CHAPTER 7

IDENTIFYING AND IMPLEMENTING A STRATEGY FOR AUTHENTICATION OF GENUINE INDIAN HANDLOOM PRODUCT

7.1 Introduction

The results of Chapter 4 highlighted that providing a genuine handloom product is the second most important strategy to fulfil the customer's requirements. At present, this sector in India has been facing hard challenges in marketing and sales (Kethan et al., 2022). This is because the power looms produced a similar design and texture for a common consumer who could hardly distinguish between the original and the duplicate (Lalitha and Vinayan 2019). This resulted in the collapse of handloom cooperative societies and weaving houses, leading to the migration of a large section of weavers to other professions (Khatoon and Iffat, 2022).

India handloom customers do not have direct contact with the handloom weavers (Mahajan, 2022). In most cases, to get information about the raw material, design pattern, etc., they have to depend on the mediators/sellers (Bhagavatula et al. 2010). Customers need quick and complete information before purchasing a genuine and costly product. The non-availability of such information can lead to a decline in customer interest and confidence in purchasing handloom products. Sivasakthi and Basariya (2018) conducted a study to identify how far consumers are aware of handloom products, and their results showed that customers are not fully aware of the qualities of handloom products and methods to differentiate them from the rest of the products. A similar study by Kethan et al. (2022) also revealed that customers are willing to buy handloom and handcrafted products, but they do not have this knowledge of the original or the imitated product. So,

an awareness campaign needs to be launched to highlight the superior features of the handloom product (Dhineshkumar, 2018). An effort to address such issues has been made by the government by providing handloom mark, silk mark, and GI mark to highlight the Genuity of handloom mark products. These means are used by weavers of various weaving houses in the form of (hand) paper tags. One such tag provided with the handloom products is shown in Figure 7.1.

Figure 7.1: Handloom mark, Silk mark, GI mark

The tags are removed by anyone before use or sale and so a misuse is quite possible. This research aims to provide a unique strategy for easy identification of genuine handloom products. The chapter presents the research objectives as follows:

- Identification of product requirements for authentic handloom products,
- Identification of the design requirements to fulfill the product requirements,
- Design of QR code on handloom product to provide information about manufacturing weavers, the material used and cost.
- weaving of undetachable handloom logos on the product

7.2 Methodology

The methodology used in this study is a combination of the AHP and QFD methods. The advantages of the AHP and QFD method are discussed in the previous section 2.8. According to Tu et al. (2013), the AHP-QFD method can be used for new product development. Similarly, Das and Mukherjee (2008) mentioned that the AHP-QFD framework will take care of customer needs and help in designing the product according to customer requirements. The researchers Ho et al. (2011) highlighted that the application of AHP ensures consistent measurement, whereas QFD provides the weight of the evaluating criteria. Similarly, a study by Marini et al. (2016) mentioned that both QFD and MCDM implementations ensure the success of product development, where the QFD tool is used to interpret the customer voice into engineering specifications. Whereas Multi-Criteria Decision Making (MCDM) methods like AHP are used to enable designers to decide on the best design and material for the product. The steps of the AHP and QFD are mentioned below.

7.2.1 AHP method

AHP is a multicriteria decision analysis technique based on mathematics and psychology (Azizkhani et al., 2017) and was introduced by the satty in 1977 (Perçin, 2006). The AHP method is advantageous than the other methods as compared in the section 2.8.1. In this section, the steps due Kouatli (2019) and Sequeira et al. (2021) are reproduced here and applied to the case of the handloom of Varanasi City.

Step 1: Identification of customer requirements

According to the study's objectives, customer requirements within the sector were identified through literature surveys and expert opinions.

Step 2: pairwise criteria comparison

With the discussion of the expert's team, a questionnaire was developed, and a pairwise comparison matrix was formulated. To make a comparison matrix was formulated, a nine-point scale was used by Satty (1990) and is shown in Table 7.2.

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Table 7.1: The scale used for pairwise comparison

Importance intensity	Preferred judgment
1	Equally important
3	Moderately important
5	Strongly important
7	Extremely important
9	Extremely more important
2,4,6,8	Intermediate values between adjacent scale values

(Source: adapted from (Satty, 1980)

Step 3: weights calculation

Once the pairwise matrix is formulated, the next step was to calculate the criteria weights. This is accomplished by determining the principal eigenvector of each matrix. The eigenvector represents the relative weights of the criteria. The mathematical equations Saaty (1990) provided are used to find the eigenvector.

Step 4: Consistency ratio (CoR)

After the calculation of the eigenvectors of the matrix, it is important to check for consistency ratio (CoR). According to Kouatli (2019), a value of C.R. less than 0.1 is acceptable if CR>0.1; revision of the questionnaire and the pairwise matrix is required.

7.2.2 QFD method:

The Quality Function Deployment (QFD) method employs a range of matrices called the House of Quality (HoQ) to translate customer requirements into technical requirements (Ashtiany and Alipour, 2016). The most important advantage of QFD is the quantification of subjective expert opinions, thus facilitating the determination of preferences (Kürüm Varolgüneş, 2021). The researchers explain the QFD methos' steps (Lapinskienė and Motuzienė, 2021; Deepu and Ravi, 2020).

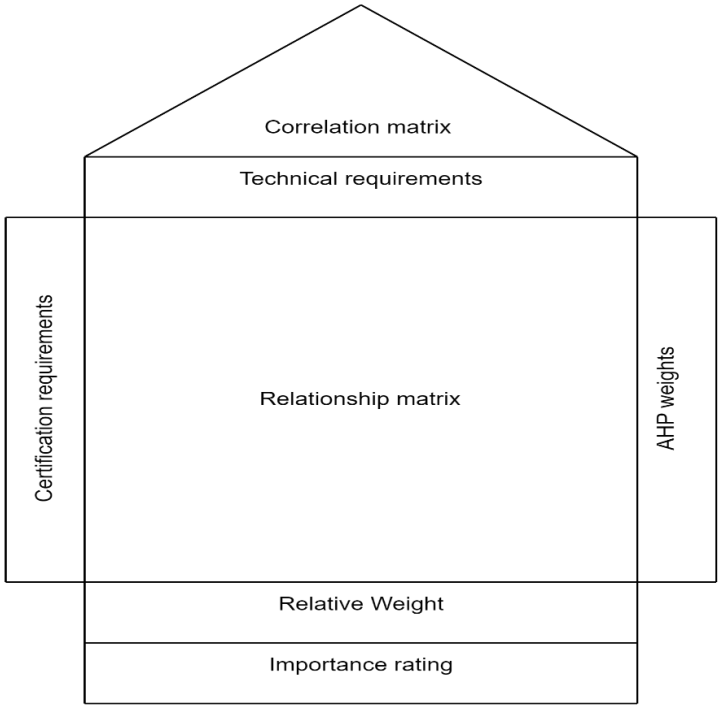


Figure 7.2: House of quality matrix

Step 1: Identification of product requirement (P.R.): For the case of Varanasi handloom, The existing strategies identified from the literature and new strategies proposed by the authors are provided with relative weight by using the AHP method. For example, the weight of the HM is 0.13.

Step 2: Finalization of design requirements (D.R.s): The design requirements for the weaves are finalized by brainstorming sessions with the experts' team to achieve the strategies

Step3. Formulation of the interrelation matrix: The P.R.s and D.R.s relation and were mapped by using the values 0= no relationship, 1= weak relationship, 3= average relationship, and 9= strong relationship (Vazifehdan and Darestani, 2019).

Step 4: Formulation of technical correlation matrix: The triangular roof matrix is created to identify the relationship between the design requirements. It was represented with symbols "– – = strongly negative, - = negative, empty = none, + = positive, ++ = strong positive".

Step 5: Rating of D.R.s: The final rating of D.R.s is the main attribute of the QFD process to meet P.R. The P.R.s are ranked by using relative importance, as mentioned by Kowalska et al. (2018).

7.3 Calculations, results, and discussion

Step 1: A literature survey was conducted to identify the existing handloom product identification techniques. With the opinion of experts, new proposed techniques were also incorporated. All the identification techniques are summarized in Table 7.2. The demographic information of the experts who participated in the study is shown in Table 7.3.

Table 7.2: Customer requirement

Name	Description	References
Existing Handloom Mark Tag (HMT)	The handloom mark is used to guarantee the consumer that the product is genuinely hand-woven in India.	Handloom Mark scheme (2023)
Existing Silk Mark Tag (SMT)	Silk Mark is used to guarantee the consumer that the product is made of pure silk.	Silk Mark, (2023)
Existing Geographical	A geographical indication is used to identify that the product is manufactured in a specific region. i.e., Varanasi handloom clan	Intellectual Property India, (2023)

Indication Mark Tag (GiMT)		
Certification Paper (CP)	The paper bill was provided along with the product to certify it is a handloom product to increase consumer trust.	McNeish, (2015)
Undetachable Tags (UT)	In-built tags are provided in the product to avoid duplicates and authentication of the product.	Authors contribution
Manufacturer Information Tag (MIT)	Manufacturer details are provided to know about the manufacturer's location and the work's authenticity.	Authors contribution
Material Details Tag (MDT)	Complete information about the raw material used to manufacture the handloom product is provided to authenticate the product.	Authors contribution
Quick response code to access instant online information (QR)	The product was provided with a QR code. By scanning the QR code with the mobile phone, customers can access the product's detailed information.	Authors contribution

Table 7.3: Demographic details of experts

Expert type	**Age**	**Sex**	**Working Experience**
Academic 1	55	F	16
Academic 2	59	F	18
Master weaver 1	51	M	26
Master weaver 2	52	M	21
Independent weaver 1	65	M	30
Independent weaver 2	48	F	18
Cooperative Society Weaver 1	59	M	29
Cooperative Society Weaver 2	52	M	25

Step 2: The identified certification requirements are provided to the customers for formulating the pairwise comparison. Saaty scale was used for the data collection (Saaty, 1980). In this study, 116 customers were contacted for data collection, and 82 were accepted for the survey. The individual customer's data was aggregated using the geometrical method. For example, If the customer feels the requirement of Silk mark (SM) and Quick Response (QR) code are equal, they mark it as one. Table 7.4 shows the pairwise comparison of the matrix of all the customer requirements.

Table 7.4: Pairwise comparison certification technique

Criteria	HM	SM	GI	CP	UT	MI	MD	QR
HM	1.00	1.00	1.00	3.42	1.00	1.00	1.00	1.00
SM	1.00	1.00	1.00	3.48	1.00	1.00	1.00	1.00
GI	1.00	1.00	1.00	3.51	1.00	1.00	1.00	1.00
CP	0.29	0.29	0.28	1.00	0.18	0.30	0.31	0.23
UT	1.00	1.00	1.00	5.56	1.00	3.36	3.00	1.00
MI	1.00	1.00	1.00	3.33	0.30	1.00	1.00	0.27
MD	1.00	3.00	1.00	3.23	0.33	1.00	1.00	0.28
QR	1.00	1.00	1.00	4.35	1.00	3.00	3.00	1.00
Total	7.29	9.29	7.28	27.87	5.81	11.66	11.31	5.78

Step 3: Calculation of weights**:** By using the pairwise comparison matrix, the eigenvalues and eigenvectors are calculated. Then, the calculated eigenvectors are used for computing relative weights. Table 7.5 and Figure 7.3 show the importance of the criteria.

Table 7.5: Relative weights

Criteria	HM	SM	GI	CP	UT	MI	MD	QR	Weights
HM	0.14	0.11	0.14	0.12	0.17	0.09	0.09	0.17	0.13
SM	0.14	0.11	0.14	0.12	0.17	0.09	0.09	0.17	0.13
GI	0.14	0.11	0.14	0.13	0.17	0.09	0.09	0.17	0.13
CP	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.04	0.03
UT	0.14	0.11	0.14	0.20	0.17	0.29	0.27	0.17	0.18
MI	0.14	0.11	0.14	0.12	0.05	0.09	0.09	0.05	0.10
MD	0.14	0.32	0.14	0.12	0.06	0.09	0.09	0.05	0.12
QR	0.14	0.11	0.14	0.16	0.17	0.26	0.27	0.17	0.18

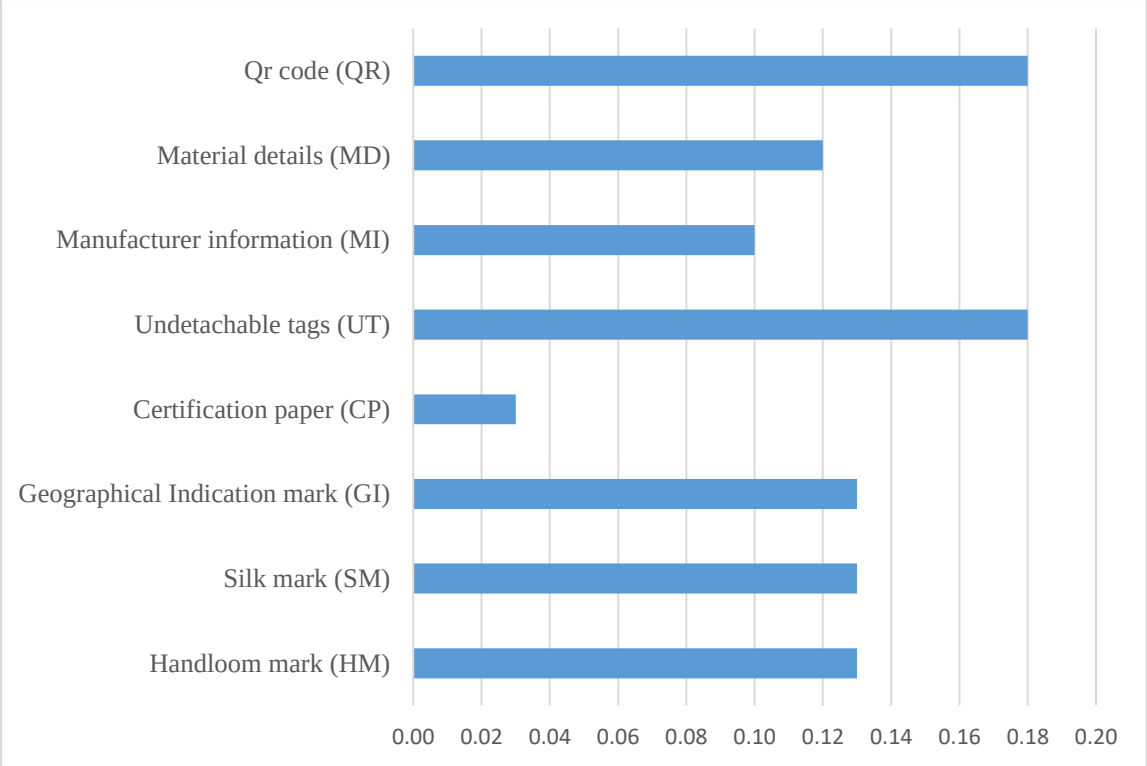


Figure 7.3: Criteria weights

Table 7.5 shows that the criteria weight of the QR code has the highest value of 0.18. Simultaneously, the criteria weight of the Handloom mark, Silk Mark, and Handloom mark are rated as 0.13.

Step 4: Consistency ratio (CoR)**:** The consistency ratio is calculated for the pairwise comparison matrix to ensure consistency in the judgment. The consistency ratio (CoR) is computed by using the expression CoR= CI/RI, where CI= $(\boldsymbol{\lambda max - n})/\boldsymbol{n-1}$, $\boldsymbol{\lambda max}$ =max avg value, R.I. is the random index, its value depends upon the n, The standard values of R.I. for up to 10 criteria are shown in Table 7.6. The value of CoR should be less than 0.10 for a better level of consistency.

Table 7.6: The value of the random index (An adoption of Wind and Saaty (1980))

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.40	1.49

$$\boldsymbol{\lambda max} = ((0.13 \times 7.29) + (0.13 \times 9.29) + (0.13 \times 7.28) + (0.03 \times 27.87) +$$

$$(0.18 \times 5.81) + (0.10 \times 11.66) + (0.12 \times 11.31) + (0.18 \times 5.78) = 8.62$$

$$\textbf{CI} = (\lambda max - n)/n - 1 = (8.62\text{-}8)/7 = 0.09$$

CoR = CI/RI= 0.09/1.40=0.06 <0.10 (Accepted)

The value of the CoR is less than 0.10, and it signifies that the results of the respondents are consistent.

Step 5: The strategies for achieving the customer requirements are formulated by discussion with the expert panel. Table 7.7 shows the Strategies for fulfilling the customer requirements.

Table 7.7: Technical requirements (strategies)

Sr. No	Name of Technical requirement
1	Handloom Mark Paper Tag (HMPT)
2	Silk Mark Paper Tag (SMPT)
3	Geographical Indication Paper Tag (GIPT)
4	Manufacturer Information Paper Tag (MIPT)
5	Material Details Paper Tag (MDPT)
6	QR code Paper Tag (QRPT)
7	Paper Bill (PB)
8	Weaving Logos and QR code (WLQR)

The Technical requirements (T.R.) are ranked with respect to the customers' requirements (C.R.) by the expert's team. Experts ranked the relation, as shown in Figure 7.4.

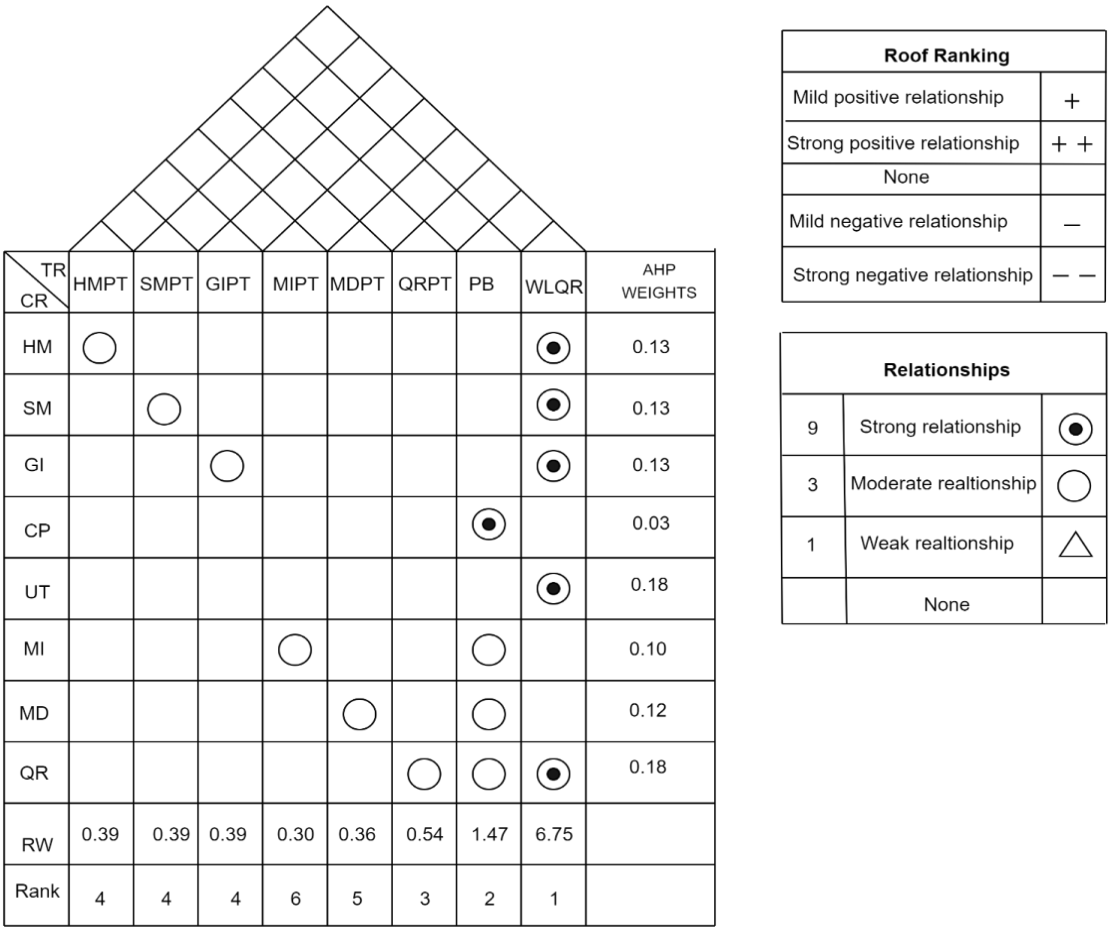


Figure 7.4: House of quality matrix for ranking strategies

Figure 7.4 shows that the product's WLQR was ranked as one with a Relative Weight (RW) of 6.66. It signifies that the strategy of Weaving logos and QR code is of great importance to the customer's requirement. The relative weight (RW) is calculated for WLQR = 9×0.13+9×0.13+9×0.13+9×0.18+9×0.18 =6.75. In Figure 7.4, the experts do not identify the correlation between the strategies, so the roof of the House of Quality is not considered.

The next step of the process is to identify design requirements to weave the QR code and logos on the handloom product. According to Kikuchi et al. (2018), The design of a QR code will require a high-contrast background. Similarly, the study of Peng et al. (2019) mentions that QR code on a general surface requires the captured code to be of good

alignment, sufficient resolution, and high contrast. A study conducted by Tarjan et al. (2014) highlighted that QR readability was influenced by the size of the code and the material used for printing. Similarly, Deineko et al. (2022) also highlighted that the size of the printed QR code is important. A study by Rojas-Torres et al. (2022) stated that durability is an important issue for the designed QR code. Based on such consideration, The different set of design requirements to weave logos and QR code is shown in Table 7.8.

Table 7.8: Design requirements of QR. code

Sr. No	Design Requirements (DR)	Explanations	References
1	Contrast (Co)	Sufficient contrast is needed between foreground and background. High contrast will help scanning devices distinguish between the code and its surroundings.	Kikuchi et al., 2018; Peng et al., 2019
2	Print Size (PS)	The size of the QR code is important to ensure smartphones or QR code scanners easily scan it.	Tarjan et al., 2014; Deineko et al., 2022;
3	Clarity (Cl)	Clarity in pattern or design is needed for scanning the QR code. The clarity of the QR code will enhance the readability.	Peng et al., 2019
4	Reflective Material (RM)	The material with which the QR code will be manufactured. Some materials will not be scanned properly because of their material properties.	Tarjan et al., 2014
5	Durability (Du)	The QR code will be exposed to different temperatures, and it was handled by different stakeholders, which can cause wear and tear.	Rojas-Torres et al., 2022
6	Cultural Preference (CP)	Some materials will not be used for special occasions.	Author contribution

A pairwise comparison of the design requirements is made to find out the weight of the design requirements. The pairwise comparison was made by consulting the experts (Table 7.3) Panel. In this study, the pairwise alternative comparison is considered equally

important. Table 7.9 shows the pairwise comparison matrix and their relative weights are shown in Table 7.10.

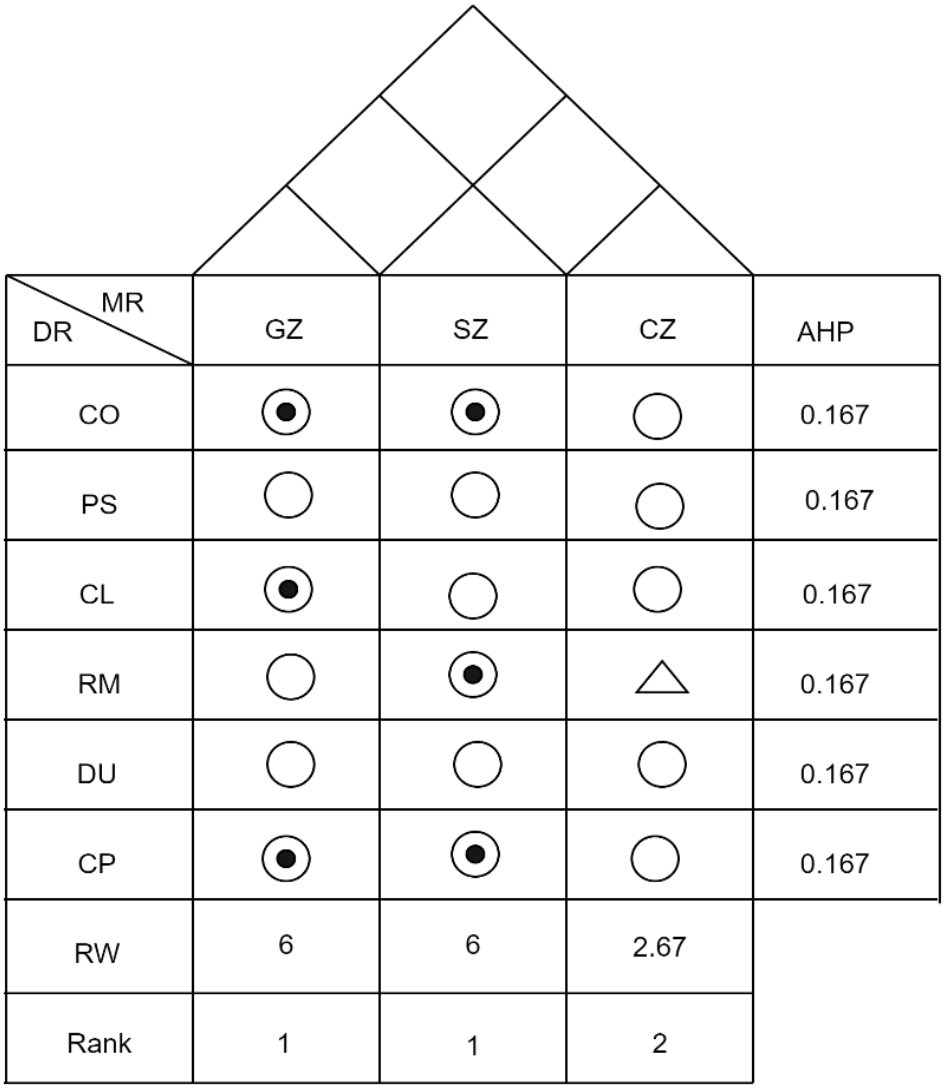
Table 7.9: pairwise comparison matrix

	Co	**PS**	**Cl**	**RM**	**Du**	**CP**
Co	1	1	1	1	1	1
PS	1	1	1	1	1	1
Cl	1	1	1	1	1	1
RM	1	1	1	1	1	1
Du	1	1	1	1	1	1
CP	1	1	1	1	1	1
Total	6	6	6	6	6	6

Table 7.10: Relative weights

	Co	**PS**	**Cl**	**RM**	**Du**	**CP**	**Weights**
Co	0.167	0.167	0.167	0.167	0.167	0.167	0.167
PS	0.167	0.167	0.167	0.167	0.167	0.167	0.167
Cl	0.167	0.167	0.167	0.167	0.167	0.167	0.167
RM	0.167	0.167	0.167	0.167	0.167	0.167	0.167
Du	0.167	0.167	0.167	0.167	0.167	0.167	0.167
CP	0.167	0.167	0.167	0.167	0.167	0.167	0.167

According to a study by Chauhan (2022) in the Varanasi handloom sector, three kinds of zari material are used in the manufacturing of saree. These are Golden Zari (GZ), Silver Zari (SZ), and Copper Zari (CZ). Similarly, Jamal and Sen (2018) also mentioned that the Varanasi saree is made with gold and silver zari and is recognized as the queen of sarees. So, in this study, these three types of zari are considered as Material Requirements (MR) for making QR code. With the expert opinion, the correlation between these materials was not found, so the roof of HOQ is dropped.



DR \ MR	GZ	SZ	CZ	AHP
CO	◉	◉	○	0.167
PS	○	○	○	0.167
CL	◉	○	○	0.167
RM	○	◉	△	0.167
DU	○	○	○	0.167
CP	◉	◉	○	0.167
RW	6	6	2.67	
Rank	1	1	2	

Figure 7.5: House of Quality matrix for ranking of material

Figure 7.5 shows that the cultural preference (CP) is valued as nine for golden zari and silver zari, but for the copper zari, it was valued as three. This is because most handloom customers wear the saree on special occasions, and they, in most cases, will not prefer to wear the saree, which consists of copper material. The calculation of the RW shows that the value of Golden Zari (GZ) and Silver Zari is 6. So, the QR code was made with a combination of the Golden and Silver Zari.

7.4 Weaving of logos and QR code

The Varanasi handloom products are made on pit looms; the skilled weavers operate the looms, and they are locally called "Karigar." As Kushwaha et al. (2023) mentioned, the weaving preparation consists of different steps and is explained as follows.

Step 1: Design sketch and graph preparation

The design of the GI mark, Handloom mark, Silk Mark, and QR are sketched in the computer and then transferred into the graph sheets. The graph sheets are shown in Figure 7.6.

Figure 7.6: Graph of Handloom mark logo, Silk mark logo, G.I. mark logo design graph, QR code

Step 2: Card cutting and punching

The card cutter was used to cut the stiff paper according to the standard dimensions of the industry. According to the design graph, the workers use the punching equipment to punch the stiff paper. This equipment consists of a horizontal wooden frame and iron plate, as shown in Figure 7.7. The whole process is done manually by the workers.

Figure 7.7: Card punching

Step 3: Card lacing

After completing the punching process on the cards, the cards are laced together to create a card chain. It is shown in Figure 7.8.

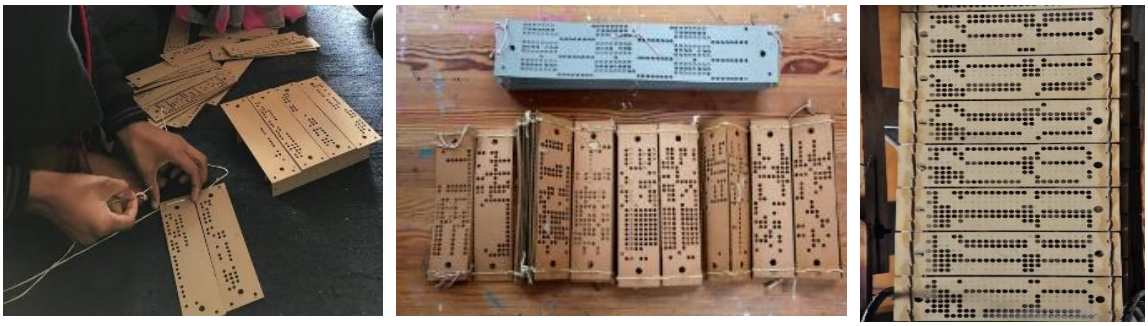


Figure 7.8: Card lacing

Step 4: Denting and drafting

Denting and drafting are two different processes. The drafting process is also called the drawing in. The weavers pass the wrap through the heddles, as per the drafting order. Basically, heddles is a frame to hold the heald wires. For example, the first end will be passed to the first heald. The second wrap passes through the second heald, whereas the third wrap passes through the first heald, and so on. The denting is a process of passing the drawing in ends through the reed for beating purposes. The process of drafting and denting is shown in Figure 7.9:

Figure 7.9: Drafting and denting process

Step 5: Dyeing of yarn

A suitable fabric was selected for the weaving, and it was sized according to the requirement of the length of the product. Then, the material was sent for the next process of dying. The dyeing is the process of applying dyes on the fibers to achieve the desired color. The fiber's color can be selected using the standard color shade sheet. The dye solution was prepared by using natural or chemical dyes, and the fabric was dipped in the solution. The process of dying is shown in Figure 7.10.

Figure 7.10: Dying process

Table 7.10. Specification of weaving

Sr. No	Parameters	Value
1	Ends per inch	112
2	Picks per inch	86
3	Reed number	112
4	Twist per inch	20
5	Count of Wrap	20/22 denier
6	Count of weft	20/22 denier
7	Count of extra weft	2/60 Ne
8	Wrap yarn	Mulberry silk
9	Weft yarn	Mulberry silk
10	Extra weft yarn	Zari
11	Wrap color	Dark green
12	Weft color	Dark green
13	Extra weft color	Golden zari
14	Weave	Plain Weave
15	Denting order	2 in a dent
16	Technique of weaving	Extra weft kadwa technique
17	Number of hooks used to design QR code	120 hooks
18	Loom	Handloom (Pit loom)
19	Width of design	1 inch

Step 6: Weaving activity

The traditional pit loom with the jacquard machine was used for weaving, and the technique used for the weaving was "Kadwa." The Kadwa technique is famous and well-established in producing handloom products in Varanasi. The punched cards are loaded in the jacquard machine to lift the threads for making a shade, as shown in Figure 7.11(i). The weaver will operate the loom by pressing the treadles and batten, as shown in Figure 7.11 (ii). saree and design of the blouse. Figure 7.12 shows the placement of the QR code and logos on the saree. Figure 7.13 shows a sample of woven QR code and logos in the saree.

(i) (ii)

Figure 7.11: weaving activity

In the traditional handloom saree, the saree and blouse are woven together. For the separation of saree and blouse, weavers will provide a gap, in the local weaver's language, the gap locally called Patha. Basically, Patha is a plain weave that is used to separate saree and blouse. The designed QR code and logos are weaved on the Patha so that it will not affect the main design of the saree in order to maintain customer satisfaction.

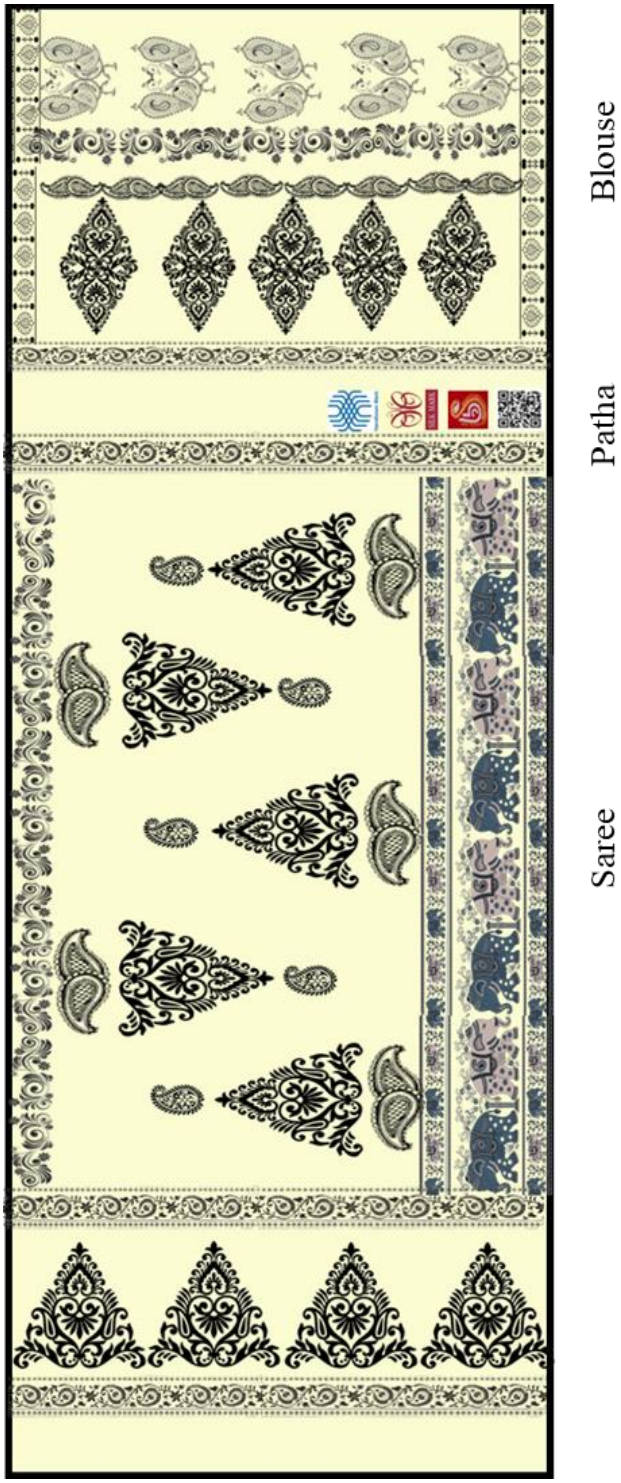


Figure 7.12: Design layout for placing QR code and logos on saree

The weavers weaved the QR code and logos on the saree while weaving. The handloom weavers weave the QR code and are able to scan it with any QR scanner app. Figure 7.13 shows the weaved QR and logos on the handloom product.

Figure 7.13: The weaved QR code and logos on the handloom

7.5 Conclusion

The study aims to identify and implement a strategy for authenticating genuine Indian handloom products, one of the top customer requirements, as highlighted by the application of the combined method of AHP and QFD. QFD approach and its process were implemented, and it was learnt that undetachable logos and QR codes will make more reliance on the customers. The effort made in this regard brings a novel approach. weaving logos and QR codes on a saree, a very costly handloom product. Such Logos and QR codes weaved and incorporated into the handloom saree were tested to find their proper functioning.