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Digital IP Development and Industrial Ecology Construction of Linchuan Cultural and Historical Figures Based on AIGC

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SUMMARY: *In the context of the Digital Intelligence Era, the digital transformation of cultural IP has become an inevitable trend of cultural inheritance and innovation. The study focuses on the digital IP development of historical figures of Linchuan culture, explores the design process of AIGC technology-enabled digital cultural IP development, focuses on the mining of user needs using Kano model, and finally proposes the strategy of industrial ecology construction for digital IP development. The Beter and Worse coefficients for each user demand factor range from 0.2632 to 0.5980 and from -0.5222 to -0.1513 respectively. Users have the most sensitive and preferred demand qualities for digital IP of historical figures of Lincang culture: having emotional resonance, awakening memories of Lincang culture, cultural traits being easily identifiable and memorable, and accurately reproducing the morphological characteristics of the historical figures of Lincang culture, which can more accurately guide the design of digital IP. The satisfaction score of digital IP design is 7.53, which obtains a high degree of audience acceptance and satisfaction. The research in this paper presents a new field of intermingling traditional culture and modern technology, providing ideas for subsequent research in the field of traditional culture protection and inheritance innovation.*

KEYWORDS: *AIGC; Kano model; user demand; digital IP; Linchuan culture*

1 Introduction

Linchuan culture, as an important pillar of Jiangyou culture, began to develop from the Qin and Han Dynasties, and after thousands of years of inheritance and development, it has become a regional culture with rich connotation, wide radiation and unique characteristics. Under the development of Linchuan culture, a number of Linchuan cultural celebrities have emerged who have been used by the world and left a good reputation for posterity, such as Tang Xianzu, Wang Anshi, Wang Anli, Yanshu, Zeng Gong and Lu Jiufen. However, with the progress of the times, modern media such as movies, TV and internet have been widely popularized, enriching the connotation of people's cultural life while changing their aesthetic tastes, bringing serious impact to the survival of Linchuan culture and leading to the situation that the cultural heritage is facing the danger of no one to succeed it and being on the verge of extinction.

Digital IP is one of the effective brand marketing tools for modern marketing and promotion, which can help cultural and creative products or services to quickly establish cognitive systems such as identification and memory, so as to obtain a good market advantage, and has also become an important cultural symbol to enhance the effect of cultural inheritance and promote the development of cultural industry, which brings new opportunities for the survival of

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Linchuan culture [1-5]. IP initially refers to the Internet Protocol, and with the popularization of the network With the popularization of the network and the development of network culture, the meaning of IP is gradually expanded, and it begins to refer to intellectual property rights, which becomes the confirmation of innovation results and the protection of rights of individuals or organizations in the field of innovation, creativity and intellectual activities. Digital IP is the establishment of an information recognition system in the formation and development of industry, including the visual, auditory and even tactile and gustatory innovative transformation of all aspects of product or service information, thus forming a continuous identification and memory, and can meet the unique cultural aesthetic experience and expectations of contemporary groups [6-8].

In the context of digitization, combining digital technology with cultural resources can not only enrich and deepen the theoretical study of cultural resources, but also provide new ideas for their inheritance and development in the Internet era, but also transform the advantages of cultural resources into economic development advantages, optimize the ecology of the cultural industry, improve the economic benefits of the development of the cultural industry, and provide references to the development and utilization of cultural resources [9-12]. With the rapid development of AI technology, AI-generated content (AIGC) has become a research hotspot. AIGC technology is able to automatically create high-quality text, image, audio, and video content, which revolutionizes digital IP development and the cultural industry.

Literature [13] takes Hemudu culture as an example to explore the application of AIGC in digital IP design. By decoding cultural genes, AIGC improves the design efficiency and narrative innovation, but also faces the challenges of standardization and sustainability, which provides theoretical references for the industry. Literature [14] constructed a five-phase design framework based on AIGC to empower the creation of non-heritage IP images, which can improve efficiency and dissemination, but needs to be alert to the risk of shallow cultural meaning. Literature [15] utilizes convolutional neural network and AIGC technology to generate Dunhuang digital IP design, and its design management capability is the key regulating factor of human-machine co-creation, and its strategic positioning, resource integration and innovation management are the core paths to realize the unity of technology and culture. Literature [16] creates an AI and VR-based minority digital IP design system for Hui'an women's clothing, which realizes the decomposition and reconstruction of elements by parsing cultural genes, enabling users to generate characteristic IP images in an immersive environment, and verifies its innovative potential in cultural dissemination and memory storage. Literature [17] uses AIGC technology to create digital IP images of Beijing opera “Sheng Dan, Jing Chou”, and through the standardized process of data collection, model training, and generation and adjustment, it explores a new path of integrating traditional opera elements with modern design, and assists in the dissemination of cultural innovation. Literature [18] indicates that AIGC can significantly improve the efficiency and quality of tourism IP image design, reduce the time and cost, and has important practical value for promoting the development of tourism creative industry. Literature [19] proposes a multimodal rural digital IP design method based on AIGC, which generates IP images by analyzing the differences of visual elements and expands them into interactive products, and the practice of applying it to the village IP of “Langlang” shows that the method can improve the design efficiency and satisfy the diversified aesthetic needs of users.

This paper integrates Linchuan culture with AIGC technology, takes the design of digital IP of historical figures in Linchuan culture as the research object, and explores the design process of AIGC technology applied in the development of digital IP. In order to better develop the digital IP of historical figures in Linchuan culture, Kano model is introduced to mine user needs. After selecting the IP design elements from three levels, the data were collected through the

Kano model two-way questionnaire survey, evaluated by the Kano model two-factor scale, followed by calculating with the Better-worse coefficient with the relevant formula, presenting the user's order of importance for the digital IP design elements, and drawing the Beter-Worse scatter plot to classify the different attributes of the IP design elements to determine the design direction of IP image. The evaluation and verification of the IP design is implemented through user satisfaction research. Further, based on the perspective that AIGC technology empowers the development of traditional culture, we discuss the industrial ecological construction strategy of digital IP development.

2 Design application of AIGC in Linchuan Historical Figures IP

2.1 Linchuan Culture

Linchuan culture to Linchuan ancient rule of the genus as the core, covering more than ten counties in Jiangxi Fuzhou as the center, generated in the Qin and Han dynasties, flourished in the Song Dynasty, extending in the Ming and Qing dynasties. Linchuan region has always been outstanding, talented people, and gradually formed a unique culture of talent. Linchuan culture is centered on the culture of talented people, with profound connotation of literature, philosophy, medicine, art, science and technology, military and other aspects.

Lincuan has always had a thriving literary culture throughout history, with numerous talented individuals emerging. Historically, Lincuan has produced 7 prime ministers, 13 vice prime ministers, and 2,451 scholars. The "Dictionary of Famous Chinese Figures in History" records 134 people from Lincuan, and the "Comprehensive Collection of Literary and Artistic Figures from Jiangxi Throughout History" includes a total of 1,296 individuals, among whom nearly 300 are from Lincuan, accounting for nearly a quarter. The talented individuals of Lincuan in all periods have made outstanding contributions to the development of Lincuan literature. "Talents of Lincuan" is the most distinctive aspect of Lincuan culture. A large number of scholars, capable officials, patriots, and filial sons emerged there. They have made significant contributions to the development of Chinese civilization in various fields such as politics, theory, military affairs, poetry, calligraphy, drama, and science, earning the reputation of "Talents of Lincuan Dominating the World".

2.2 Digital IP Design Flow

AIGC refers to Artificial Intelligence Generated Content, AIGC is an intelligent program that appropriately generates relevant content based on existing data based on large scale pre-trained simulations, generative adversarial networks, natural language models, data algorithmic evolution, and multi-mode cumulative combinations, etc. AIGC tools are disruptive to IP design, where designers input specific requirements to generate base design solutions and sketches, which improves the The AIGC tool has had a disruptive impact on IP design, with designers inputting specific requirements to generate basic design solutions and sketches, thus improving the efficiency of designers and advancing projects. The inheritance and promotion of Linchuan culture urgently needs to be integrated with new technologies. Based on the analysis of Linchuan talent culture, Linchuan historical figures are mainly the images of ancient literati, this paper combines the digital IP with Linchuan historical figures, and utilizes the AIGC technology to design the digital IP of Linchuan cultural and historical figures.

How to scientifically and clearly understand the user's demand for the IP image of Linchuan cultural and historical figures is an important step in the design and development of IP, which

is of great significance to IP design. On the basis of the research of IP users' needs, the design of this paper tries to refine and design Linchuan cultural and historical figures into digital IP images, using AI tools such as Midjourney and StableDiffusion to generate images. In the generated image, the digital IP image of Linchuan historical figures is selected for its beautiful appearance, bright color, flexible shape and prominent image for secondary creation, and the application of PS, AI, Procreate and other graphic software, the integration of design theories, the creation of IP images suitable for the public's aesthetics, and finally the application of Stable Diffusion to generate an exclusive model of the digital IP image of the Linchuan historical figures.

The idea of transforming the digital IP image of Linchuan historical figures is shown in Figure 1. The steps of AIGC-based digital IP design include:

(1) Extracting the image, shape, and color factors of Linchuan cultural and historical figures to make basic materials for subsequent image generation.

(2) Communicate with ChatGPT to derive the keywords of Linchuan cultural and historical figures to facilitate the subsequent image generation of Midjourney and Stable Diffusion.

(3) Draw line drawings of Linchuan cultural and historical figures, and deliver the line drawings to Midjourney to generate high-quality IP images, so as to determine the characteristics of the IP images.

(4) Deliver the IP image to Stable Diffusion to create a three-dimensional model of the IP image, and ultimately generate the IP image of cultural and creative products and artifacts.

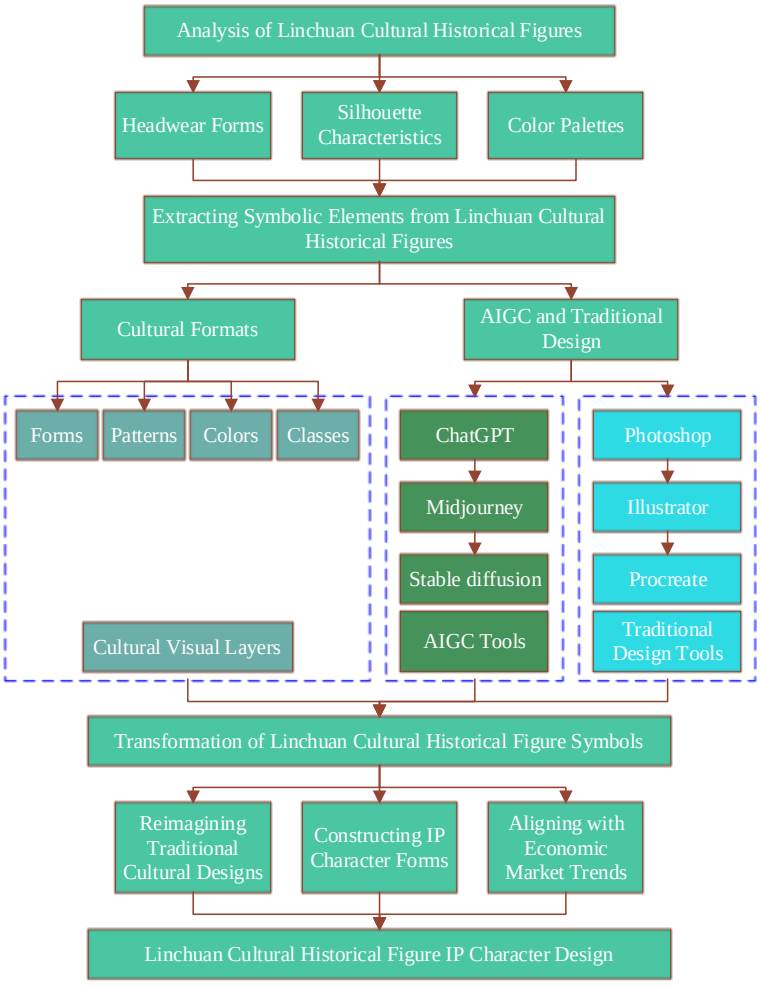


Figure 1: Ideas for IP image transformation of Linchuan historical figure

3 Analysis of digital IP user requirements

3.1 Purpose of Research

In order to better utilize AIGC technology to design the digital IP of Linchuan cultural and historical figures, and to deeply explore the users' needs for the digital IP of Linchuan cultural and historical figures, a research on the design of digital IP of Linchuan cultural and historical figures was conducted. The purpose of the research is to obtain clear user feedback to clarify the IP design direction and content. For this reason, this study will adopt Kano model as the main research method.

3.2 Methods of analysis

3.2.1 Kano model

Kano Model As shown in Figure 2, Kano Model is a linear relationship model used to present the relationship between product attributes and user satisfaction (X-axis is product attributes or qualities and Y-axis represents user satisfaction), which is an important model to support the assessment of the quantitative results of the user needs of digital IP in this study.

Products are categorized into five qualities in the Kano Model:

(1) Necessary quality (M): it is the basic standard of the product, without which satisfaction will be reduced, but with which satisfaction will not be increased additionally.

(2) One-dimensional quality (O): user satisfaction is directly proportional to the performance of the product quality.

(3) Charming quality (A): it is charming and attractive to users, which greatly affects user satisfaction.

(4) Undifferentiated quality (I): with or without this quality satisfaction has no effect.

(5) Reverse quality (R): this quality and user satisfaction is inversely proportional to the quality of user satisfaction, user satisfaction with this quality, on the contrary, will be reduced.

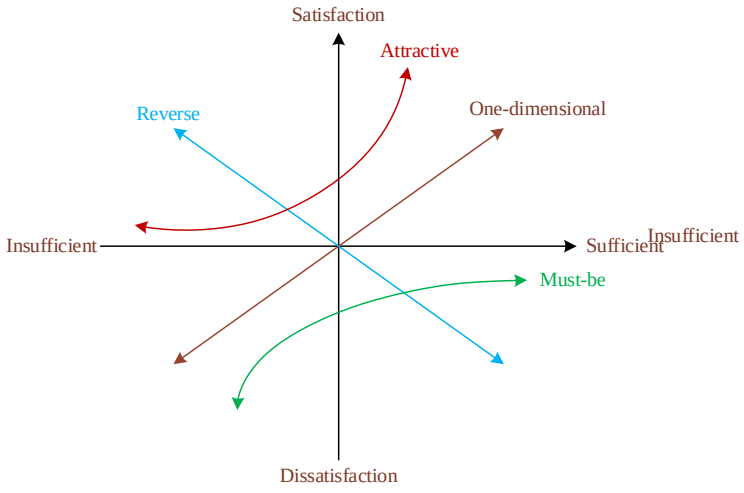


Figure 2: Kano model

3.2.2 Better-worse factor

The Kano model explores the categorization of product attributes, but the best quality results cannot be filtered through Kano alone. Using a combination of Better/Si-Worse/Di coefficient algorithms, the results can present the degree of user satisfaction with the addition of a particular

attribute to the Linchuan Cultural and Historical Figures Digital IP, or the degree of impact on the user after eliminating a very disliked feature attribute.

Better/Si is usually a positive value, and the result close to 1 means that the user satisfaction is higher after adding the feature, while Worse/Di is usually a negative value, and the result closer to -1 means that the impact of losing the feature on the user satisfaction is stronger. The formula is as follows:

$$Better/S_i = (A+O)/(A+O+M+I) \tag{1}$$

$$Worse/D_i = -1*(O+M)/(A+O+M+I) \tag{2}$$

3.3 IP Design Elements

The cultural three-level theory points out that the cultural three-level framework for studying cultural product design divides the cultural space into three levels: the outer middle and the inner, and corresponds them to the design elements. This paper combines the characteristics of Linchuan cultural and historical figures, and transfers the cultural attributes to the digital IP design elements for classification and generalization:

(1) The design elements at the external level are: shape, proportion, expression, color, and expression style.

(2) Design elements at the intermediate level include: functionality, applicable scenarios, and viewing experience.

(3) Design elements at the inner level include: cultural characteristics, storytelling, emotion, and fun.

Based on the characteristics of Linchuan cultural and historical figures, the different cultural attributes and design attributes of its digital IP image are initially refined, and the attributes of the elements at different levels can also provide a more three-dimensional perspective to understand the multi-faceted nature of the insight into user preferences. The design elements of the digital IP of Linchuan cultural and historical figures are shown in Table 1, resulting in 14 cultural attribute design elements.

Table 1: Design elements of digital IP

Level	Design attribute	Factor analysis
External level	Shape	Restore the morphological characteristics of the Linchuan historical figure stereotype F1
	Proportion	Cartographic ratio F2
	Expression	It's active F3
	Color	Use traditional colors F4
Intermediate level	Functional	It has a broad practicability F5
	Application scenario	Multiple scenarios are applicable and malleable F6
	Perception experience	Wake the cultural memories of Linchuan F7
Inner level	Cultural traits	It reflects the history style F8
		Cultural traits are familiar F9
		Cultural characteristics are easy to identify and remember F10
		Reflect the traditional Linchuan cultural aesthetic interest F11
	Feature	It has a story expressive and associative F12
	Emotions	Emotional resonance F13
	Enjoyment	Humorous F14

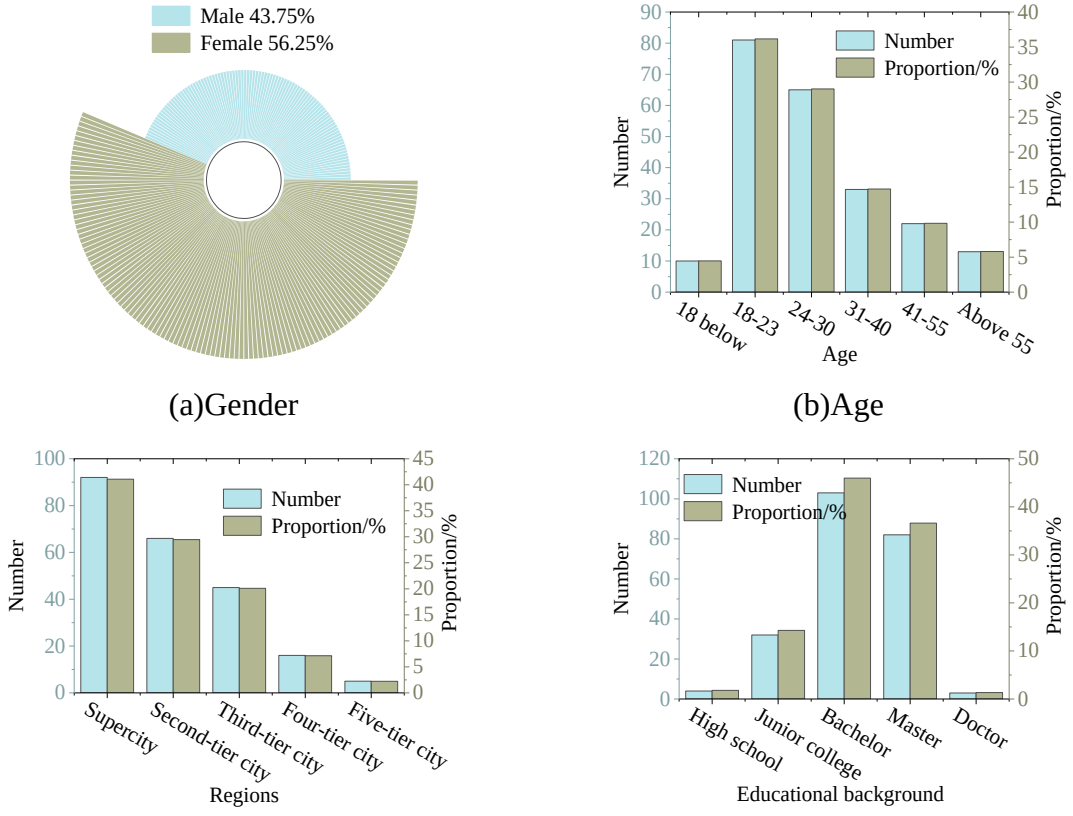
3.4 Questionnaire survey and analysis of results

3.4.1 Questionnaires

This audience questionnaire design in addition to the basic information, mainly including the current stage of Linchuan cultural and historical figures cognitive degree, and Kano model two-way questionnaire. A total of 250 questionnaires were distributed for this user research, covering both online and offline, and the online questionnaire was distributed using Questionnaire Star. A total of 224 valid questionnaires were recovered, and the effective rate of questionnaire recovery was 89.6%.

3.4.2 Basic situation analysis

The basic situation of the questionnaire respondents is shown in Figure 3, and Figures (a), (b), (c) and (d) represent the distribution ratio of gender, age, region and education of the respondents, respectively. Among the 224 respondents who participated in this user needs research, there were 98 males (43.75%) and 126 females (56.25%), and the main age group was 18-30 years old (65.18%), so the respondents were mostly young. In terms of educational background, 45.98% of the respondents have a bachelor's degree and 36.61% have a master's degree, which means that they have a certain degree of acceptance and understanding of traditional culture and refined arts. In terms of current city of residence and industry, 41.07% of the respondents live in megacities such as Beijing, Shanghai and Guangzhou, while 29.46% and 20.09% of the respondents live in second-tier and third-tier cities respectively. From the basic situation of the respondents, it is consistent with the definition of the target audience for the digital IP design of Linchuan cultural and historical figures.



(a)Gender (b)Age

(c)Regions (d)Educational background

Figure 3: The basic situation of the questionnaire surveyor

3.4.3 Cognitive situation analysis

The analysis of the respondents' knowledge of Linchuan culture and historical figures is shown in Figure 4. In the question of users' knowledge of Linchuan culture, only 1.79% and 5.80% of the population indicated that they knew very well and relatively well, 31.25% indicated that they knew in general, and 35.71% and 25.45% indicated that they did not know very well and did not know, so the users' knowledge of Linchuan culture is very limited at this stage.

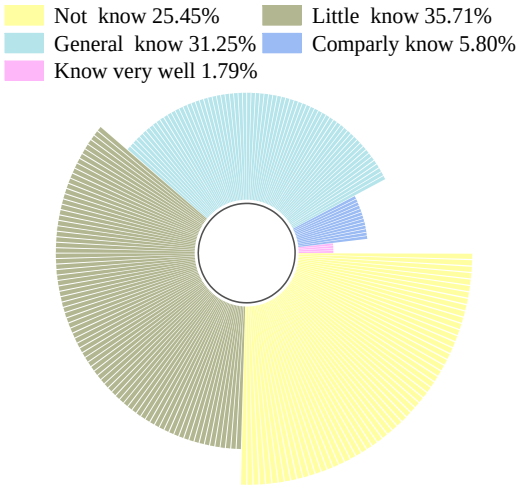


Figure 4: The cognition of the Linchuan historical figure

3.4.4 Digital IP Attribute Analysis

According to the recycled data, the frequency proportion of different qualities was calculated to determine their quality classification, and the quality classification results are shown in Table 2. The digital IP attributes of Linchuan cultural and historical figures are categorized into A, I and O, with 2, 9 and 3 respectively.

Table 2: Quality classification results

Factor	A	O	R	I	M	Q	Results
F1	30.357	15.625	7.589	24.554	17.857	4.018	A
F2	14.286	3.571	20.982	43.304	6.696	11.161	I
F3	29.911	16.964	6.250	33.036	7.143	6.696	I
F4	25.893	10.268	13.393	35.714	8.036	6.696	I
F5	29.464	15.625	10.714	32.143	8.929	3.125	I
F6	32.589	21.875	7.143	26.786	9.821	1.786	A
F7	17.857	32.589	6.696	25.446	14.732	2.679	O
F8	22.768	16.964	5.804	35.268	16.071	3.125	I
F9	20.536	22.321	7.589	35.714	10.714	3.125	I
F10	20.089	30.357	3.571	25.446	17.857	2.679	O
F11	18.750	25.446	4.464	29.018	16.518	5.804	I
F12	21.429	21.875	7.589	31.250	14.286	3.571	I
F13	21.429	30.357	4.464	24.107	15.179	4.464	O
F14	29.018	12.500	7.589	36.607	11.161	3.125	I

Afterwards, the Beter-Worse coefficient values of each attribute are calculated and ranked, and the results are shown in Table 3. The SI index values range from 0.2632 to 0.5980, the DSI

index values range from -0.5222 to -0.1513, and the top 3 factors that increase the ranking of the user satisfaction coefficient (SI) are: F6 multi-scenario adaptability and malleability, F13 with emotional resonance, and F7 awakening Linchuan cultural memories. The top three factors that decrease the coefficient of user dissatisfaction (DSI) are: F7 awakens memories of Linchuan culture, F10 cultural traits are easy to recognize and remember, and F13 has emotional resonance.

Table 3: Beter-Worse coefficient

Factor	Beter/SI	Ranking	Worse/DSI	Ranking
F1	0.5202	7	-0.3788	6
F2	0.2632	14	-0.1513	14
F3	0.5385	4	-0.2769	11
F4	0.4525	12	-0.2291	13
F5	0.5233	6	-0.2850	10
F6	0.5980	1	-0.3480	9
F7	0.5567	3	-0.5222	1
F8	0.4363	13	-0.3627	8
F9	0.4800	10	-0.3700	7
F10	0.5381	5	-0.5143	2
F11	0.4925	8	-0.4677	4
F12	0.4874	9	-0.4070	5
F13	0.5686	2	-0.5000	3
F14	0.4650	11	-0.2650	12

Scatter plots were drawn based on the results of the coefficients and the Beter-Worse scatter plot is shown in Figure 5. The factors of charismatic quality are F3, F5, F6, the factors of undifferentiated quality are F2, F4, F14, the factors of basic quality are F8, F9, F11, F12, and the factors of desired quality are F1, F7, F10, F13, and the desired quality is emphasized in the four regions, and the further the desired quality is from the origin means the higher the priority, and the higher the user's sensitivity to it, which can be concluded as follows The ordering of quality requirements is: F13, F7, F10, F1.

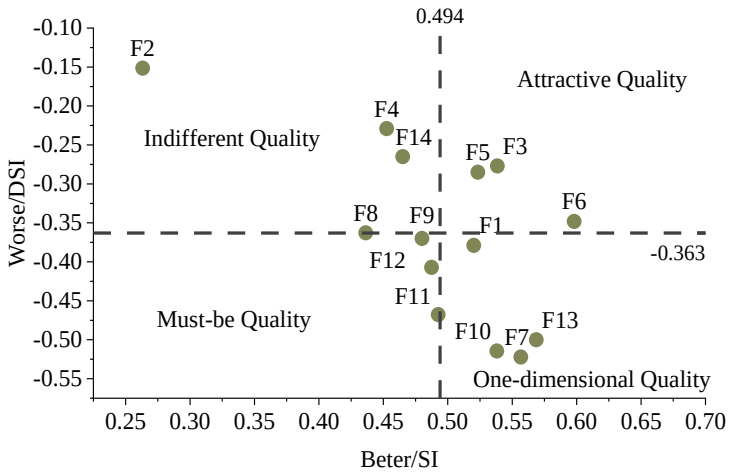


Figure 5: Beter-Worse scatter diagram

3.5 Design Evaluation Verification

3.5.1 User Satisfaction Survey

Based on the research of user requirements for digital IP, AIGC was utilized to design the Linchuan cultural and historical personification digital IP according to the design process in chapter 2.2. In order to realize the design closure and evaluate the effectiveness of the Linchuan cultural and historical personification digital IP design solution, audience satisfaction measurement was conducted after the design practice was completed.

In the user satisfaction measurement, the design takes three dimensions into account. The first is user demand satisfaction, which is a very important dimension that involves the user's satisfaction with the use experience, function and performance of the product or service. The second is the reasonable use of Linchuan cultural and historical figures design elements, which is one of the important criteria for evaluating Linchuan cultural and historical figures design, and requires designers to reasonably utilize Linchuan cultural elements so that the design has high cultural connotation and communication value. The last is whether the IP design of Linchuan cultural and historical figures can help the dissemination and influence of Linchuan culture. Designers should fully explore the cultural value of Linchuan historical figures and create cultural IPs with cultural significance and innovativeness, so as to help the dissemination of Linchuan culture and expand its influence.

3.5.2 Analysis of Research Results

Fifty users who know Linchuan culture and its historical figures were invited to participate in the evaluation and score the practice program. The scoring was based on a 10-point scale, with less than 5 indicating dissatisfaction, 6 to 8 being good, 8 or more being satisfactory, and 10 being very satisfactory. For each evaluation index, the average score of 50 users was calculated and the specific evaluation results were derived as shown in Figure 6. According to the results of the satisfaction assessment, the assessment has reached a satisfactory level, with a total composite score of 7.53 points. Among them, “perception of Linchuan culture” was the highest rated, with a score of 7.72 points. This was followed by “visual aesthetics” and “IP favoritism”, both scoring between 7.68 and 7.62 points. However, among the indicators, “IP usefulness” and “willingness to pay attention to IP” scored relatively low.

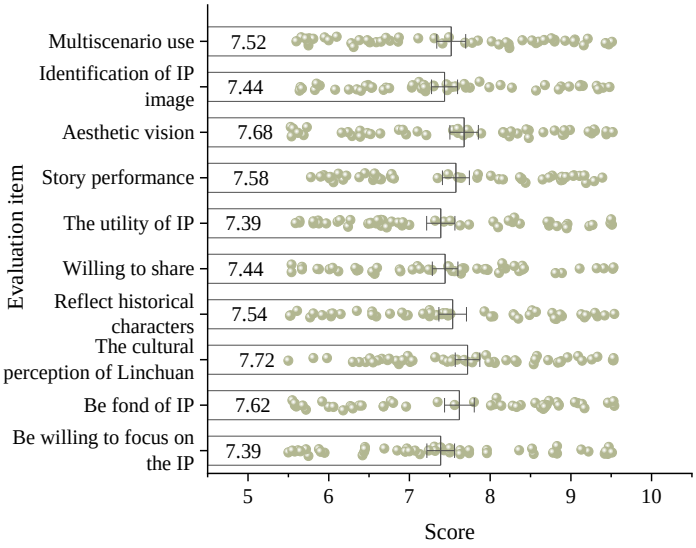


Figure 6: Satisfaction evaluation result

4 Building the industrial ecosystem

AIGC's involvement in the artistic creation process of digital IP of Linchuan cultural and historical figures is not only to provide new creative tools, but also to guide the creators to reconstruct the symbol system and narrative logic of Linchuan culture, and to build a new production paradigm and cultural industry ecology.

4.1 AIGC Driver Symbol Translation

With the image generation, style migration and intelligent design functions of AIGC technology, the visual elements of the digital IP of Linchuan cultural and historical figures can be innovatively reconstructed, and the communication heat can be activated through topic marketing. In terms of styling, for example, the unique style of digital IP can be generated in batch through MidJourney, and at the same time, focusing on seasonal fashion elements, seasonal and holiday limited series can be launched, and cross-border cooperation with popular movies, TV shows, and games can be carried out to create an IP-linked visual program. On this basis, through social media, digital art exhibitions and other channels, combined with topic challenges, blind box digital collections on sale and other marketing methods, to stimulate the enthusiasm of users to participate and willingness to spread. In addition, the use of technological empowerment to inject intelligent interactive attributes into the IP, ultimately realizing the transformation of traditional cultural IP from a short-term consumption hotspot to a sustainable modern mode of translation and dissemination.

4.2 Expanding diversified ecological applications

Relying on intelligent cultural creation to promote product iteration and upgrading, the digital IP of Linchuan culture and historical figures is applied to different scenes to enrich user experience. In the cultural tourism scene, users can upload photos with digital IPs of Linchuan culture and historical figures through scenic area small programs, or transform users' card photos or tour track maps into physical cultural creations in real time. In the field of education, the digital IP of Linchuan cultural and historical figures can be utilized to provide intelligent educational accompaniment services, while the function of AI interaction.

4.3 Multi-disciplinary resonant development

The project realizes the digital innovation and translation of Linchuan culture through the three-dimensional resonance and synergy of technology, culture and business. At the same time, with the help of innovative development of commercial value, the project builds a modernized communication carrier for traditional culture, and promotes its living inheritance and sustainable development. On the technical level, digital IP development is realized with the help of AIGC technology. In the cultural dimension, the digital IP of Linchuan cultural and historical figures is integrated into popular topics for re-creation. In the commercial field, AI tools are used to generate adapted marketing copy, screen suitable online bloggers for online promotion, create topic heat to activate playback, and at the same time, launch online and offline dual-track co-branded customized peripheral products to further expand the commercial value.

5 Conclusion

The study researches the digital IP of historical figures of Linchuan culture, introduces the process of developing digital IP using AIGC technology, investigates the user's demand for

digital IP of historical figures of Linchuan culture by combining with the Kano model, and discusses the development of digital IP and the construction of its industrial ecology.

In this paper, 14 IP design factors are selected, which are divided into 3 charm quality factors, 3 undifferentiated quality factors, 4 basic quality factors and 4 expectation quality factors by Kano model analysis, and the Beter coefficient of each design factor is 0.2632~0.5980, and the Worse coefficient is -0.5222~-0.1513. digital IP multi-scenario adaptation, attributes with emotional resonance and awakening memories of Linchuan culture have the greatest impact on increasing user satisfaction, and the attributes of awakening memories of Linchuan culture, cultural traits that are easy to recognize and remember, and having emotional resonance have the greatest impact on decreasing user satisfaction. Therefore, when designing the digital IP of historical figures of Linchuan culture, special attention should be paid to its emotional resonance attributes and Linchuan cultural characteristics. The overall score in the user satisfaction survey is 7.53, which indicates that the digital IP of historical figures of Linchuan culture has achieved the ideal design effect.

Through symbol reconstruction and scene innovation, AIGC technology effectively activates the audience's enthusiasm for Linchuan culture protection and inheritance, realizes the development of industrial ecology in the fields of technology, culture, and commerce, and provides a new paradigm for the digital translation of similar intelligent cultural and creative products. In the future, it can continue to expand AIGC's digital heritage in traditional culture and promote the creative transformation and innovative development of traditional culture in the digital era.

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About the Author

Yajun Su was born in Changchun, Jilin, China, in 1986. She graduated from Adamson University and obtained a doctoral degree. Currently, she works at the School of Humanities, Jiangxi Institute of Fashion Technology. Her main research fields are media and visual design as well as cultural heritage management.

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