



Artificial Intelligence for Personalized Marketing Strategy: A Pathway to the Survival of Geographical Indication Handloom Products in Kerala

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Abstract.

The Indian Handloom possess a rich cultural heritage and tradition with the distinguished skills being handed over through centuries. Geographical indications (GIs) are certificates, given to quality products with reputation and characteristics are attributed to its place of origin and are important in revitalizing the countryside. Despite rich heritage and artisanal nature, handloom products frequently find themselves at a disadvantage when competing in a globalized marketplace filled with mass-produced designs. In order to get pass this barrier, brands can use AI-based marketing strategies that focus on the unique aspects of handloom products. This research tried to explore the awareness, implementation status and perceived adoption barriers among different agents in the marketing channel of GI Handloom Products by conducting interview with 168 samples. For the analysis of data, Wilcoxon Signed-Rank Test and Spearman's rank correlation, Friedman test and Kruskal-Wallis H test were used with the help of SPSS. The study revealed that the awareness level towards the potential of digital marketing, AI and personalization different among different agents, while no significant difference on the perception of difficulties to using the modern marketing technologies and personalization. To identify the barriers to the adoption intention of digital marketing, Partial Least Squares Structural Equation Modelling (PLS-SEM) on SmartPLS 4.0. was conducted. The awareness Barriers have the strongest positive and significant effect on AI Adoption Intention. Technology-related challenges do influence adoption but their impact is more modest. Financial and Organizational Barriers do not have significant effects on AI Adoption Intention

Keywords: Handloom industry, Geographical Indication, digital marketing, artificial intelligence. personalization, marketing strategies, perceived barriers

1. Introduction

India's cultural heritage and artistic prowess are manifested through its dynamic handloom traditions, characterized by distinct weaving techniques and elaborate designs that serve as reflections of the region's multifaceted history and cultural diversity. The Indian Handloom possess a rich cultural heritage and tradition with the distinguished skills being handed over through centuries [4]. In India it is not only a livelihood activity but it's an art or creativity of human being. The handloom sector is predominantly occupied by women and is marked by households characterized by low levels of education, income disparities, and limited access to credit [56]. During India's struggle for independence, the sector served as an important mode of protest when the freedom fighters call for swadeshi movement. A key feature of the sector is the quality and diversity of its products and vast scope for empowering women enhanced rural development. According to the 4th All India Handloom Census, there are 3,144,839 weaver households in India, with 87% of them situated in rural areas. These households collectively employ 3,522,512 workers, comprising both weavers and allied workers, with approximately 72% of them being women. The top six states account for 78.13% of handloom workers nationwide, with Assam (36.45), West Bengal (17.93), Tamil Nadu (6.91), Manipur (6.38), Uttar Pradesh (5.42) and Andhra Pradesh (5.04) constituting the highest shares.

Geographical indications (GIs) are certificates or collective trademarks, given to quality products with reputation and characteristics are attributed to its place of origin and are important in revitalizing the countryside. Discussions regarding the economic and social ramifications of employing geographical indications have persisted since the enactment of the GIs of Goods (Registration and Protection) Act, 1999 in India. Geographical Indications (GIs) represent a pivotal legal framework that safeguards the distinctive traits and cultural heritage associated with handloom products, thereby ensuring that only those goods produced within designated regions can rightfully carry the GI label. This protection not only reinforces the authenticity and quality of such products but also protection of our traditional products and indirectly it leads to the increase in the economic contribution of local products to the region, preserve cultural heritage, and to contribute to the promotion of the region through these products [16]. Since then, the process has gained momentum, and first GI registered product in India, Darjeeling tea from West Bengal on 15th September 2003 under the category of agriculture, second Aaranmula Kannadi from Kerala under handicraft has been followed with other registrations. As per the registration details of geographical indications Registry a total of 573 products were registered under GI in India. Majority of goods belongs to handicraft category that is 53%. Details of GI registered handloom products under GI ACT, 1999 as on 15th March, 2023 is 74 [38].

Geographical Indication (GI) labelled handloom products, consumer perception is attached to cultural legacy and the authenticity factor of the products, which plays a major role in enhancing their value perception over and above non-GI products. This

value is not just a measure of a quality but also of the emotional and historic narratives that consumers attach to the products. However, the process of global integration for handloom producers is filled with challenges that prevent them from being competitive. One of the challenges is their restricted access to high-level marketing technology and data analysis that allows a firm to leverage market information in more effective ways. In addition, due to the fact that consumers brand-identification or brand recognition is an unknown domain with reference to geographical indications, there is a struggle to market handloom goods as a 'premium' product. These interconnected problems highlight the need for research into new forms of addressing these issues, especially personalization methods powered by AI, that can help increase the visibility and market power of GI-tagged handloom products.

2. Innovative marketing strategies in Handloom sector: a theoretical background

Studies focused on innovative marketing strategies in handloom sector are limited and no studies are carried out in geographical indication tagged handloom products. Sivasakthi and Rabiyaathul [75] highlighted the need for continuous promotion and advertising campaigns to sustain customer engagement in the Kanchipuram handloom sector, while Iyer [39] showed that mobile-based consumer interactions improve customer acquisition and experience. Mishra et al. [84] advanced this perspective by proposing web-based applications that provide small-scale producers equitable opportunities to compete against larger textile industries. Subsequent works like Sudha and Das [77] and Patra [65] explored the role of digitalization and e-markets, revealing that younger weavers are more interested toward digital adoption and that e-market platforms are increasingly promoting handloom products. Studies on social media marketing, such as Balasubrahmanyam and Muthumeenakshi [8], further demonstrated that social media enhances customer awareness and contributes to increased sales of handloom products. Other contributions More recent studies, such as Meera and Vinodan [57] and Guha et al. [33], emphasized the adoption of innovative marketing models and social media strategies, but also noted that the industry is still lagging in digital adoption. Naik and Bharadwaj [60] proposing an augmented reality-based business model to enhance market competitiveness, addressing the growing need for technology-driven transformation in the handloom sector.

3. Literature review

The application of artificial intelligence (AI) in marketing has undergone broad transformation, fueled mainly by the progress in machine learning algorithms and the capacity of processing data. AI is an innovation driver that enables marketers to gain richer insights into consumer preference and behavior, transforming traditional marketing strategies [9]. AI technologies enable the real-time analysis of vast volumes of data, and marketers can identify patterns, trends, and relations that would be impossible

by purely manual means [52]. For example, NLP algorithms can analyze and interpret unstructured data from online forums, social media, and customer reviews and uncover rich insight into consumer sentiment and preference [42]. This qualitative data enriches marketers' insight into target consumers, enabling them to tailor messaging and offerings more effectively. Moreover, AI enables predictive analytics, empowering marketers to forecast consumer behavior and preference with high accuracy [34]. AI algorithms that search through history and identify patterns can predict trends in the future, and this enables marketers to modify their approach and campaigns in advance to meet the evolving needs of consumers [82]. This predictive capacity not only enhances relevance and effectiveness to marketing campaigns but also results in optimizing business results and return on investment (ROI). Moreover, artificial intelligence-powered automation increases the effectiveness of marketing processes and procedures, thus freeing up valuable time and resources for strategic decision-making [89]. Most processes such as data gathering, segmentation, and campaign optimization can be carried out by AI-powered tools, allowing marketers to focus on more valuable activities such as creative development and customer engagement [37]. Based on a study, conducted by Shah, companies that adopt AI-powered automation witness a 25% increase in marketing effectiveness and a 20% reduction in marketing expenses [85]. Artificial intelligence plays a pivotal role in transforming marketing practices through data-driven decision-making, predictive analysis, and process automation. As artificial intelligence continues to evolve and grow, marketers need to incorporate such technologies to remain competitive in an increasingly dynamic and data-driven market [85].

One solution to the growing challenges of digital marketing and branding has been the adoption of data analytics, artificial intelligence (AI) in particular, as a means of remaining competitive in a hyper-competitive field [88]. They utilize a set of technology that offer important knowledge about consumer behavior and market patterns and that can inform decision making on the basis of data. The use of predictive analytics and machine learning can be used to fine tune marketing strategies for maximum performance and return on investment [14]. This is advantageous in that it helps enable very individualized marketing. This more granular level of data allows for better targeting, so that the marketing can be more relevant and, in turn, lead to increased engagement [3]. In addition to this, AI allows for finding patterns in the actions that allow us to adapt to new strategies in real-time to improve success in marketing campaigns [55], but concerns such as identity theft, security measures, and ethics have to be examined further, since there could be real concerns when thinking about the information that can be collected and the potential of knowledge that can be harvested in order to maintain consumer trust [70]. Furthermore, ongoing education to keep marketing teams capable of using such technologies is necessary [72]. The rise of influencer marketing, where brands co-create content with trusted people for increased credibility and reach [28] is another example. Online services have been incorporated more smoothly with social platforms, thus allowing for more direct conversion [90].

4. Research Gap

The existing literature directs that prior research in this area has limited and mainly concentrated on large industries and developed countries. It is not convenient for the analysis of traditional cottage industries working in developing countries. To address this gap, future studies incorporating traditional cottage industries samples are essential for developing more insights. Furthermore, the specific challenges and requirements of these industries have often been underexplored in previous work. In response, the present study seeks to adopt a more comprehensive approach by examining the current state of AI-Powered Personalization in Digital Marketing for GI tagged handloom units in India especially Kerala. Many studies discuss technological and financial issues for the implementation of digital marketing but awareness barriers like lack of knowledge for implementation, lack of sufficient information about benefits, not aware of successful cases from the industry remain underexplored despite being critical in early adoption stages especially in small cottage industries [90].

The research addresses three core objectives: 1. To identify the level of awareness and use of modern digital marketing strategies among different agents in the marketing channel of GI tagged handloom products. 2. To find out various barriers which influence the AI adoption intentions in the GI tagged handloom industry. 3. To explore various AI driven personalized marketing strategies for GI Handloom Products

5. Problems faced by handloom products in competitive global market

Though Geographical Indication labels attempt to protect the traditional products in some ways, Indian handloom still has significant marketing constraints. The sector has often been hampered by the inadequate availability of quality raw material, the hike in prices of silk and reliance on imports leads to decline in the production and productivity levels in the mainstream industry like Banaras Brocades and Sarees [84]. Tiwari and Sinha [79] also find small storage and warehousing capacity as a barrier for artisans to store their products, and to exhibit them. As Promotional, poor exporting facilities, high advertisement cost, no innovative promotional policies stymie GI tagged products from benefiting from international exposure [11],[22]. The government support given to them post registration is typically insufficient, and as such, these artisans lack the capital to be able to leverage their GI status for contriving brands or enter new markets [84],[25]. Also, sparse availability of raw material as well as no change in design innovation keep the production lines very limited and the demand for these goods is highly price sensitive as well as highly seasonal [79].

The intermediary role is also disruptive because it means that intermediaries reap most of the profits and weavers are underpaid while rapid fashion change itself desensitizes the relevance of traditional patterns as well [84]. Problems for consumer too are alarming. Counterfeiting and machine-made copies also flood the market, decreasing

people's faith in original handloom goods [22]. Little information on the part of consumers, as well as poor data availability also results in unaware purchases and disrespect for authentic GI- labelled products [25]. Moreover, weavers rarely have the ability to get merchandise to market in a timely manner and miss out on trends, and face strong competition from cheap, mass- produced fabrics [81]. The lack of available, lower-cost sales channels also restricts prospects of reaching a wider market and therefore income. The handloom dealers are finding it difficult to compete in these global economies due to limited access to advanced marketing technologies and data analytics that would help them to take advantage of market opportunities. Furthermore, the unawareness regarding brand name and geographical indication hurdle the producers to reap benefit from consumer market. These combined challenges necessitate an exploration of new kinds of solutions, specifically around personalized AI-based solutions, to make GI-tagged handloom products more visible in and accessible to the market.

The perception of Geographical Indication (GI) labelled handloom goods is heavily influenced by their cultural heritage and authenticity, which substantially boosts their perceived worth compared to non-GI items. This value is not solely tied to quality; it also encompasses the emotional and historical stories linked to these products. Integrating handloom makers into global markets presents substantial challenges hindering their competitiveness. A major barrier is their restricted access to advanced marketing technologies and data analytics, which limits their ability to utilize market insights effectively. Additionally, the general lack of brand recognition and consumer awareness about geographical indications complicates the promotion of handloom goods as high-end products in a competitive market. These interconnected issues highlight the need for exploring innovative solutions, particularly AI-driven personalization strategies, to improve the visibility and market reach of GI-tagged handloom products.



Fig. 1. Marketing challenges of GI tagged handloom products

Figure 1 showcase various marketing challenges faced by GI tagged handloom products in Kerala. The fast-growing realm of digital marketing has seen the incorporation of artificial intelligence (AI) becoming a determining factor of consumer engagement and brand loyalty. This is especially important for niche markets, particularly those for handloom products marked by Geographical Indications (GIs). GIs not only represent the special features of goods associated with specific regions but also denote cultural heritage and craftsmanship. Yet, despite their rich heritage and artisanal nature, handloom products frequently find themselves at a disadvantage when competing in a crowded marketplace filled with mass-produced designs. Using data analytics and machine learning, brands can personalize their stories to connect with target markets even more, highlighting the stories behind each product as well as the artisans that make them. In order to recover from this barrier, brands can use AI-based strategies that focus on the unique aspects of handloom products, while also building a stronger emotional connection with consumers.

The use of AI-powered personalization offers a paradigm-shifting strategy, enabling marketers to tailor their approach to suit the diverse needs of consumers more effectively. With the assistance of data analysis and machine learning processes, organizations can derive meaningful information related to consumer behavior, preference, and purchasing patterns, thereby enabling them to develop personalized experiences that resonate on an emotional level. This is particularly crucial for GI-tagged handloom products, which require the integration of storytelling elements that resonate with their exclusivity and cultural heritage. By integrating stories into their marketing strategies, brands can achieve a higher level of engagement with consumers, enabling them to not

only appreciate the product itself but also the rich heritage and craftsmanship that it represents.

6. Methodology

This study was carried out by using a semi-structured interview, which are capable of allowing in-depth exploration of the participant's views [50]. The interviews were carried out between November 2024 and February 2025. The main focus of the research is to identify the gaps in present handloom marketing process in order to support and implement modern marketing techniques such as digital marketing and personalized AI marketing strategy. All the agents in the marketing chain are deliberately included in the study sample, especially the weavers, as a result of their predominant role in the production and marketing of the GI handloom products. Village traders, wholesalers, retailers and cooperative societies were also encompassed in the sample for more comprehensive, complete and contrasting view on the awareness and implementation of modern marketing tools. First of all, overall awareness, implementation status and perceived hurdles towards digital marketing, artificial intelligence and personalization technique were compared and investigated. In the next stage, conditions with these technologies were compared between different agents in the marketing channel. Figure 2 depicts the different agents in the marketing channel of GI products. A set of problems faced with adoption of modern marketing methods were identified from the interviews. Importance of modern marketing techniques and its enabling factors for the survival and development of the GI handloom factors was pursued from the extant literature, with the help of AI experts, study also identified various AI personalized digital marketing strategies suitable for the implementation in handloom industry to optimize sales, production and profit through marketing channel. The study uses Kerala as the sampling unit for the study, the state with advanced digital infrastructure facilities and high digital literacy rate among the Indian states. Six handloom products of Kerala have received Geographical Indication, Cannanore Home Furnishings, Balaramapuram Sarees and Fine Cotton Fabrics, Kasaragod Sarees, Kuthampully Sarees, Chendamangalam Dhoties & Set Mundu and Kuthampully Dhories & Set Mundu. On site interviews were carried among the producers of these products and also among the marketing agents by using semi structured interview schedule.

A 5-point Likert scale indicating "1- strongly disagree, 2- disagree, 3- Neutral, 4- agree and 5- Strongly agree" was used to marking their opinion towards the statements related to digital marketing, artificial intelligence and personalization. The statements are enumerated in Tables 2. All the statements related to digital marketing was first asked followed by artificial intelligence and personalization. All the statements and questions are clearly explained in the local language and the opinions are marked by the researcher according to their view points. This approach helped to reduce errors in the data collection process. The interview schedule included questions about the respondent's basic conditions like age, gender, education, experience etc. followed by questions related to level of awareness, use and awareness of Modern marketing tools in their organizations.

Distribution Channels for GI Handloom Products

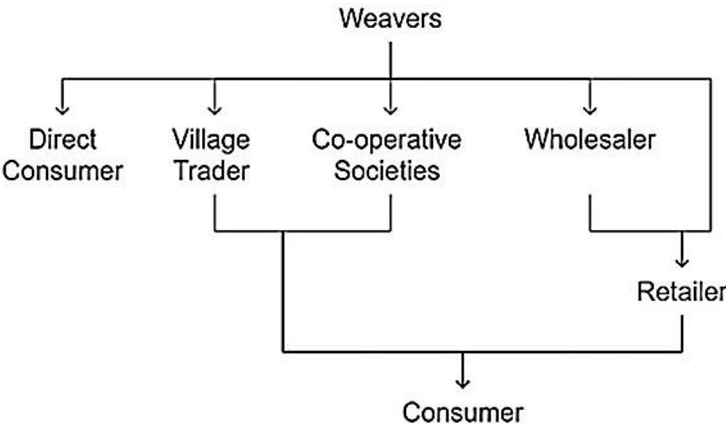


Fig. 2. Agents in the marketing channel of GI

The targeted sample size was 200; from the targeted sample 168 respondents were completely cooperated for the study within the time limit. Cronbach’s Alpha had been used to test the reliability of the scales in the question schedule prepared to conduct interview. The Cronbach’s Alpha is 0.851, indicating good reliability.

Table 1. Characteristics of sample units

No.	Category	Number of Respondents
1	Weavers	87
2	Wholesalers	23
3	Retail	32
4	Cooperative society	8
5	Village Traders	18

Source: sample data

As shown in table 1, the response was collected from weavers (51.8%), retailers (19%), wholesalers (13.7%), village traders (10.7%) and cooperative societies (4.8%). in this field.

Table 2. Demographic Profile of the respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	138	82.1
	Female	30	17.9
Age (Years)	< 30	0	0.0
	30 – 50	31	18.5
	50 – 60	58	34.5
	60 – 70	59	35.1
	> 70	20	11.9
Education	Illiterate	7	4.2
	Primary (1–4)	33	19.6
	Upper Primary (5–7)	43	25.6
	High School (8–10)	37	22.0
	Pre-Degree (11–12)	22	13.1
	Graduation and above	26	15.5
Experience (Years)	1 – 10	18	10.7
	10 – 20	29	17.3
	20 – 30	38	22.6
	30 – 40	52	31.0
	40 – 50	22	13.1
	> 50	9	5.4

Source: sample data

Table 2 reflects a male-dominated, highly experienced workforce with limited formal education and managed by older individuals; it influences the AI and digital technology awareness and adoption in the handloom sector.

IBM SPSS Statistical package version 22 was used to analyze the data. Shapiro–Wilk test, was used to find out the normality of survey data, the results revealed that all variables, including awareness of digital marketing, Artificial intelligence, and personalization, as well as their respective usage status and perception on hurdles, significantly deviated from a normal distribution ($p < .05$ for all variables). Hence, non-parametric tests were used for further analysis.

7. Awareness perceptions and adoption levels of digital marketing, Artificial intelligence, and personalization

Friedman test was carried out to find out variations in participant responses across nine related items measuring awareness, usage, and perceived hurdles regarding digital marketing, AI and personalization. The results indicates that a statistically significant difference in median rankings across the items, $\chi^2(8) = 726.088, p < .001$. This indicates that respondents did not rate all statements equally, there is a significant difference in their rating depends on the specific topic.

To identify which specific group differ from each other, a pair wise comparison using Wilcoxon Signed-Rank Tests was conducted, and Spearman rank correlation was carried out to identify how they correlated.

Table 3. Wilcoxon Signed-Rank Test and Spearman’s rank correlation (n=168)

Comparison	Z	p-value	Spearman’s correlation
Awareness of AI vs. Digital Marketing	-8.709 ^a	.000	.742 ^{**}
Awareness of Digital Marketing vs. Personalization	-4.184 ^a	.000	.052
Awareness of Personalization vs. AI	-8.860 ^b	.000	.014
Making use of Digital Marketing vs. Making use of AI	-4.702 ^a	.000	.633 ^{**}
Making use of AI vs. Personalization	-8.382 ^a	.000	.176 [*]
Making use of Digital Marketing vs. Personalization	-8.716 ^a	.000	.232 ^{**}
Hurdles to use AI vs. Digital Marketing	-5.067 ^b	.000	.390 ^{**}
Hurdles to use AI vs. Personalization	-6.779 ^b	.000	.061
Hurdles to use Personalization vs. Digital Marketing	-3.308 ^a	.001	.250 ^{**}

a – Based on positive ranks

b- Based on Negative ranks

^{**}. Correlation is significant at the 0.01 level (2-tailed).

^{*}. Correlation is significant at the 0.05 level (2-tailed).

A Wilcoxon signed-rank test was carried out to compare participants’ awareness, implementation, and perceived hurdles regarding AI, digital marketing, and Personalization. This test is suitable for related samples with ordinal data, such as Likert-scale responses [27], [41]. The analysis revealed statistically significant differences in all nine pairwise comparisons with all p-values less than 0.001. Given the multiple comparisons of variables, a Bonferroni correction was applied to control for Type I error increasing [5], correcting the significance threshold to 0.0056 ($\alpha = 0.05 / 9$

comparisons). All comparisons statistically important even under this more conservative threshold. These findings indicate that expression of respondents have meaningful differences across awareness, usage, and implementation hurdles related to emerging digital technologies. The prior researches also stress the differentiated perceptions and adoption levels of technologies like AI and digital tools among organizations [83].

Spearman's correlation test exposed several significant relationships between the variables. A strong, statistically significant positive correlation was found between awareness of digital Marketing and artificial intelligence ($\rho = .742$, $p < 0.01$), also between its uses ($\rho = .633$, $p < 0.01$). A moderate positive correlation was found between hurdles to use AI vs. digital marketing ($\rho = .390$, $p < 0.01$), suggesting that as one's use increases, the other tends to increase moderately. A weak but significant correlation was observed between making use of AI vs. Personalization ($\rho = .176$, $p < 0.05$). Weaker but statistically significant positive associations were observed between making use of digital Marketing vs. Personalization ($\rho = .232$, $p < 0.01$), and hurdles to use Personalization vs. digital marketing ($\rho = .250$, $p < 0.01$). However, the correlation between hurdles to use AI vs. Personalization ($\rho = .061$) awareness of digital Marketing vs. Personalization ($\rho = .052$) awareness of Personalization vs. AI ($\rho = .014$) was very weak and not statistically significant.

Table 4. Median and Kruskal-Wallis H test across five independent groups

	Median (Weavers)	Median (whole-salers)	Median (Retailers)	Median (Village Traders)	Median (Cooperative societies)	Chi-Square (χ^2)	P Value
Aware of the potential of digital marketing	2	4	4	2	4	21.028	0.00
Aware of the potential of AI	1	1	2	1	2	18.486	0.001
Aware of the potential of Personalization	4	2	2	2	4	37.451	0.00
Making use of digital marketing	1	2	2	1	2	24.422	0.00
Making use of AI	1	1	1	1	1	12.986	0.001
Making Use of Personalization	2	2	2	2	2	1.838	0.766

Hurdles to use digital marketing	4	4	4	4	4	4.604	0.330
Hurdles to use AI	5	5	5	5	5	4.541	0.338
Hurdles to use Person-alization	4	4	4	4	4	0.779	0.941

Source: sample data

Kruskal-Wallis H test was conducted to determine if there were statistically significant differences in dependent variable across the five independent groups: Weavers, wholesalers, retailers, village traders and cooperative societies. The awareness level towards the potential of digital marketing, artificial intelligence and Personalization different among five groups. $p < .005$. Therefore, the null hypothesis was rejected, indicating that at least one group significantly differed in their awareness of digital marketing potential, artificial intelligence and Personalization. There is no significant difference among the 5 groups on the perception of difficulties to using the modern digital marketing technologies and Personalization in the GI handloom marketing so retain the null hypothesis. Making use of digitalization and AI, $p < .005$, null hypothesis was rejected and it indicate the differences in the use of digital technologies for marketing.

8. Barriers to adopting Digital marketing in the GI tagged handloom industry

The implementation of digital marketing in handloom industry has various challenges in terms of knowledge, infrastructure, finance and organization. The inadequate amount of information and knowledge [18], [43] and weak top management involvement [53], [1] complicate early adoption efforts, whereas the number of skilled workers exacerbates the situation because it is challenging to implement digital marketing in a business and customer interaction [59]. Cost is also one of the obstacles, and there is little money available to employ, educate, and invest in infrastructure [53],[1]. Also, most handloom enterprises are located in rural settings with weak IT infrastructure and access to the internet, so it is challenging to connect in real-time through digital based interactions [63],[41]. Legal uncertainties and privacy risks are just a few of the regulatory concerns that restrain adoption [54],[1] which are amplified by the fear of failure because there is not much evidence of digital marketing payoffs [2], [54]. Adoption of new marketing strategies is also limited by the digital illiteracy of the industry, the absence of government policies that support the industry and its research and development [53] ,[49],[1]. There are 4 categories of barriers that are a collectively of concern from literature review i.e. Financial Barriers, Awareness Barriers, Organizational Barriers and Technological Barriers. Figure 3 provides a detailed picture of these four barriers of digital marketing.

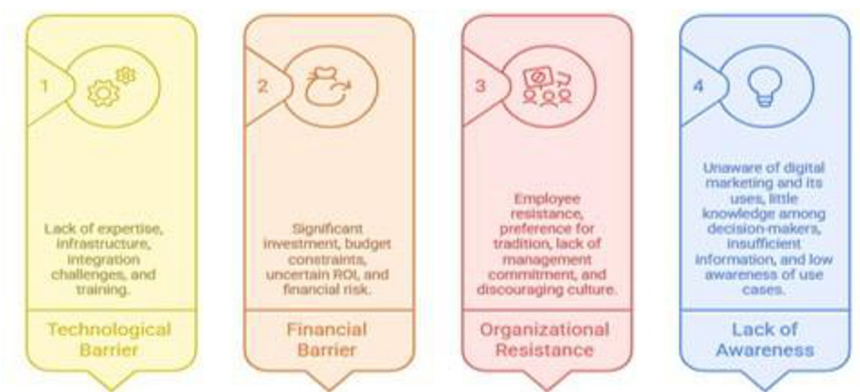


Fig. 3. Barriers to digital marketing

8.1 Structural Equation Model (SEM)

Structural Equation Model (SEM) evaluation helps to explain what extent the model explains one or more variables (Hair et al. 2022). Structural Equation Modelling (SEM) using Partial Least Squares (PLS-SEM) was employed to analyze various perceived barriers which influence the AI adoption intentions in the GI tagged handloom industry, Financial Barriers, Awareness Barriers, Organizational Barriers, Technological Barriers, and AI Adoption Intention were measured using validated scales adapted from prior literature. Each construct was measured with 4 items on a 5-point Likert scale. To confirm reliability, validity, and discriminant validity of the considered constructs analytical operations were implemented.

Table 5. Normality, Reliability and Variability tests.

Variable	Items	Skewness	Kurtosis	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	VIF
AI Adoption Intention	4	-0.574	-1.343	0.941	0.942	0.850	-
Financial Barriers	4	-1.275	0.456	0.862	0.914	0.708	1.751
Awareness Barriers	4	-1.129	0.323	0.835	0.852	0.672	2.763
Organizational Barriers	4	-1.377	2.022	0.799	0.812	0.624	2.224
Technological Barriers	4	-1.258	0.802	0.846	0.866	0.685	1.989

Source: sample data

Table 5 shows that the values of skewness and kurtosis of each construct were within the acceptability range which implies that the data is normally distributed. Normality, Reliability and Variability tests. The Cronbach alpha varied between 0.799 and 0.941, showing that the internal consistency is strong and the composite reliability estimates were above 0.80 on all constructs. The values of all Average Variance Extracted (AVE) were bigger than the recommended minimum threshold of 0.50 with the range between

0.624 and 0.850. Furthermore, all the Variance Inflation Factor (VIF) measures were significantly below the critical point of 5 and therefore, proved that the issue of multi-collinearity was not a point of concern in this study.

Table 6. Outer loadings

Item	Outer loadings	Item	Outer loadings
AI1	0.912	LA3	0.914
AI2	0.935	LA4	0.858
AI3	0.903	OR1	0.778
AI4	0.937	OR2	0.757
FB1	0.940	OR3	0.755
FB2	0.905	OR4	0.864
FB3	0.681	TB1	0.914
FB4	0.815	TB2	0.845
LA1	0.736	TB3	0.747
LA2	0.759	TB4	0.795

Source: sample data

Outer loadings of each indicator are indicated in Table 6. Most of the items scored higher than 0.70 on loadings, which is a testimony to good indicator reliability. The constructs AI Adoption Intention and Financial Barriers had very strong loadings, between 0.903 and 0.940. Some of them especially Awareness Barriers and Organizational Barriers reflected slightly lower loadings (0.736 0.759); however, all were within acceptable level of research applications. These results validate that the indicators are valid representations of their constructs.

Table 7. The Heterotrait - Monotrait (HTMT) Ratio

Variables	AI Adoption Intention	Financial Barriers	Awareness Barriers	Organizational Barriers
AI Adoption Intention				
Financial Barriers	0.577			
Awareness Barriers	0.901	0.727		
Organizational Barriers	0.625	0.523	0.831	
Technological Barriers	0.645	0.411	0.738	0.784

Source: sample data

Table 7 presents the results of Heterotrait-Monotrait (HTMT) ratio analyses used to evaluate discriminant validity. All values of HTMT were lower than 0.90, which means that the constructs were different enough to be independent of each other. The largest value of HTMT was 0.901 between AI Adoption Intention and Awareness Barriers, which is still within an acceptable range. The relative distinctiveness of constructs is further supported by lower HTMT values, like 0.411 between Financial and Technological Barriers.

Table 8. Coefficient of determination (R2) and Cross-validated predictive ability test (Q2)

	Coefficient of determi- nation		Cross-validated predictive ability test (CVPAT)		
	R ²	Adjusted R ²	Q ² predict	RMSE	MAE
AI Adoption Intention	0.664	0.656	0.634	0.61	0.434

Source: Sample data

The R² value is 0.664, indicating that approximately 66.4% of the variance in AI adoption intention is explained by the exogenous variables. The adjusted R² is 0.656 further confirms the model’s robustness. The Q² of 0.634 reveals that the model has strong predictive relevance for AI adoption intention. The Root Mean Square Error (RMSE = 0.61) and Mean Absolute Error (MAE = 0.434) values are relatively low, indicating that the model can generate accurate predictions for the endogenous construct. The high R², positive Q² predict, and low prediction errors validate that the proposed model possesses significant explanatory and predictive ability, making it suitable for decision-making and theoretical advancement. Below Figure 4 provides an evaluation of PLS-SEM (P values and Path coefficients)

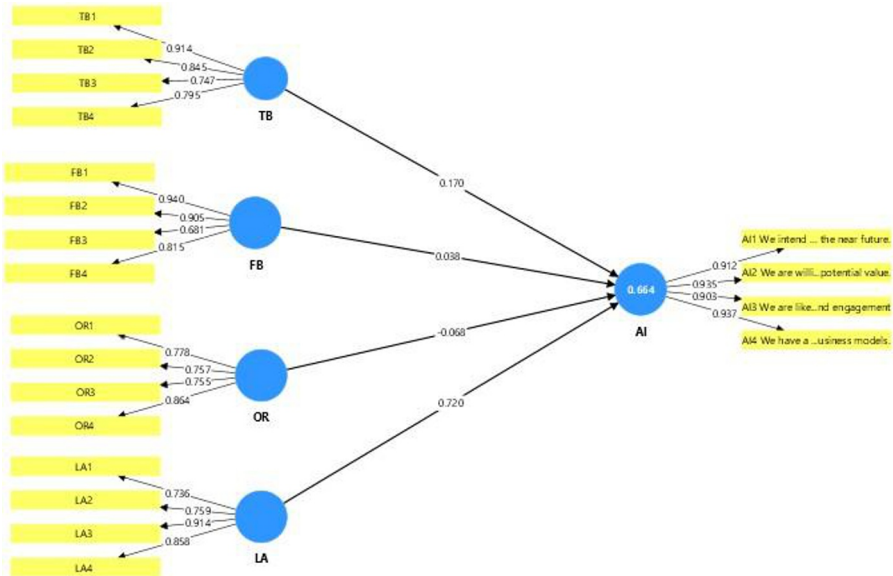


Fig. 4. Evaluation of PLS-SEM (P values and Path coefficients)

Table 9. Path coefficient and f^2

Variables	Path coefficient	T statistics	P values	f^2 (Effect size)
Financial Barriers	0.038	0.470	0.638	0.002
Awareness Barriers	0.720	8.142	0.000	0.558
Organizational Barriers	-0.068	0.792	0.428	0.006
Technological Barriers	0.170	2.332	0.020	0.043

Source: Sample data

The results of the structural model are provided in Table 9 that presents path coefficients, t-statistics, p-values and effect sizes (f^2) of the links between the barrier constructs and AI Adoption Intention. According to the results, the most powerful and significant effect of Awareness Barriers on AI Adoption Intention was established (0.720, $t = 8.142$, $p < 0.001$), and the effect size is large ($f^2 = 0.558$). This suggests, that the challenges that organizations have to face in the context of awareness are determinant in the determination of their intention of using AI. The effect (Technological Barriers 0.170, $t = 2.332$, $p = 0.020$), is however, quite large positive and significant indicating that the effect is not small, and might have a significant influence just at a slightly lower degree of impact. Conversely, the relationship with AI Adoption Intention is not significant with Financial Barriers (0.038, $t = 0.470$, $p = 0.638$) and Organizational Barriers

(0.068, t 0.792, p 0.428), whose effect sizes are both non-existent (f^2 0.002 and 0.006, respectively). This means that, in practice, the financial and organizational reasons will not significantly impair the decisions on AI adoption in this case as opposed to awareness and issues related to technology. In general, the structural model reveals that enhancing the awareness and paying attention to technological issues are the primary triggers to advance the intentions in AI adoption, whereas financial and organizational barriers seem not to be the significant motivators so much. Figure 5 explains path co-efficient histograms.

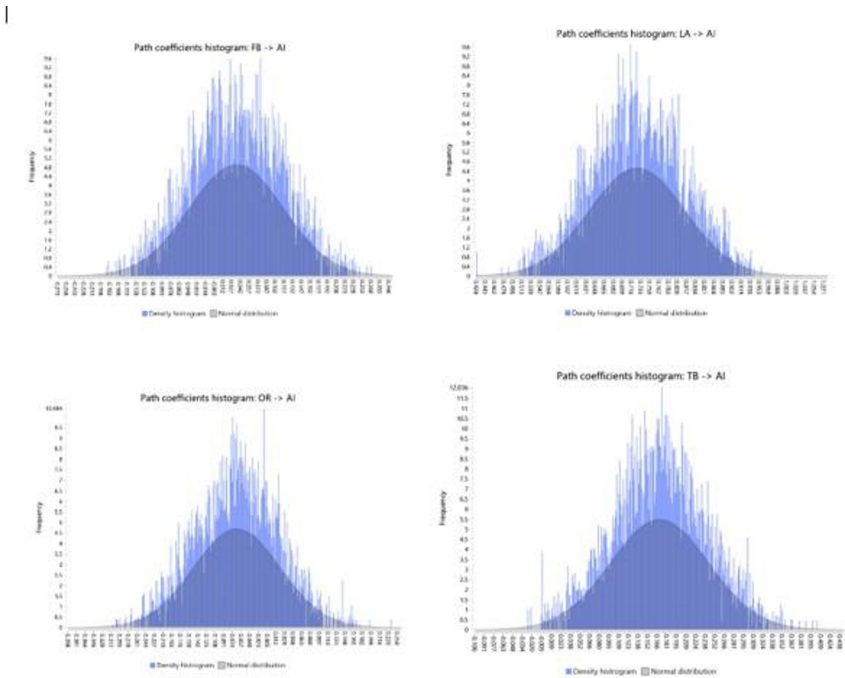


Fig. 5. Path co-efficient histograms

9. AI based digital marketing Personalization techniques in handloom

The space of marketing for handloom products has changed considerably, from print and fair marketing to more advanced data-driven approaches that take advantage of the large online footprint of social media and other websites. This transformation is compounded with advances in artificial intelligence, that will enable the brands to provide customization and personalized experiences to their customers resulting in increased brand engagement and ultimately money in hands. Given the evolving competitive landscape, it is important to recognize these strategic shifts as a condition for utilizing AI-driven personalization effectively. Here the tension between digital media as new

innovations and an historical continuity with older forms of marketing becomes interesting.

There are new approaches that are merging old and new media styles in order to allow companies to attempt to create an integrated, coherent message that tracks across multiple points of contact with its customers. Such integrative approach not only develops brand loyalty but indeed it also creates a bond with the consumer. Brands that listen to their customers and engage in open dialogue will better tap into the needs and preferences of consumers, and this process of constant improvement serves brands as well as customers. It also allows brands to stay ahead by not just fulfilling current consumer needs but by identifying how to satisfy future consumer wants in advance, staying ahead in a competitive market place. This section examines a range of AI-driven digital marketing techniques and strategies suggested by selected AI marketing professionals for the handloom industry, with a focus on enhancing personalization.

Table 10. Digital marketing techniques

Techniques	B2B Application	B2C Application	Example
AI-Driven Product Recommendations	Suggests bulk yarn/colour combos to weavers based on trends.	Recommends matching accessories (e.g., "Buy this ikat fabric with tassels").	"Weavers who bought organic cotton yarn also liked these natural dyes."
Dynamic Pricing Optimization	Adjusts bulk pricing for retailers based on demand/season.	Offers personalized discounts (e.g., "10% off for first-time buyers").	Monsoon-season discount on handloom cotton sarees.
Visual Search & Fabric Matching	Helps retailers source similar handloom designs from weavers.	Users can upload photos to find matching handloom fabrics.	"Find a handloom silk similar to this celebrity's saree."
AI Chatbots for Customer Support	Assists wholesalers with bulk order inquiries (WhatsApp/web-site).	Provides styling tips (e.g., "How to drape a handloom dupatta?").	Chatbot suggests "best handloom fabrics for summer" based on user queries.
Predictive Trend Forecasting	Alerts weavers about rising demand for specific patterns (e.g., checks vs. florals).	Promotes trending designs to consumers (e.g., "Rustic khadi is in this season!").	AI detects rising Pinterest searches for "tribal handloom shawls."
Hyper-Personalized Email Campaigns	Sends weavers updates on global handloom demand trends.	Abandoned cart emails with discounts (e.g., "Complete your Khadi kurta purchase!").	"Your favourite handloom cotton is back in stock!"
Social Media Sentiment Analysis	Tracks demand for sustainable handloom among B2B buyers.	Identifies trending hashtags (e.g., Handmade with Love) for UGC campaigns.	Promoting "zero-waste handloom" after positive insta buzz.

AI-Curated Loyalty Programs	Rewards bulk buyers with early access to new collections.	Offers points for referrals (e.g., "Get a free handloom scarf for 5 referrals").	"Earn double points on every handloom purchase this month."
Blockchain + AI for Authenticity	Certifies genuine handloom origins for exporters.	Consumers can scan QR codes to verify artisan-made products.	"This Madhubani print is ethically sourced from Bihar—scan to learn more."
R/VR Virtual Try-On	Virtual showrooms for retailers to preview bulk collections.	Customers visualize handloom drapes/stitched outfits.	"See how this Banarasi silk saree looks on you via AR."

Source: Author's own creation

AI and digital marketing can be employed in both B2B (business-to-business) and B2C (business-to-consumer) contexts for the digital transformation of the handloom industry. Within B2B, weavers and retailers are supported through predictive forecasting, visual search, and blockchain, and are informed about print trends, product authentication, and virtual showrooms. B2C applications, in the meantime, deploy AI chatbots, hyper-personalized emails, visual search, or AR/VR try-ons to improve customer engagement and shopping experiences. Consumers can, for example, get personalized product recommendations, or try on-virtual handloom outfits, before making a purchase, while businesses can take advantage of alerts on trends, or dynamic pricing options. These technologies contribute not only to increased efficiency of operation in the textile industry but also to making textile production more sustainable and less destructive of the local culture. Both technology and strategies are explained by utilizing the expert opinion and from previous studies.

Table 11. AI based Personalization strategy

Strategy	How It Works	Example
AI-Generated Dynamic Emails	Emails adapt content in real-time (e.g., show silk sarees if user browsed silk last).	"Nitha, your favourite Kanjivaram silk is back in stock! Here's 15% off just for you."
Behavioural Trigger Campaigns	Automatically sends offers when users take specific actions (e.g., abandoned cart).	"You left a handloom GI tagged product in your cart—here's free shipping to complete your order!"
Location-Based Personalization	Suggests products suited to local climate/culture.	Promoting Kuthampully sarees to users in hot climates/ GI Kasavu sarees in Onam festival.
Past Purchase Predictions	Recommends complementary items (e.g., matching blouse fabric for saree buyers).	"Pair your new Banarasi silk with this zari border blouse piece (often bought together)."
Hyper-Targeted Social Ads	Uses AI to show ads only to users who engaged with similar handloom content.	Instagram ad for Ajrakh block-print scarves shown only to users who liked sustainable fashion posts.
Personalized Loyalty Rewards	Customizes rewards based on individual purchase patterns.	"As loyal handloom buyer, get double points on all GI handloom products this month!"

AI-Powered Styling Guides	Generates outfit ideas based on past buys/browsing.	"How to style your Balaramapuram kasavu sarees in this festival season with 3 different looks."
Real-Time Website Personalization	Changes homepage banners/products based on visitor's history.	A returning customer sees "Welcome back! New ikat designs just for you."
Event-Based Campaigns	Suggests products for upcoming occasions (birthdays, festivals).	"Diwali is coming! Here's a curated list of festive handloom sarees based on your past purchases."
Voice/Visual Search Optimization	Allows personalized results via voice/image queries.	User asks Google Assistant: "Show me blue GI tagged handloom fabrics under ₹5000"—AI shows tailored options.

Source: Authors own creation

Personalization techniques using AI are currently being integrated into the handloom industry to help connect the producer and consumer spaces more efficiently, as well as to improve marketing techniques in a largely informal sector. Advanced dynamic emails and behavioural triggers via messages such as email, SMS and MMS can send context-based re-engagement messages based on browsing and purchasing patterns. Through location-based personalization and post-purchase predictions, product relevance is achieved via suggestions of climate-appropriate items or products complementary. Data can be leveraged to hyper-target social ads, AI style guides, and other next-generation user tools to shape the experience around customer behaviour, and event-based and loyalty benefits blur the line also help create life-long brand relationships with customers. Live web personalization and optimization for voice/visual search also personalize the web experience and facilitate natural product discovery, and are natural means of interfacing with your website. These add up to a personalized customer experience that has made handloom products more easily accessible and desirable in the online space.

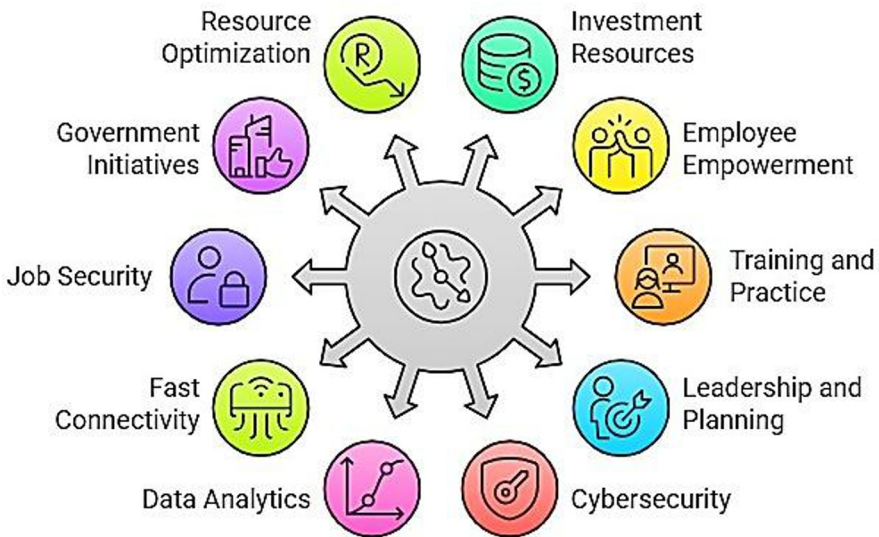


Fig. 6. AI based digital marketing enabling factors

Overall, the application and success of these technological marketing approaches that hinge on AI in the case of GI tagged handlooms require organizational, technological and policy led initiatives. Figure 6 provides a depiction of AI based digital marketing enabling factors. The existence of diverse resource of investment and the appropriate budget for the effort of a technological project represent the first needed pre-condition: Information requirements patterns do require multiple investments and have overall budget implications [76]. There is an equal importance to also empowering workers as well as cultivating an overall disposition to wanting to know more and work with new technology which can encourage a high degree of workforce adaptability and a capacity for innovation [10]. They are further reinforced by training and rehearsal sessions and, critically, simulation exercises that are essential to building skills in digital tools and AI. Leadership and planning are very crucial as well in this transformation. However, strong leadership can help provide strategic guidance and moral support at all stages of the migration process as well as forecast, to help organizations understand where the market is heading towards and how they could adjust their digital marketing strategies to better suit the new trends, as suggested by Kazakova et al., [44].

Technically, AI is heavily dependent on data, which can work as fuel to train algorithms, and on this side cybersecurity becomes crucial to protect data of consumers' and create trust in AI- powered platforms [47], while the use of data analytics allows for personalized marketing campaigns more commonly referred to as data-driven marketing [73]. Fast connectivity to allow for uninterrupted digital operations and job security to eliminate the risk of job replacement through automation [62] are also cited

as facilitators. Furthermore, macro-level drivers like government policies in education, trade policies, inward investments, and/or outsourcing can foster an enabling environment for AI technology adoption [31]. Organizations should also learn to better exploit available resources in order to cut costs and boost efficiency [15]. These include insurance reflection, use of software, and how actors within the industry are cooperating, they also help drive the shift to digital technology. These two trends make the adoption of AI in digital marketing strategies amongst handloom producers much more feasible, allowing them to scale up in a sustainable and competitive manner.

10. Conclusion

The current study focused on the level of awareness and use of modern digital marketing strategies among different marketing agents in the GI tagged handloom products and also explored various barriers which influence the AI adoption intentions in the industry. According to the findings, use of digitalization, AI and Personalization among different marketing agents are very low and their level of awareness is also moderate. They are not trying to utilize the wide scope of this new modern digitalized market in the near future due to some barriers. The key barriers of adoption of digital marketing strategies are lack of level of awareness and technological skills, whereas the minor factors are financial and organizational barriers. And likewise, the lack of knowledge, availability of talent, poor IT infrastructure, cost, and lack of government support hinder the adoption of digital marketing in the handloom industry. Such results strongly support the argument that there is a necessity to bring capacities, digital literacy programs, and policies in order to mitigate the differences between established handloom production and the new technology-assisted trend of marketing.

When compared to the recent studies Naik & Bhardwaj [60], which underscore the importance of technological and awareness-related factors as the crucial drivers of the digital transformation of heritage-based and small-scale industries, the findings materialize under the consistent pattern. To provide an example, Zhang et al. [90] emphasize that organizations that have better technological abilities and AI literacy adopt it more quickly and ensure better competitiveness in the market. On the same note, Meera and Vinodan [57] and Guha et al. [33] state that although social media and e-commerce platforms are gaining prominence to promote handloom work, the industry is yet to follow the new type of digital solutions in terms of applying AI-based marketing personalization and customer engagement. In practice, the paper indicates that policymakers and stakeholders in the industry need to focus on raising awareness activities, infrastructure improvement projects, and capacity development especially in the skills sector to promote faster adoption of technology. The future research may use these results to experiment with AI-based marketing models in the handloom industry and examine the impacts of the adoption of modern marketing strategy in consumer interaction and the general market.

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