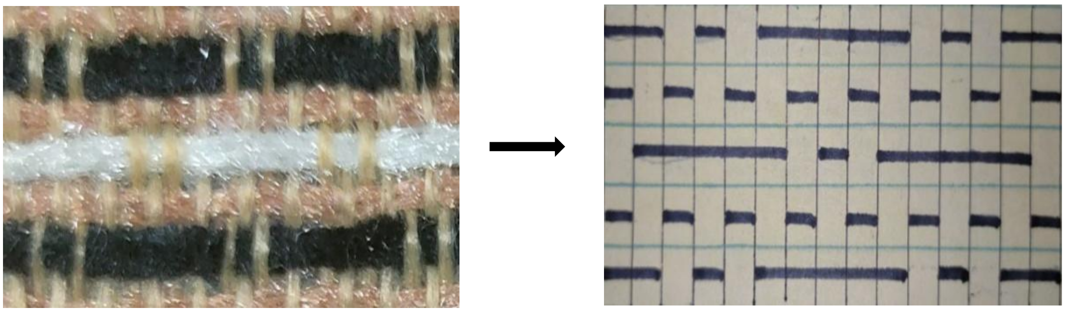

Figure 10
Slippers

This figure shows the enlarged photo of the design of the slippers used in the study. This is necessary since, from this illustration, the lengthwise yarn (warp) and crosswise yarn (weft) are closely seen.

Notice that Weavers would use a system of dots and dashes to represent the 1s and 0s in the pattern. A dot would represent an "on" thread, while a dash would represent an "off" thread. This system of representing patterns allowed weavers to create complex designs using a binary code long before computers existed.

0	0	1	0	1	0	0	0	0	0	1	0	1	0	0
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
1	0	0	0	0	0	1	0	1	0	0	0	0	0	1
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
0	0	1	0	1	0	0	0	0	0	1	0	1	0	0

→

5	0	21
10	21	10
16	10	1
10	21	10
5	0	21

Figure 11
Translated Binary Code of the Slippers' Design

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Figure 11 shows the mathematical description of the weave code used in matrix form. The entries of the matrix were based on the warp, coded by 1, and the weft was coded by 0. The size of the matrix depends on the length of the design that is considered to be coded. The bigger the size of the matrix, the better since the pattern or the sequence of the design could be easily seen and traced. In this particular product, a 15 x 5 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next matrix based on the Baudot code.

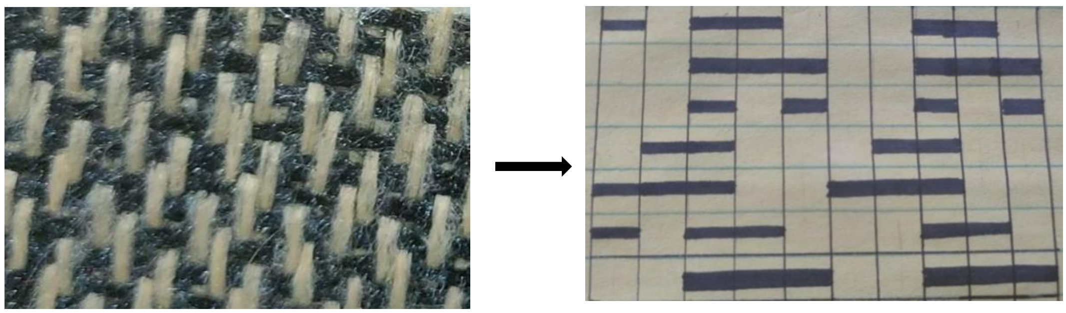

Figure 12
Illustration of the Slippers' Lower Design

This figure shows how the design of the lower part of the slippers is illustrated. From this illustration, the warp and weft are closely seen. This is utilized for binary coding.

The binary code is presented in Figure 13 using a 10 x 7 matrix.

0	1	0	0	1	1	1	0	0	1
1	1	0	0	0	1	1	0	0	0
1	1	0	1	0	1	1	0	1	0
1	0	0	1	1	1	0	0	1	1
0	0	0	1	1	0	0	0	1	1
0	1	0	0	1	1	1	0	0	1
1	1	0	0	0	1	1	0	0	0

→

9	25
24	24
26	26
19	19
3	3
9	25
24	24

Figure 13
Translated Binary Code of the Slippers' Design

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Figure 13 shows the mathematical description of the weave code used in matrix form. The entries of the matrix were based on the warp (1), and weft (0). In this particular product, a 10 x 7 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

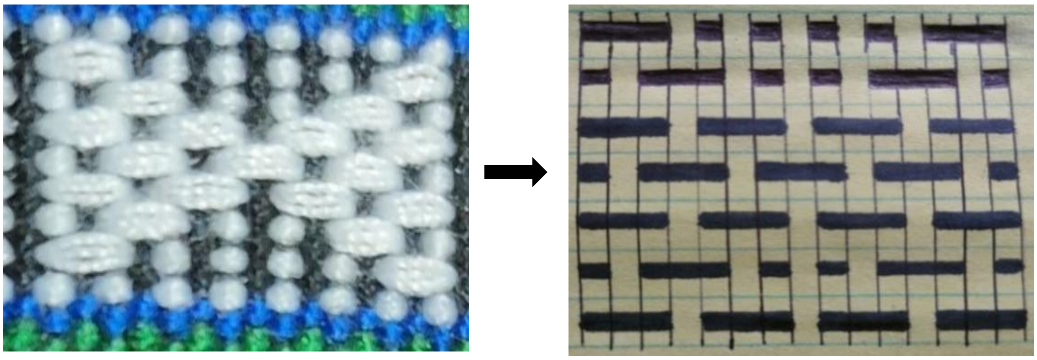

Figure 14
Illustration of the Facemask's Design

The facemask used in the study shows the illustration where the binary code will be taken. The conversion of the design to binary code is seen in Figure 15.

$$\begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix} \rightarrow \begin{matrix} 2 & 21 & 8 \\ 8 & 21 & 2 \\ 2 & 4 & 8 \\ 8 & 17 & 2 \\ 2 & 4 & 8 \\ 8 & 21 & 2 \\ 2 & 21 & 8 \end{matrix}$$

Figure 15
Translated Binary Code of the Facemasks' Design

Figure 15 gives the mathematical description of the weave code used in matrix form. This is represented by a 15 x 7 matrix. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

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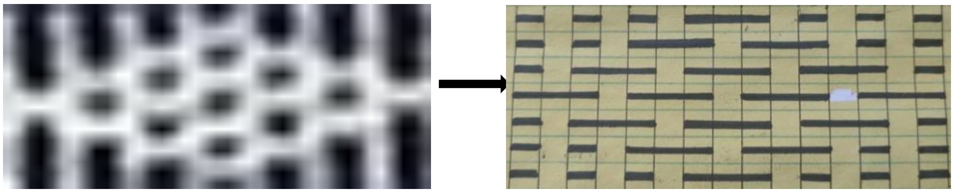

Figure 16
Illustration of the lower design of the Facemasks

0	1	0	1	0	1	0	0	0	1	0	1	0	1	0
0	1	0	1	0	0	0	1	0	0	0	1	0	1	0
0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
0	1	0	1	0	0	0	1	0	0	0	1	0	1	0
0	1	0	1	0	1	0	0	0	1	0	1	0	1	0

→

10	17	10
10	4	10
8	17	2
2	4	8
8	17	2
10	4	10
10	17	10

Figure 17
Translated Binary Code of the Facemasks' Design

Figure 17 shows the mathematical description of the weave code used in matrix form. In this particular design, a 15 x 7 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

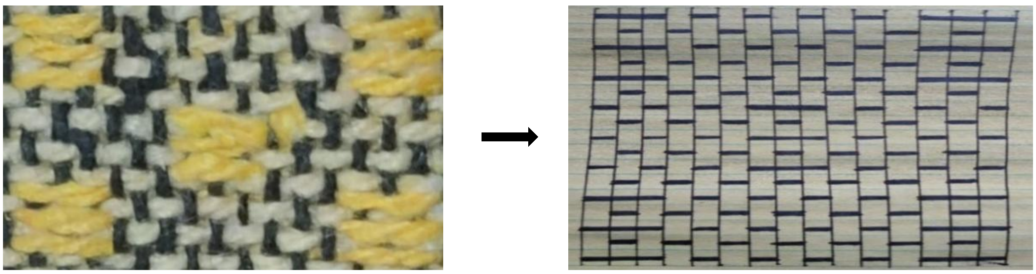

Figure 18
Illustration of the other side of Pouch Design

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This figure shows the enlarged photo of the pouch's design used in the study. The illustration is shown on the right side of the figure. The illustration is used to represent the matrix form of the binary code.

0	0	0	1	0	1	0	1	0	1	0	1	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1	0	1	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1	0	1	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	0	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	0	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	0	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1	0	1	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1	0	1	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1	0	1	0	0	0

→

2	21	8
21	10	21
2	21	8
21	10	21
2	21	8
21	10	21
10	17	10
21	10	21
10	17	10
21	10	21
10	17	10
21	10	21
2	21	8
21	10	21
2	21	8
21	10	21
2	21	8

Figure 19
Translated Binary Code of the Pouches' Design

Figure 19 presents the mathematical description of the weave code used in matrix form. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

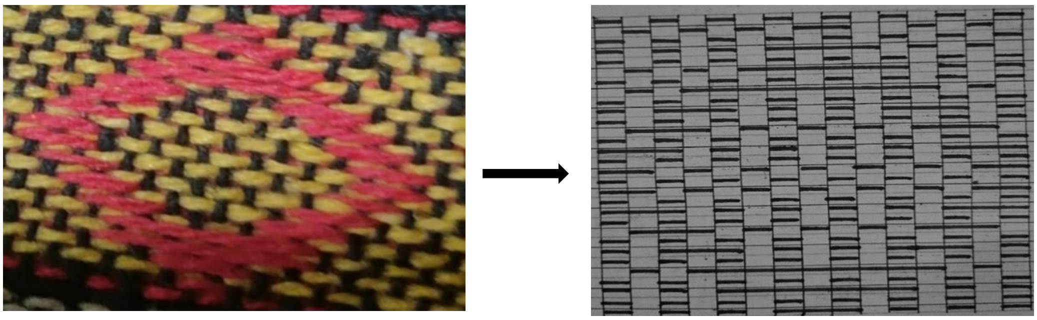

Figure 20
Illustration of the Pouches' Design

This figure illustrates the enlarged photo of the design of the pouch used in the study. This is necessary since, from this illustration, the lengthwise yarns (warp) and crosswise yarn (weft) are closely seen.

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$$
\begin{bmatrix}
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&1&0&1&0&1&0&0&1&1&0&1&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&1&0&1&0&1&0&0&0&0&1&0&1&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&1&0&1&0&0&0&0&0&0&1&0&1&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&1&0&0&0&0&0&0&0&0&0&1&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&1&0&0&0&1&0&1&0&1&0&0&0&1&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&0&0&1&0&1&0&1&0&1&0&0&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&0&0&1&0&1&0&1&0&1&0&1&0&0&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&0&1&0&1&0&1&0&1&0&1&0&1&0&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&0&1&0&1&0&1&0&1&0&1&0&1&0&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&0&0&1&0&1&0&1&0&1&0&1&0&0&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&0&0&1&0&1&0&1&0&1&0&0&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&1&0&0&0&1&0&1&0&1&0&0&0&1&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
1&0&1&0&0&0&0&0&0&0&0&0&1&0&1\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&1&0&1&0&0&0&0&0&0&0&1&0&1&0\\
0&1&0&1&0&1&0&1&0&1&0&1&0&1&0\\
0&1&0&1&0&1&0&0&0&1&0&1&0&1&0
\end{bmatrix}
\rightarrow
$$

10	21	10
21	9	21
10	21	10
10	16	21
10	21	10
21	0	21
10	21	10
21	21	5
10	21	10
8	21	5
10	21	10
17	10	17
10	21	10
2	21	8
10	21	10
5	10	20

Figure 21
Translated Binary Code of the Pouches' Design

Figure 21 shows the mathematical description of the weave code used in matrix form. The size of the matrix depends on the length of the design that is considered to be coded. In this particular product, a 15 x 17 matrix was obtained to present the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

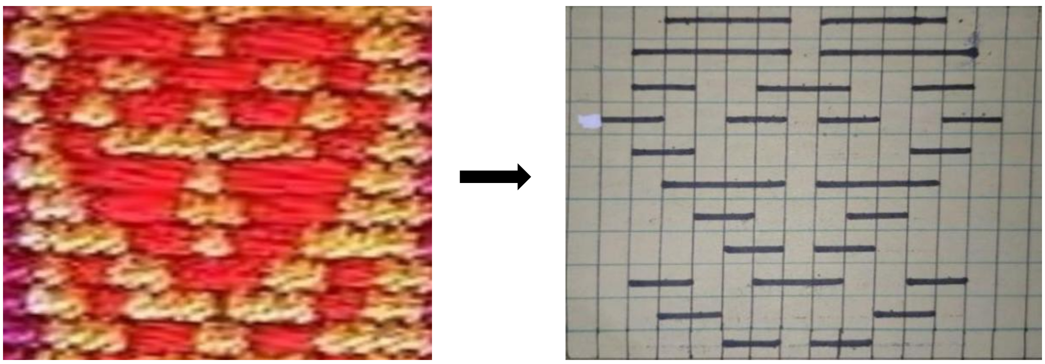

Figure 22
Illustration of the Pouches' design

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This figure shows the enlarged photo of the design of the pouch used in the study where the lengthwise yarn and crosswise yarn is closely seen.

$$\begin{bmatrix} 1&1&1&1&1&0&0&1&0&0&1&1&1&1&1 \\ 1&1&1&0&0&1&1&1&1&1&0&0&1&1&1 \\ 1&1&0&0&1&1&0&0&0&1&1&0&0&1&1 \\ 1&1&1&1&1&0&0&1&0&0&1&1&1&1&1 \\ 1&1&1&1&0&0&1&1&1&0&0&1&1&1&1 \\ 1&1&1&0&0&0&0&1&0&0&0&0&1&1&1 \\ 1&1&0&0&1&1&1&1&1&1&1&0&0&1&1 \\ 1&0&0&1&1&0&0&1&0&0&1&1&0&0&1 \\ 1&1&0&0&1&1&0&0&0&1&1&0&0&1&1 \\ 1&1&0&0&0&0&0&1&0&0&0&0&0&1&1 \\ 1&1&1&0&0&0&0&1&0&0&0&0&1&1&1 \end{bmatrix} \longrightarrow$$

31	4	31
28	31	7
25	17	19
31	4	31
30	14	15
28	4	7
25	31	19
19	17	25
25	17	19
24	4	3
28	4	3

Figure 23
Translated Binary Code of the Pouches' Design

Figure 23 shows the description of the weave code using the 15 x 17 matrix. The entries of the matrix were based on the warp (1) and weft (0). The size of the matrix depends on the length of the design that is considered to be coded. From the 15 x 17 matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

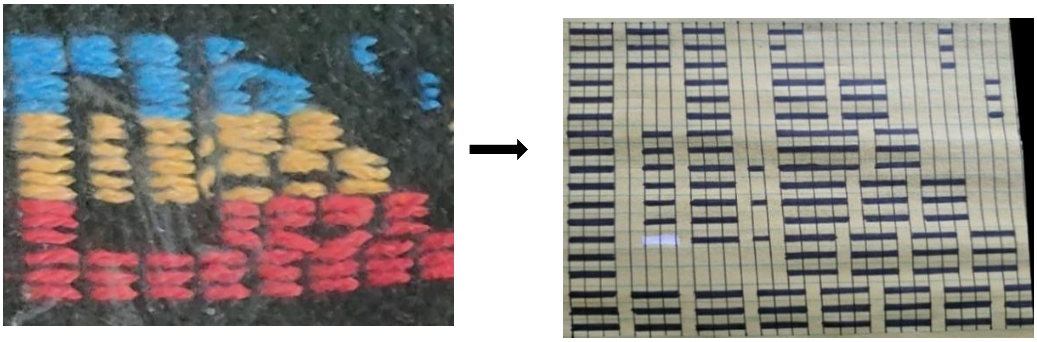

Figure 24
Illustration of the Bags' Design

This figure shows the design of the bag used in the study. This is necessary since in this illustration, the warp and weft are closely seen.

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The matrix form of the binary code taken from the illustration is shown in Figure 25.

0	0	0	1	0	0	0	1	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1
0	0	0	1	0	0	0	1	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
0	0	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1
0	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1
0	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1
0	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1
0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1
0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1
0	0	0	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1
0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1
0	0	0	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1
0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1
0	0	0	1	1	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0

→

2	4	14	15	31	15
2	4	14	31	31	15
2	4	14	7	31	15
3	28	14	4	15	29
3	28	14	4	15	29
3	28	14	4	15	29
3	4	14	1	3	31
3	4	14	1	3	31
3	4	10	1	3	31
3	4	14	2	4	15
3	4	10	2	4	15
3	4	14	4	8	15
3	31	10	4	8	17
3	31	31	4	8	17
3	31	31	4	8	17
2	4	8	17	2	4
2	4	8	17	2	4
2	4	8	17	2	4

Figure 25
Translated Binary Code of the Bags' Design

Figure 25 shows the description of the weave code used in matrix form. The entries of the matrix were based on the warp, coded by 1, and weft, coded by 0. The size of the matrix depends on the length of the design that is considered to be coded. The bigger the size of the matrix, the better since the pattern or the sequence of the design could be easily seen and traced. In this particular product, a 30 x 18 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

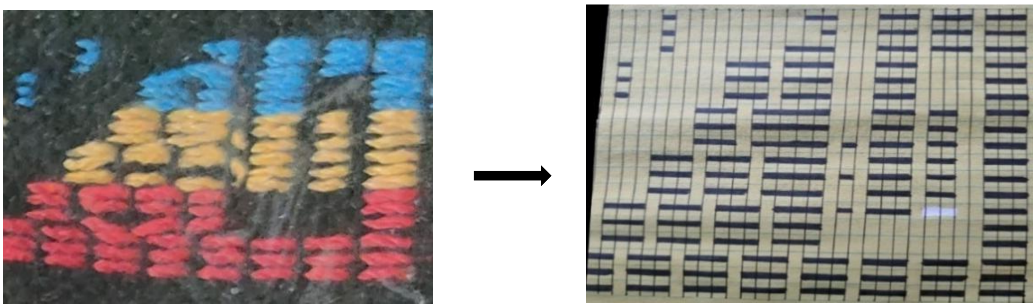

Figure 26
Illustration of the Bags' Design

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This figure shows the enlarged photo of the design of the bag used in the study. This is necessary since, from this illustration, the lengthwise yarn (warp) and crosswise yarn (weft) are closely seen.

1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0
1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0
1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0
1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0	0	0
1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0	0	0
1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	0	0	0
1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	0	0	0
1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	1	0	0	0
1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	0	0	0
1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	1	0	0	0
1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	0	0	0
1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	1	1	1	1	1	0	0	0
1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0
1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0
0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0

→

15	31	15	14	4	2
15	31	31	14	4	2
15	31	7	14	4	2
29	15	4	14	28	3
29	15	4	14	28	3
29	15	4	14	28	3
31	3	1	14	4	3
31	3	1	14	4	3
31	3	1	10	4	3
15	4	2	14	4	3
15	4	2	10	4	3
15	4	2	14	4	3
17	8	4	10	31	3
17	8	4	31	31	3
17	8	4	31	31	3
4	2	17	8	4	2
4	2	17	8	4	2
4	2	17	8	4	2

Figure 27
Translated Binary Code of the Bags' Design

The entries of the matrix were based on the warp, coded by 1, and weft, coded by 0. The size of the matrix depends on the length of the design that is considered to be coded. The bigger the size of the matrix, the better since the pattern or the sequence of the design could be easily seen and traced. In this particular product, a 30 x 18 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

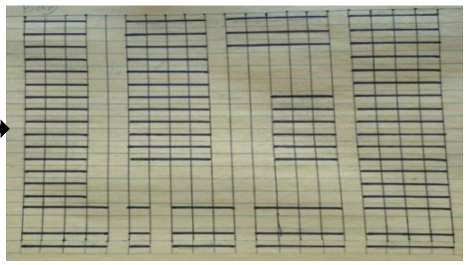

Figure 28
Illustration of the design used in the bag product.

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This figure displays the enlarged photo of the design of the bag used in the study. This is necessary since, from this illustration, the lengthwise yarn (warp) and crosswise yarn (weft) are closely seen.

0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0

3	1	0	16
3	1	0	16
3	1	0	16
3	1	31	16
3	1	31	16
3	1	31	16
3	1	24	16
3	1	24	16
3	1	24	16
3	1	24	16
3	1	24	16
3	1	24	16
3	31	31	16
3	31	31	16
3	31	31	16
1	8	16	16
31	31	31	31
1	8	16	16
1	8	16	16

Figure 29

Translated Binary Code of the Bags' Design

The entries of the matrix were based on the warp, coded by 1, and weft, coded by 0. The size of the matrix depends on the length of the design that is considered to be coded. The bigger the size of the matrix, the better since the pattern or the sequence of the design could be easily seen and traced. In this particular product, a 20 x 19 matrix was obtained using the binary code. From the matrix, 5 bits were used, resulting in the next figure based on the Baudot code.

CONCLUSIONS

The findings of this study may influence modern industry and education and preserve cultural heritage while fostering innovation and sustainability by integrating sustainable principles into textile designs and engineering curricula. Moreover, it may help highlight traditional methods in campaigns to preserve and promote heritage crafts.

Slippers, facemasks, pouches, and bags have different weaving patterns, which are designed from simple to complex. The products contain elements of mathematics such as measurements, straight lines, and patterns that can be represented by using binary codes. This study shows the innovative ways of generative weaving codes for the Abel Iloko products and other means of enhancing the handwoven products. The training enabled them to share and discuss the technique of weaving, which could help facilitate better production. Moreover, the results of the study provided new research directions and ideas for innovation.

RECOMMENDATIONS

Based on the findings, the following are recommended. The instructional medium may be used in learning for students in Ilocos Sur, where education could be made more varied and students get to know their culture and preserve the culture of Abel Iloko products. The result of this study may be used by researchers as a basis for future research to develop a warp-weighted loom simulation so that historical weaving processes may be explored and shared, to generate new fabrication possibilities.

It can be generalized that binary codes can be used for weaving by integrating traditional techniques with digital technology, allowing precision and customization. Globally, this will enable intricate patterns in textiles. Binary codes will allow precise replication.

ETHICAL STATEMENT

The researchers conducted the study without any conflict of interest. The study was conducted primarily for academic purposes. The confidentiality of the information collected was appropriately maintained, a target place was purposively selected, did not involve major risks and the data were gathered from the displayed weaving products. The study did not use any specimens.

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