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THE MARKET PROSPECTS OF THE GUANGXI ZHUANG EMBROIDERED BALL AND CONSUMERS' PURCHASE INTENTION

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Abstract: This study examines embroidered balls (xiuqiu), a Guangxi Zhuang craft listed as intangible cultural heritage, and draws on 481 valid responses from an online and offline questionnaire. Using logistic regression and cluster analysis, it answers two questions: which factors shape a consumer's willingness to buy an embroidered ball, and how consumer segments differ in that willingness, which together indicate where the market for this craft is heading. The core buyer is a female undergraduate aged 19 to 23. Women and residents of central and western Guangxi show significantly stronger purchase intentions than other groups. Cluster analysis sorts consumers into three groups: price-sensitive (35%), quality-oriented (45%) and culturally committed (20%). The industry also faces an ageing pool of inheritors and weak demand. The paper proposes strategies along four lines: production, policy, transmission of the craft, and promotion.
Keywords: Guangxi Zhuang embroidered ball; Purchase intention; Logistic regression; Cluster analysis; Intangible cultural heritage industry

1 INTRODUCTION

To carry out the national strategy of building a strong culture, the Guangxi Zhuang Autonomous Region has been promoting the transmission and development of traditional folk culture [1]. The embroidered ball is one of Guangxi's most important heritage items and a customary gift. Cultural revival policies and the growth of cultural tourism have turned it into a sought-after traditional handicraft, and the market has expanded alongside heritage protection programmes and the rise of guochao, the fashion for home-grown design. Its delicate compact shape and fully-handcrafted workmanship have earned it the reputation of “the finest Jingxi embroidered balls”. Jingxi itself is known as the home of the embroidered ball, which is why this study takes the Guangxi Zhuang embroidered ball as its subject.

The embroidered ball is a significant part of China's intangible cultural heritage (hereafter ICH), and its transmission has flourished in several regions with sizeable markets [2]. Production centres on Jingxi in Guangxi, Taiping in Shanxi and Tangshan in Hebei. Jingxi has built a courtyard-economy model in which enterprises, villages and households work together [3]. Balls from Jingxi sell across China and are exported to Southeast Asia, the United States, Japan and South Korea, carrying Zhuang culture abroad. Taiping has set up cooperatives and a cultural industry park and runs training programmes; the sector there is now worth close to one million yuan a year in output. Tangshan has raised its profile through exhibitions and cultural exchanges and has widened its markets at home and abroad.

In 2013 the embroidered ball was added to Guangxi's representative list of intangible cultural heritage, and it has held a place in the handicraft market ever since [4]. From 2014, Jingxi has staged the Qixi Embroidered Ball Festival five times, and with policy and funding support it turned Jiuzhou Street into an autonomous-region-level demonstration base for the ICH industry. Cultural tourism programmes and the application for the home-of-the-embroidered-ball title have put Jingxi's ball industry on a fast track. Local residents and businesses have used that opening to build out online and offline channels, reaching customers through heritage experience centres and social media, gathering feedback and reading demand more precisely. E-commerce platforms have added heritage sections that raise visibility, and local authorities has worked with companies to set up digital heritage workshops and cross-border platforms, pushing exports to Southeast Asia, Europe and the United States. In the digital age the craft keeps its traditional methods while moving towards mechanised, standardised production.

Yet as sales have grown, the people of Jiuzhou have kept making balls by hand, even though mechanised production technology is now well developed and mechanised, standardised output has begun. Handwork limits how fast the industry can grow. Many firms have also been slow to build brands and lack recognition and influence, which holds back the widening of the market and of sales [5]. This paper therefore uses a questionnaire survey, logistic regression and cluster analysis to assess the current state of the market and to identify the factors and the innovation strategies that matter for its development, so that practical recommendations can be made and the craft can be transmitted and developed in a healthy, sustained way. Unlocking market potential, expanding market scale and identifying market breakthrough points are of great practical significance [6].

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Jingxi embroidered balls are a traditional Zhuang handicraft that has become a scaled industry with annual sales above ten million yuan. Balls are exported to Japan, South Korea and elsewhere, and the Jiuzhou trademark has been registered, turning the craft into a commodity. Buyers have widened from older collectors to young women, cultural-creative derivatives such as earrings and key rings are popular, and livestream commerce has become an important sales channel, which has rejuvenated the brand and enlarged the market.

To sum up, this paper surveys young people in Guangxi, looks at how the embroidered ball is faring today, analyses the market's prospects and consumers' willingness to buy, and proposes innovation strategies for the industry.

2 DATA AND METHODS

2.1 Data Sources and Preprocessing

The questionnaire survey covers consumption of embroidered balls in Guangxi and is intended as a reference for innovation and marketing. For people who have not bought a ball, it asks why not, how they rate the product, what they expect of it and whether they want one, which gives a measure of purchase intention. For owners, it asks about their experience, the occasions on which they use the ball, their emotional attachment to it and how it compares with other cultural-creative products, which gives a measure of satisfaction. The questionnaire was designed around these two groups.

The questionnaire contains 31 questions. Respondents took 235 seconds on average to complete it, and the lower quartile was 124 seconds, so any response finished in 124 seconds or less was treated as invalid. Because some respondents might submit the form more than once, we checked for duplicate IP addresses and found none, so duplicate submissions are not an issue here.

After these checks, 500 questionnaires had been collected, of which 481 were valid, a valid response rate of 98.6%.

Internal consistency is the most widely used reliability measure for rating scales in market research, so this report assesses internal consistency with Cronbach's alpha. We used SPSS 26.0 to compute the coefficient across all respondents and all items. Multiple-choice items were split into binary sub-items, and on the basis of their internal relationships the items were grouped into two sets: satisfaction among owners, and purchase intention among non-owners. The reliability test in Table 1 shows Cronbach's alpha above 0.60 for both sets and 0.840 for the questionnaire as a whole, a level that is highly reliable. The scale is fully acceptable and needs no adjustment, which indicates that the structure and the item design are sound.

Table 1 Reliability Statistics

Cronbach's alpha	Number of items
0.840	33

Validity refers to whether a measurement captures the trait it is meant to capture, and covers relevance, objectivity, reliability and practical usefulness. A Kaiser-Meyer-Olkin test and Bartlett's test of sphericity (Table 2) returned a KMO coefficient of 0.890 and a p-value of approximately 0.000. The data are therefore suitable for factor analysis, which confirms the soundness of the questionnaire structure and provides a reliable basis for extracting dimensions.

Table 2 KMO and Bartlett's Test of Sphericity

Measure		Value
KMO value		0.890
Bartlett's test of sphericity	Approx. chi-square	335.792
	df	78
	p	0.000

The sample was drawn both online and offline. If the two sources did not yield consistent data, later analysis would not be reliable, so we ran a Kruskal-Wallis test on respondents' basic characteristics across the two samples. Table 3 shows p-values above 0.05 for all five variables. We therefore cannot reject the null hypothesis and conclude that the online and offline samples come from the same population.

Table 3 Kruskal-Wallis Test

Variable	p-value
Age	0.684
Education	0.212
Employment	0.730
Monthly spending	0.126
Region	0.260

2.2 Methods

(1) The Study Combines Four Methods.

a questionnaire survey, a logistic regression model and cluster analysis. Each is described below. Questionnaire survey The questionnaire was designed around the research questions, with question types, order and wording chosen accordingly. An appropriate sampling method produced a representative sample, and the valid data were entered into SPSS for descriptive statistics and correlation analysis, among other procedures, to reveal patterns in consumer behaviour and to inform decisions [7].

(2) Logistic Regression.

This statistical method models the relationship between a binary or multi-category dependent variable and several independent variables. A logistic function converts the result of a linear regression into a probability between 0 and 1, which expresses how likely an event is, and the method is used widely across fields. This paper uses it to test how user characteristics affect purchase intention [8]

(3) Cluster Analysis.

This method groups data objects described by several variables according to their similarity. We applied density-based clustering, hierarchical clustering and K-means to explore patterns of preference and behaviour in the market, to identify latent market segments and consumer groups, and to provide a basis for targeted marketing and market strategy [9].

3 THE MARKET TODAY: A DESCRIPTIVE ANALYSIS

3.1 Respondents' Demographic Profile and Their Awareness of the Craft

The demographic profile of the valid sample is shown in Table 4.

Table 4 Demographic Profile of Respondents

Dimension	Category	Share
Age	14-18	22.2%
	19-23	49.7%
	24-28	28.1%
Gender	Male	43%
	Female	57%
Occupation	Student	57%
	Employed	43%
Education	Primary school or below	0%
	Junior secondary	7%
	Senior secondary (incl. vocational)	16%
	Junior college	24%
	Undergraduate	39%
	Postgraduate or above	14%

The profile points to the following patterns.

(1) Age: 19 to 23 is the core audience.

The age distribution is markedly uneven. The 19 to 23 group accounts for 49.7%, close to half the sample, which makes young adults the core audience of this survey: they accept and take an interest in embroidered-ball heritage more than any other group and are the main pool of potential buyers. Teenagers aged 14 to 18 and young adults aged 24 to 28 make up sizeable shares as well, so the youth market still has room to grow. Products and promotion can be differentiated by age group [10].

(2) Gender: women are the main participants.

Women make up a clearly larger share of respondents than men. Women take a greater interest in survey topics related to the embroidered ball, which may reflect the emotional symbolism attached to the craft and an aesthetic preference for hand-made heritage objects. Marketing and sales can therefore focus on women's needs first, while scenario-based marketing and cross-brand collaborations bring in more male consumers and widen coverage.

(3) Employment: students predominate.

Students are noticeably more engaged. They are curious, open to new ideas and more exposed to the current enthusiasm for heritage; they are more willing to learn about the craft, to take part in its transmission and reinvention and to try products derived from it. Employed respondents have less time to follow heritage culture but still encounter embroidered balls through news coverage and policy campaigns and retain some willingness to buy, so lighter, occasion-specific derivatives could be developed for them.

(4) Education: graduates of junior college and above dominate.

Respondents' education clusters at senior secondary level and above, which matches the general rise in educational attainment among young people and suggests that better-educated consumers know and accept embroidered-ball heritage more readily. Embroidery culture could be brought into schools through design competitions and craft classes, strengthening the connection between the craft and young, well-educated consumers and building awareness, affection and spending potential among the next generation.

The chi-square tests reported below support this reading. Age, gender and education all affect willingness to buy Guangxi embroidered balls at the 5% significance level, which confirms the link between demographic characteristics

and market behaviour. Occupation is not statistically significant, so students and employed respondents do not differ meaningfully in willingness to buy, and marketing need not treat the two groups very differently.

3.2 How Demographic Groups Relate to Purchase Rates

This section analyses differences in the purchase rate for Guangxi Zhuang embroidered balls and examines how gender, age, education and occupation relate to whether a respondent has bought one, using chi-square tests and contingency tables.

Null hypothesis H0: none of the basic characteristics has a significant effect on whether someone buys a Guangxi embroidered ball.

Table 5 Chi-Square Test Results

Characteristic	Chi-square	p-value	Significance
Age	7.7528	0.021	Significant (p<0.05)
Gender	5.407	0.020	Significant (p<0.05)
Occupation (employment)	0.499	0.480	Not significant
Education	12.212	0.016	Significant (p<0.05)

The chi-square tests in Table 5 show significant effects for age, gender, occupation and education at the 5% level, so all of these factors except occupation influence the intention to buy a Guangxi embroidered ball. Occupation does not reach statistical significance.

4 HOW USER CHARACTERISTICS AFFECT PURCHASE INTENTION: A LOGISTIC REGRESSION

Having described the current market and the relationship between demographic groups and purchase rates, this paper turns to data collected by questionnaire from a range of groups and builds a logistic regression model of the relationship between user characteristics and purchase intention. The results provide empirical support for refining market strategy and guidance on product positioning and target-group profiles when the embroidered ball is redesigned [11].

4.1 Model Specification

The study concerns the factors linking user characteristics to purchase intention. The question of whether a respondent would buy a redesigned embroidered ball admits only "yes" or "no", so the dependent variable is binary and a logistic regression is appropriate. Categorical variables dominate the questionnaire data and continuous variables are few, which makes the logistic model the more reasonable choice. The model is specified as follows:

$$P=\frac{e^{\alpha+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n}}{1+e^{\alpha+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n}} \tag{1}$$

In equation (1), β j (j = 1, 2, 3, …, n) represents the regression parameters. The probability that the event occurs is P and the probability that it does not is 1 - P; the ratio of the two is the odds ratio (OR).

From equation (1), let the linear predictor be $Y=\alpha+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n$, then we have

$$P=\frac{e_y}{1+e_y} \tag{2}$$

Equation (2) converts the non-linear model into a linear one, as follows:

$$Logit(P)=ln\frac{p}{1-p}=\alpha+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n \tag{3}$$

In equation (3), P is the probability that the binary dependent variable takes the value 1. The X terms are the explanatory variables, that is, the factors listed above, and they are used to explain how each factor affects consumers' willingness to buy a redesigned embroidered ball. Alpha is the constant. The beta coefficient of an explanatory variable gives the change in the logit of P when that variable rises by one unit and the others are held constant, which in this study means the strength of each factor's influence on willingness to buy an innovative embroidered ball.

4.2 Variables and Dummy Coding

Much of the questionnaire data is categorical; education, for example, has six levels. Numbering the levels in sequence and entering the number as an independent variable would assume that the size of the gap between levels reflects the size of their effect. Ordinal treatment also fails for unordered categories such as employment, where the options have no natural ranking, so a single coefficient cannot meaningfully represent the change in the dependent variable as employment rises by one unit. To avoid the bias that an imposed order would introduce, every multi-category independent variable was dummy coded before being entered into the logistic regression: 1 marks selection of a category and 0 marks non-selection. Table 6 gives the variable names, meanings, coding and reference groups.

Table 6 Variables, Meanings, Coding and Reference Groups

Type	Variable	Meaning	Coding
Dependent variable	Y	Intention to buy a redesigned embroidered ball	0 = no; 1 = yes
Demographic	Age1	Age: 14-18	1 = yes; 0 = no
	Age2	Age: 19-23	1 = yes; 0 = no
	Age3	Age: 24-28	Reference group
	Gender1	Gender: male	1 = yes; 0 = no
	Gender2	Gender: female	1 = yes; 0 = no
	Edu1	Education: primary school or below	1 = yes; 0 = no
	Edu2	Education: junior secondary	1 = yes; 0 = no
	Edu3	Education: senior secondary (incl. vocational)	1 = yes; 0 = no
	Edu4	Education: junior college	Reference group
	Edu5	Education: undergraduate	1 = yes; 0 = no
	Edu6	Education: postgraduate or above	1 = yes; 0 = no
	Job1	Occupation: student	1 = yes; 0 = no
	Job2	Occupation: employed	1 = yes; 0 = no
	Job3	Occupation: other	Reference group
Economic	Con1	Monthly spending: 0-1,000 yuan	1 = yes; 0 = no
	Con2	Monthly spending: 1,000-2,000 yuan	1 = yes; 0 = no
	Con3	Monthly spending: 2,000-4,000 yuan	Reference group
	Con4	Monthly spending: 4,000-6,000 yuan	1 = yes; 0 = no
	Con5	Monthly spending: above 6,000 yuan	1 = yes; 0 = no
Regional	City1	City of residence: central Guangxi	1 = yes; 0 = no
	City2	City of residence: eastern Guangxi	1 = yes; 0 = no
	City3	City of residence: southern Guangxi	Reference group
	City4	City of residence: western Guangxi	1 = yes; 0 = no
	City5	City of residence: northern Guangxi	1 = yes; 0 = no
Psychological	Aff1	Favour towards a redesigned ball: very favourable	1 = yes; 0 = no
	Aff2	Favour towards a redesigned ball: fairly favourable	1 = yes; 0 = no
	Aff3	Favour towards a redesigned ball: neutral or below	Reference group

4.3 Model Testing

Table 7 Logistic Regression Model Fit

Likelihood-ratio chi-square	P	AIC	BIC
60.641	0.000***	110.641	175.77

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

A likelihood-ratio chi-square test assesses the overall validity of the model. As Table 7 shows, the likelihood-ratio chi-square is 60.641 with a p-value of 0.000***, which is significant and rejects the null hypothesis: taken together, the independent variables explain differences in willingness to buy a redesigned embroidered ball. The AIC of 110.641 and BIC of 175.77 fall in a reasonable range, which further indicates a good fit and supports use of the model in the analysis that follows.

4.4 Results

Table 8 Logistic Regression Results

Reference category = no	S.E.	P	OR	95% CI for OR	
				Upper	Lower
Age2	1.187	0.0541	0.102	0.01	1.042
Gender2	1.066	0.0411	8.872	1.098	71.694
Edu5	1.646	0.423	3.738	0.148	94.102
Edu6	2.343	0.0991	0.021	0	2.065
Job2	1.264	0.223	0.215	0.018	2.555
Con4	2.729	0.129	0.016	0	3.344
City1	0.943	0.0081	0.081	0.013	0.516
City4	2.375	0.0171	0.003	0	0.359
Aff1	1.353	0.0041	0.019	0.001	0.274
Aff2	1.302	0.0021	0.019	0.002	0.25
Dependent variable: Would you buy an embroidered ball?					

The model is valid, so the logistic regression can be used to analyse willingness to buy. Table 8 gives the results. City1, City4, Aff1, Gender2 and Aff2 all have p-values below 0.05, which means they significantly affect the intention to buy. City1 and Aff1 have odds ratios of 0.081 and 0.019, so the variables that define them are associated with a markedly lower intention to buy. Aff2 has an odds ratio of 0.019, which also points to a significant negative effect. Age has a p-value of 0.0, so it significantly affects the willingness of young people to buy. Taken together, the market responds to

a regional focus and to improving consumer attitudes, and young people deserve particular attention: redesigning the embroidered ball in forms that young people like raises acceptance and sales.

4.4.1 How user characteristics affect purchase intention

The empirical analysis shows that age significantly affects whether marketing innovation strengthens young people's willingness to buy an embroidered ball. Young people living in western and central Guangxi are noticeably more willing to buy. Favour towards the product also matters: people who rate innovative balls as very good or fairly good show a stronger intention to buy. Gender matters too; young women are the more willing group. Occupation, education and monthly spending all have p-values above 0.05 and fail the significance test on model coefficients, so they have no significant effect on young people's willingness to buy a redesigned ball. They may still play a subtle role in particular situations.

Young people are open-minded and creative, and they set trends. They take readily to new things and welcome products that blend in new elements. The gap between young people in western Guangxi and those in central Guangxi is telling: the closer they live to Jiuzhou in Jingxi, the home of the embroidered ball, the more willing they are to buy a redesigned ball. Better favour means that consumers rate the appearance and design of a redesigned ball positively, which stimulates the wish to buy and leads them to pay for something they like. Women, who tend to take more interest in arts and craft objects, are drawn by the cultural depth of the embroidered ball, and redesigns attract their attention more than the traditional form, which explains their stronger intention to buy.

5 SEGMENTING THE MARKET BY CLUSTER ANALYSIS AND BUILDING TARGETED MARKETING

This chapter segments the market for Guangxi's heritage embroidered balls and sets out a targeted marketing strategy, using cluster analysis. Demand and preferences among buyers of embroidered balls are naturally heterogeneous, and a single dimension of segmentation cannot cover cultural, practical and collectible consumption at once. Cluster analysis identifies groups of similar consumers directly from the data, which gives a basis for differentiating products, placing channels and reaching customers. Three algorithms, density-based clustering, hierarchical clustering and K-means, are used together rather than as redundant copies. Each has its own logic: density-based clustering separates a genuine core of buyers from scattered marginal demand, hierarchical clustering shows how groups relate to one another in levels, and K-means extracts the shared traits of each group efficiently. Used together they check one another, which offsets the parameter sensitivity and the chance results of any single algorithm and yields steadier, more reliable segments that can support marketing decisions.

5.1 Model Building

Cluster analysis is a statistical method that divides the samples in a dataset into categories so that samples within a category resemble one another closely and samples in different categories do not. In this study it is applied to the craft features, cultural value and market demand for the embroidered ball, which supplies data on which strategies for transmission and development can rest.

(1) Density-based clustering (DBSCAN)

Where the density of data points in an area exceeds a set threshold, those points form a cluster. Points above the threshold are core points, points within a set distance of a core point are border points, and points in low-density areas are noise. The analysis first clusters the data and summarises the distribution of clusters, then labels each sample with its cluster, and finally plots a scatter diagram to show the result [12].

(2) Hierarchical clustering

Hierarchical clustering is a standard method that merges data points into clusters recursively until all points form one cluster or a preset number is reached. The result is usually shown as a dendrogram and can also be plotted as a scatter diagram in which each point stands for a data point and its colour or shape indicates its cluster. The analysis checks missing values to judge how far clustering can be trusted, reads the agglomeration schedule for distances between samples, and then examines the dendrogram to observe the clusters, probe the data and find the hierarchical relationships between them [13].

(3) K-means clustering

K-means rests on a theory of grouping by similarity and on a specific algorithm. The theory uses distance to assign samples: a point belongs to the group whose centre is nearest. The algorithm works as follows. Set the number of groups, k, in advance; that k must be specified beforehand is one of the method's drawbacks, since the right number is often unknown. Choose k points at random as the initial centres; because the process iterates, their starting position matters little. Compute the distance from every sample to each centre and assign each sample to the nearest one, which gives k initial groups. Recompute each centre as the mean of the points now in its group. Repeat the assignment and recomputation until no point changes group, or a set number of iterations is reached [14].

5.2 Applying the Models

5.2.1 Preprocessing and variable selection

The clustering uses demographic variables (age, gender, education, employment, monthly spending and region) together with behavioural and attitudinal variables (favour towards the embroidered ball, purchase intention and preference for

different innovation strategies). The logistic regression had already shown these variables to correlate with purchase intention to varying degrees.

5.2.2 Reading the results

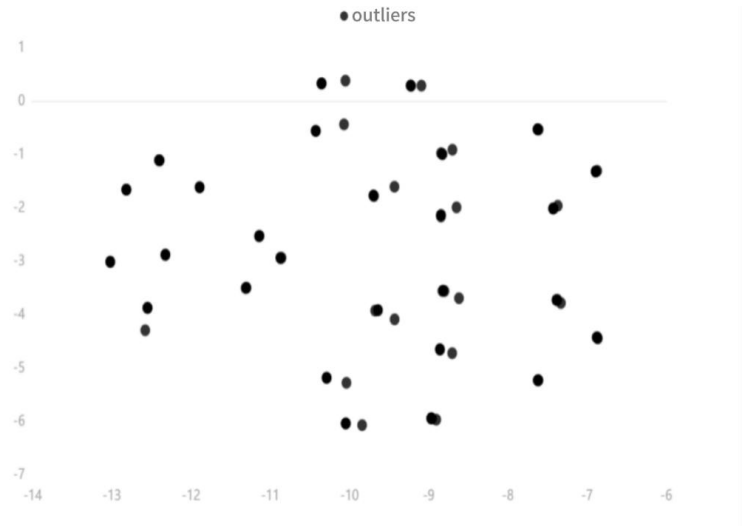

Figure 1 Density-Based Clustering Scatter Plot

(1) Density-based Clustering.

Because there are more than two variables, Figure 1 plots the first two components after t-SNE non-linear dimension reduction.

The horizontal and vertical axes are the first two components after t-SNE, which capture the most important variation in the data. Values run from -14 to -6 on the horizontal axis and from -7 to 1 on the vertical axis.

Each black dot in Figure 1 is one point from the original high-dimensional dataset. Where the dots fall in two dimensions reflects how similar they are in the original space; nearby dots are more alike.

Figure 1 shows three clusters, that is, three patterns in how the points gather. The clusters indicate latent structure or categories in the data.

The market and its consumers thus tend towards three modes of preference or behaviour. Each cluster is likely to represent a market segment or consumer group whose members share certain traits.

(2) Hierarchical clustering.

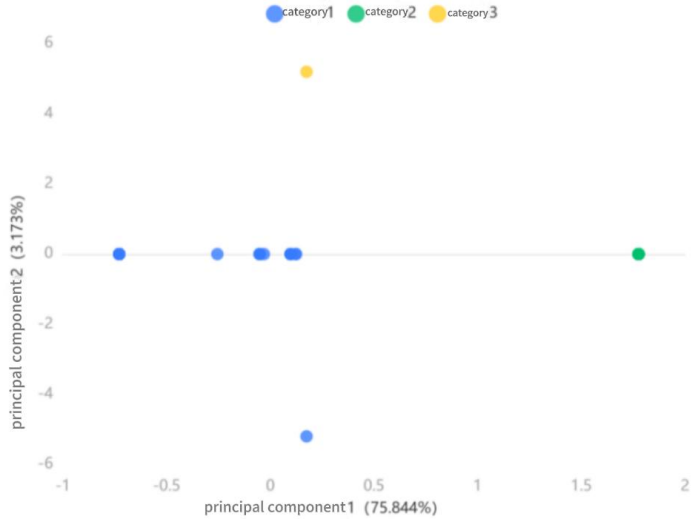

Figure 2 Hierarchical Clustering Scatter Plot

a. Principal Component Analysis(PCA).

Figure 2 shows two components, which account for 75.844% and 3.173% of the variance respectively. Most of the variation in the data can therefore be explained by these two components.

b. Distribution of Clusters.

Figure 2 shows points in three colours, standing for three clusters (Category 1, Category 2 and Category 3). Their distribution in two dimensions helps show how the clusters resemble and differ from one another.

c. Separation of clusters.

Category 1 (blue) and Category 2 (green) separate clearly on Components 1 and 2, which indicates a sharp difference between them along the main direction of variation. Category 3 (yellow) sits above the other two and takes a higher value on Component 2.

d. Compactness of Clusters.

Category 1 is fairly tightly grouped, so its points are similar within the component space. Category 2 is also fairly tight but clearly apart from Category 1. Category 3 is more isolated, which indicates a greater difference from the other two.

e. Interpretation.

The distribution gives an intuitive picture of the data's structure. Categories 1 and 2 represent two groups with similar traits, while Category 3 represents a group with distinctive traits [15].

f. Consumer Profiles.

Category 1 appears to be price-sensitive, weighing value for money and responding to promotions, discounts and price changes; competitive pricing and good value would suit them. Category 2 appears to value quality, brand value or particular features and may pay more for them; distinctive selling points and brand value would suit them. Category 3 appears to have specialised needs or preferences, a niche market with high demands on particular features or services; customised or premium products and services would suit them [16].

The scatter diagram presents the results of hierarchical clustering. Principal component analysis projects the high-dimensional data onto two dimensions, so the separation and similarity between clusters can be seen directly, which helps in reading the structure of the data and the quality of the clustering.

Table 9 Validity Indices

Silhouette coefficient	DBI	CH
0.65	0.321	78.875

The validity tests indicate that the clusters are reliable, so the three indices in Table 9 can be used to assess cluster quality. Silhouette coefficient: for a set of samples, this is the mean of the individual silhouette values. It ranges from -1 to 1; a higher score means samples within a cluster are closer together and samples in different clusters are farther apart, so clustering is better. A value of 0.65 is relatively high: most samples are well clustered, though some may sit on cluster boundaries or be misassigned.

Davies-Bouldin index (DBI): the ratio of within-cluster to between-cluster distance, averaged across pairs of clusters. Lower values indicate better clustering. A value of 0.321 is relatively low, which means samples within clusters are similar and samples between clusters are not, so clustering performs well.

Calinski-Harabasz score (CH): the numerator measures separation as the sum of squared distances from cluster centres to the dataset centre, and the denominator measures compactness as the sum of squared distances from points to their cluster centre. CH is the ratio of separation to compactness, and higher values indicate better clustering. A value of 78.875 is high, which means clusters differ clearly and samples within them are similar.

On these measures, hierarchical clustering works well on this dataset: it separates the data into clusters whose members are similar and whose differences are clear. The data also show that consumers have varied needs and preferences and attach particular weight to specific functions and to quality.

(3) K-means clustering.

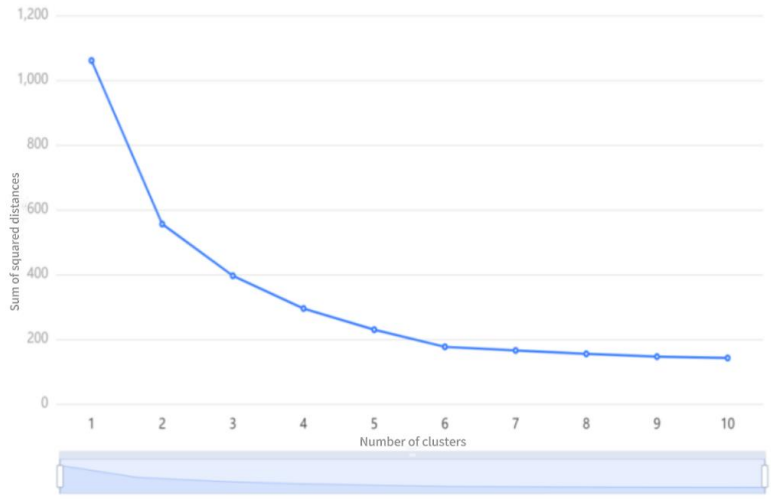

Figure 3 Elbow Plot

Figure 3 is the elbow plot from the K-means clustering, used to choose the number of clusters. The horizontal axis runs from 1 to 10 clusters.

The elbow is the point at which the curve flattens, that is, where adding another cluster no longer reduces the sum of squared distances much. In Figure 3 the fall slows markedly at three clusters, so this is the elbow, and three is the best

number of clusters. Three clusters keep the sum of squared distances low without the overfitting that too many clusters bring. Reading the centroid characteristics of each cluster gives the following:
Cluster 1 has low purchase intention, 35% of the sample. These respondents know little about embroidered-ball culture and show little wish to buy; they may know the ball only superficially and have formed neither understanding nor a motive to buy. They tend to prefer cheaper, simply designed balls.
Cluster 2 has moderate purchase intention, 45% of the sample. These respondents like the ball to some degree but are not strongly inclined to buy. They may be interested in its cultural meaning yet hesitate over the decision, and need more information and encouragement before they act.
Cluster 3 has high purchase intention, 20% of the sample. These respondents know the culture well, like the ball and intend to buy. They are its main customers and matter greatly to the craft's transmission.

5.3 Reading the Three Results Together

The three models point to the same core problem in the consumer base from different angles. K-means, working with purchase intention and level of knowledge, divides consumers into three tiers and reveals a three-way split: little knowledge with weak intent, some favour with slow action, and strong identification with active buying. It exposes a clear gap between knowing the culture and buying the product. Hierarchical clustering shows how closely samples relate to one another and brings out the graded way in which cultural identification and buying behaviour develop. Word of the craft spreads gradually, from the surface inwards, rather than splitting people into two camps. Density-based clustering identifies dense cores and sparse margins, which reflects an uneven structure in which some groups cluster geographically or in their characteristics while others scatter. It points to latent core groups that could be activated and to long-tail groups that need targeted coverage.
The three methods bring out complementary aspects of the same data. Cross-checking them offsets the parameter sensitivity and narrow angles of any one algorithm and makes the segments more robust and easier to interpret. K-means supplies an efficient baseline division of a large sample. Hierarchical clustering keeps the relationships between groups traceable. Density-based clustering catches clusters of arbitrary shape and noise points that distance-based algorithms overlook. Together they give a fuller picture of the market and a reliable basis for differentiated strategies.
The clusters call for coordinated strategies for different groups. For consumers who know little and intend little, the priority is to raise awareness of the culture through talks, exhibitions and social media, and to develop derivatives that fit modern taste and everyday use, which draw in younger buyers. For those who like the ball but are not yet inclined to buy, hands-on ball-making sessions strengthen identification, and stronger e-commerce and social channels lower the barrier to purchase. For the core group, which knows the craft well, likes it and intends to buy, custom and premium services meet individual needs, and participation in craft training and heritage protection projects builds a sense of belonging and responsibility. Seen through density, resources in dense areas should go into building the brand, with new design and local partnerships spreading the message, while sparse areas need targeted marketing, personalised recommendations and cultural guidance to build interest. In practice, the methods should be used together and against one another: K-means to set the baseline groups, hierarchical clustering to map how they relate, density-based clustering to pin down the dense core and the marginal noise, so that strategies for transmitting and developing the craft are broad and effective.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Drawing on the literature, the descriptive analysis and the models, this chapter sets out conclusions and targeted recommendations on the transmission of Jingxi embroidered-ball culture, consumption behaviour and the factors behind them. The survey data yield the following patterns.
First, density-based and hierarchical clustering establish the baseline, and K-means adds detail; together they divide consumers into three groups. Cluster 1, the price-sensitive group at 35%, prefers inexpensive, simply designed balls, and e-commerce promotions and DIY kits can lower the barrier to purchase. Cluster 2, the quality-oriented group at 45%, cares about craft and cultural meaning, and brand collaborations (with Love and Deepspace, for example) and premium custom products should be strengthened. Cluster 3, the culturally committed group at 20%, values transmission of the craft, and participatory channels such as hands-on workshops and neighbourhood embroidery hubs build their involvement. Product innovation (friendship-themed balls, anime collaborations), channel expansion (e-commerce combined with cultural tourism) and stronger promotion (short video and livestream) have proved to be the key strategies for both marketing and transmission, while tiered pricing and rotating promotions balance mass demand against the premium end [17]. The craft faces a shortage of young inheritors and a break in skills which constrains its transmission in Jingxi [18].
Second, the main audience is women aged 19 to 23, mostly undergraduates, living in central and western Guangxi, the heartland of the craft. They want cultural-creative products and a sense of cultural belonging, and they favour hands-on experiences and convenient shopping. The logistic regression shows that purchase intention is significantly higher in western and central Guangxi, the regions closest to Jingxi, than elsewhere. Favour raises intention significantly, which confirms that emotional identification drives purchases, with age and gender secondary. Young women are the more

willing buyers. Redesigns are well received: 75.06% of respondents would pay for a redesigned ball. Emotional identification drives consumption, regional preference is clear, and acceptance of new products is high.

Third, most respondents view the embroidered ball positively and only 11% negatively, which shows that the craft is well liked overall and has considerable potential. The largest single intention, at 52%, is to buy when a need arises, so the pool of potential buyers is large and suitable marketing can energise the market. Another 19% do not want to buy at present and 20% are unsure. The share with a direct intention to buy is comparatively small, and those who say they do not want one outnumber them, which indicates that the immediate pull to purchase is weak and that the product or service needs more appeal before more people act on a wish to buy.

Jingxi embroidered balls face both opportunities and challenges as the craft grows younger, more digital and more international. Finer segmentation, strategies fitted to each segment and policy support, combined with the reach of the internet, can keep the craft alive while meeting modern demand, and can lift it from a heritage emblem to a new engine of the cultural economy.

6.2 Recommendations

The Jingxi embroidered ball is a treasure of Zhuang culture, carrying distinctive craft skills and an aesthetic of its own, yet it now faces formidable difficulties in the market. Hand production is complex and costly and leaves little profit. The pool of inheritors is ageing, public awareness and market vitality are weak, and the culture risks a break in continuity. Reviving the market calls for innovation in technology, policy and social coordination. The recommendations below cover production, public support and social collaboration.

First, production needs reorganisation, the key to breaking through the traditional bottleneck. Splitting the production process so that basic steps such as cutting fabric and forming the frame are handled by machines shortens the production cycle, while core steps such as embroidery and joining stay hand-finished, which raises efficiency without losing the craft. A simplified ball, with simpler patterns or a smaller size but the twelve-petal shape retained, suits parent-and-child workshops and school classes and lowers the barrier to participation. On materials, recycled cotton in place of silk and eco-friendly dyes in place of chemical ones hold down costs and answer the demand for sustainability, which gives the craft new life.

Second, the special allowance scheme for ICH inheritors should be improved [19]. Differentiated living, housing and medical subsidies by skill grade, together with inclusion in the vocational skills certification system, give inheritors a stable career path. The legal framework should be completed with clear intellectual property protection, action against counterfeit goods and support for registering original designs, which protects the distinctiveness of the craft at its root. A dedicated fund could support equipment upgrades in embroidery workshops and start-ups run by young people, and tax relief for firms that buy locally made balls would create incentives on both the policy and the market side and give transmission a lasting push [20].

Third, the core of keeping the pool of inheritors stable is to make the work attractive and socially recognised. An ICH apprenticeship scheme, with public subsidies for the training costs borne by firms and direct employment for apprentices who pass their assessment, connects learning to work. Universities could offer programmes in heritage management that train people who know both the craft and how to run a business, which brings new blood into the sector. Media coverage and craft awards can build the image of the inheritor as a guardian of culture, and neighbourhood embroidery hubs offering free workspace and sales space raise their standing further. Full social insurance for full-time inheritors and early retirement under the special-occupation rules would ease their worries and encourage more young people to commit to the field.

Fourth, cross-industry partnerships should be deepened. In promoting the craft and its reinvention, partnerships widen the occasions on which embroidered balls appear: collaborations with game and food-and-beverage companies could produce themed in-game skins and milk-tea packaging, and product placement in film and television would raise exposure [21]. Online, leading heritage creators such as Li Ziqi, Jiuyue and Nanxiang can spread the word and widen recognition. Offline, scenic areas can host ball-making classes and themed exhibitions, and the craft can enter the craft curriculum from primary school through university, which brings it to a general audience. Derivatives built around the ball, such as ball-shaped fridge magnets, key rings, jigsaw models and custom Lego sets, meet demand for personalisation and carry the craft into daily life, which together builds promotion across many channels and raises the market reach and vitality of embroidered-ball culture.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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