Article

Research on the product language construction of China's twisted porcelain cultural heritage

Guoxian Wang[*], **Jungsik Jang**[*], **Jinwoo Shin, Dongsheng Li**

Department of Innovative Materials Renewal Design, Kookmin University, Seoul 02707, Korea
* Corresponding author: Guoxian Wang, wangguoxian23@gmail.com; Jungsik Jang, kmjanggo@kookmin.ac.kr

Abstract: This paper studies the product language construction of the twisted porcelain cultural heritage. Through field research, we collected and sorted out samples of twisted porcelain products, explored the product language characteristics of twisted porcelain from multiple aspects such as production process, product shape, and product color, interpreted cultural value, captured potential connotations, extracted representative words from user comments, quantified the relationship between users and twisted porcelain culture, realized the construction and transmission of traditional cultural language information, conveyed the traditional cultural information of the product to users, and promoted the sustainable dissemination and development of this cultural heritage. The research results show that after mining and extraction at the level of twisted porcelain characteristics, the core language constructs the cultural expression of twisted porcelain products, which is more in line with the needs of the market and users, and has the potential to be developed and disseminated using the language generation of cultural heritage products.

Keywords: sustainable development; Chinese twisted porcelain; product language

1. Introduction

Chinese traditional ceramic culture and art are an important foundation for the progress of civilization today (Hu et al., 2022). Twisted porcelain is a Chinese national geographical indication product, with its identical internal and external patterns, each twisted porcelain product that enjoys the reputation of "a porcelain junzi being for real" is unique. which first appeared in the Tang Dynasty, is a kind of ceramics made through the mixing and shaping of two or more kinds of porcelain clay with different shades together with special and complex manual porcelain-body-making techniques, as shown in **Figure 1.**

Figure 1. Exterior and interior view of twisted porcelain products.

With the development of twisted porcelain products and the maturity of firing technology, the materials of twisted porcelain utensils have changed from pottery clay to porcelain clay, with their application fields changing from funerary wares to

practical products. However, during the Yuan Dynasty in China, the traditional craft of Twisted porcelain was lost as wars and social unrest continued. So, the number of intact preservations of Twisted porcelain products today is very few, not to mention the development of Twisted porcelain traditional culture.

Nowadays, due to the influence of globalization and modernization, some traditional heritage crafts have been marginalized (Hove, 2010). There is a need to tap into the internal symbol of the product, such as shape and function, to build a connection with the user and the market through the language of the product, to drive innovation, and to convey the product message. 'Product language' refers to 'the knowledge about product signs that can be used to deliver a message to the user' (Dell'Era et al., 2008). Product language has a mediating function, building a bridge between the product and the user, helping users perceive the culture represented by the product.

We can see that both the industrial design community and academics (Csikszentmihalyi and Rochberg-Halton, 1981; Margolin and Buchanan, 1995) have recognised the importance of the semantic/design dimension for the successful development of new products and have suggested that the use of product languages should be widely promoted. Van Onck (1994) propose identifies possible signs of a product language: topology (colour, material, surface, form, texture, etc.,), mereology (continuity, interruptions, holes, boundaries, hierarchies, dimensions, orientation, etc.,) and morphology/morphogenesis (reflection, aggregation, separation, transformation, etc.,). Zhu and Teng (2020) based on the Liao porcelain meme, constructed a cultural product design method based on artifact memes and applied it to the development and design of cultural products. Marzano makes it explicit that the product semantic dimension, as a dimension that allows people to create new meanings, is capable of influencing the evolution of the socio-cultural patterns that govern our society (Marzano, 2000). Du et al. (2024) proposed a theoretical model of concept construction mechanism mediated by product language to help designers analyse product language and effectively construct and express new concepts through product language.

2. Research background and purpose

In today's rapid technological development, the protection and development of cultural heritage is very important. For consumers, the value of the product lies in the cultural meaning and cultural experience it brings. Constructing a product's language as a means of designing product innovations improves the user's understanding of the product by interpreting the product's language, and also increases the product experience. Product features, such as material, colour, signs and symbols help people to understand potential product meanings (Jahnke and Hansson, 2010; Monö, 1997).

Cultural heritage encompasses all contemporary demonstrations, when intangible, and past evidences, in the case of tangible artefacts, of human creative activity that are inherited from previous generations and considered by communities, groups or society at large to be of value, and therefore maintained in the present and transmitted to future generations for their benefit (Pereira Roders and Van Oers, 2011). Twisted porcelain product culture contains distinctive technology, modelling colour

and decorative patterns, is a representative symbol of Chinese ceramic products, due to the product to maintain a backward appearance did not keep pace with the times, the lack of innovation drive, can not meet user needs, not be good dissemination and promotion, so that for twisted porcelain product This makes the protection and development of twisted porcelain products relatively difficult. In addition to this, there is an exceptionally low level of historical documentation and dissertation material on Twisted porcelain, making it all the more incumbent upon us to engage in cultural heritage management and development activities.

The purpose of this study is to conduct a comprehensive and multi-angle study and analysis of twisted porcelain products, and collect and analyze product language from the aspects of production technology and artistic characteristics (porcelain types, colors, decorative patterns). Extract the cultural vocabulary inherent in the product, and conduct product vocabulary language evaluation tests on users to capture and identify user needs and trends, and transform them into product innovation and design drivers. **Figure 2** is a construction diagram of twisted porcelain cultural language. It adopts rational thinking and emotional expression, combined with twisted porcelain characteristics, market and user evaluation, etc., to carry out systematic planning, summarize and extract twisted porcelain product cultural language. It not only provides information materials for twisted porcelain, but also provides reference for the inheritance and development of ceramic cultural heritage.
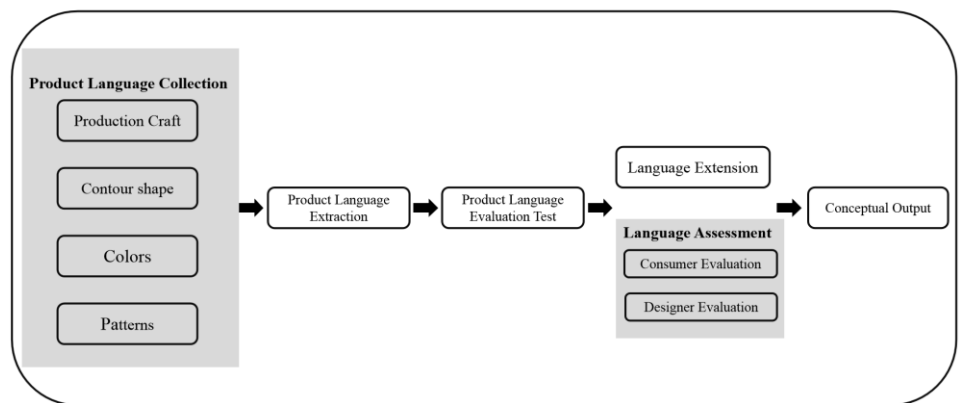
**Figure 2.** Twisted porcelain cultural and linguistic construction diagram.

3. Materials and methods

3.1. Production craft of twisted porcelain

Design activity encompasses some of the highest cognitive abilities of human beings (Zainal Abidin and Christoforidou, 2009). Originally produced with local raw materials and manufactured by ancestral processes, ceramic products have always been the result of knowledge transmitted from generation to generation. These artefacts reflect and reinterpret traditional, individual and collective formal vocabularies, integrating fragments of the day-to-day life of the local society, which conferred a geographical and sociocultural singularity revealing their local, regional, and national identities (Lobo, 2020). In order to construct the cultural semantics of twisted porcelain, it is necessary to deeply research the existing production process,

understand the meaning of the activities behind the cultural heritage of twisted porcelain, and deepen the cultural understanding of the twisted porcelain product language.

The origin of Chinese twisted porcelain products, Jiaozuo City, was selected to conduct a field survey of products and collect and observe existing products. Ceramic color appearance is dependent on a series of inter-related processes (McLachlan et al., 2022). The appearance of twisted porcelain products is closely related to the internal production process, and a detailed investigation of the production process of twisted porcelain products was conducted, as shown in **Figure 3.**
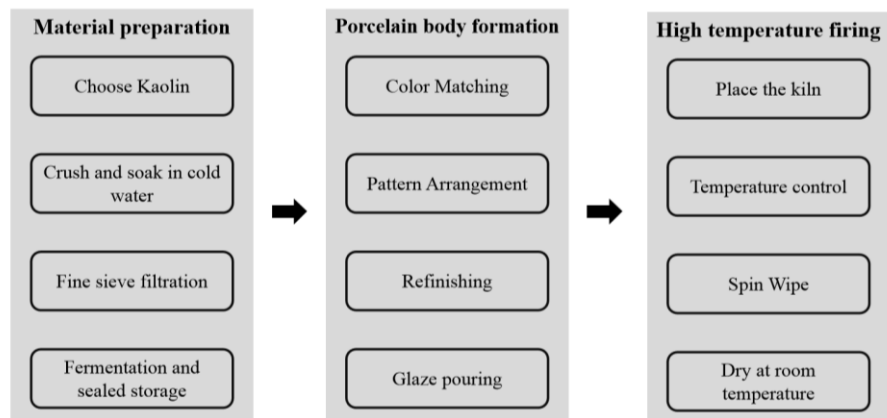
Figure 3. Twisted porcelain production process flow chart.

Firstly, in terms of material selection, kaolin was selected as the raw material of twisted porcelain. Containing rich alumina and silica, the kaolin here has the advantages of soft texture, high plasticity, and good cohesiveness, which is of great importance to the later firing of twisted porcelain. Then, the collected kaolin clods were smashed one after another immediately with a hammer. After that, these smashed clods were soaked in cold water and fully stirred to make the soils dissolve quickly. After soils were set aside for dissolving for a period of time, they were filtered through a fine sieve to remove impurities and make the mud texture more delicate. In addition, soils could be finely ground into the mud with a grinder, and then the mud was filtered through a fine sieve in an alternating and step-by-step way. Then, fermentation and water control were performed on the mud, which was then sealed in a vacuum bag for later use.

Next, color matching, trimming, and glaze pouring of the molding body were carried out. High-temperature pigments and mineral raw materials were cut and stacked and were fully kneaded after matching. After kneading, porcelain clay with different colors, such as red clay and green clay, was formed. In this section, colors necessary for the production of twisted porcelain were settled. Then, clay blocks with different colors were selected and arranged in the necessary pattern that was designed. After that, they were smashed into a flat block, which was cut from its side piece with a steel wire tool to observe its internal pattern effect. When a clear pattern was observed, there was no need to continue to smash the block. Otherwise, it should be continuously smashed. Then, the arranged and kneaded clay block was shaped, and during this process, such tools as a water absorption rod, pottery needle, and pottery

rib were used. After that, the clay block was put on a pottery wheel to perform the throwing. During the modeling process of throwing, the pattern direction of the molding body should be noticed. In order to make the shape of the twisted porcelain meet the expectation and the thickness of the modeling body be moderate, such instruments as a trimming tool, rib tool, and sponge stick were used to trim the modeling body in order of being from the inside out. The modeling body with a trimmed shape was placed in a cool place indoors for natural drying. In this way, excess water in the modeling body could be removed. However, direct sunlight should be avoided. Therefore, the cracking and deformation of the modeling body during firing could be prevented. Immediately after that, glaze pouring inside the modeling body should be conducted, and then the external part of the modeling body was glazed with glaze perfectly combined with porcelain.

After that came the important stage of firing, the modeling body was placed in the kiln furnace, and then the furnace door was closed tightly. The kiln furnaces used here can be divided into gas furnaces and electric furnaces. The twisting expansion coefficients of those different kinds of clay in the twisted porcelain are different. Therefore, temperature inaccurately controlled can lead to different expansion coefficients and different shrinkage rates among mud with different colors, thus making cracking and pores prone to appear on the glaze surface. Therefore, the top priority in twisted porcelain firing is to control the temperature. Throughout the firing process, it is necessary to observe the temperature inside the kiln and make sure that it follows the regular temperature curve. Step-by-step temperature rise was applied in the kiln firing. Temperature first rose slowly and then dropped and then rose again till it reached a horizontal level. After that, the temperature was continuously raised to around 1000 °C. Twisted porcelain perfectly fired was taken out of the kiln. After that, it should be rotated and wiped with a cord and gloves to keep its body clean and tidy.

Through the above porcelain production process, we can find that twisted porcelain relies on the special geographical location and environment to create a unique product modeling language, such as choosing local kaolin with appropriate humidity and surrounding environment with dry temperature. The special materials and production process of twisted porcelain highlight the expressiveness and artistic effect of the product, and also determine the overall effect and detail processing, which is conducive to creating a diverse and rich twisted porcelain language and shaping the product texture and cultural expression.

3.2. Artistic features of twisted porcelainty

3.2.1. Contour shape of porcelain

In ancient China, porcelain has always been based on daily-use porcelain, supplemented by decorative porcelain (Lei and Shouli, 2019). It should be noted that ceramics were not only of practical use but also of artistic value when decorated with raised ornaments or painted with colored clay (Gnesin, 2012). The artistic effects of ceramics can be mostly manifested with glazing, namely, overglaze, in glaze, and underglaze. Embellishment or artistic creation of ordinary ceramics can be realized through such methods as glazing, painting, carving, and pasting applied on their surfaces after their molding bodies take shape.

Through the application of overall appearance shapes or local features of animals and plants, a relatively complete creative conceptual body can be constituted, presenting the inherent attributes of modeling object characteristics, such as the expressions contained in the objects, with the manifestations of emotions, ideas, culture, and aesthetics. Twisted porcelain is called "the porcelain of gentleman," with the expression of the true nature of being in line with a gentleman.

Twisted porcelain is divided into three types: daily-use porcelain, burial objects, and artistic porcelain. The daily-use functional part includes jars, bowls, plates, dishes, makeup boxes, and tea sets; the burial functional part includes models of people, livestock, vehicles, ships, weapons, and furniture; the artistic functional part includes furnishings and sculptures. Line information is extracted from the external shape contour of twisted porcelain, as shown in **Figure 4.**
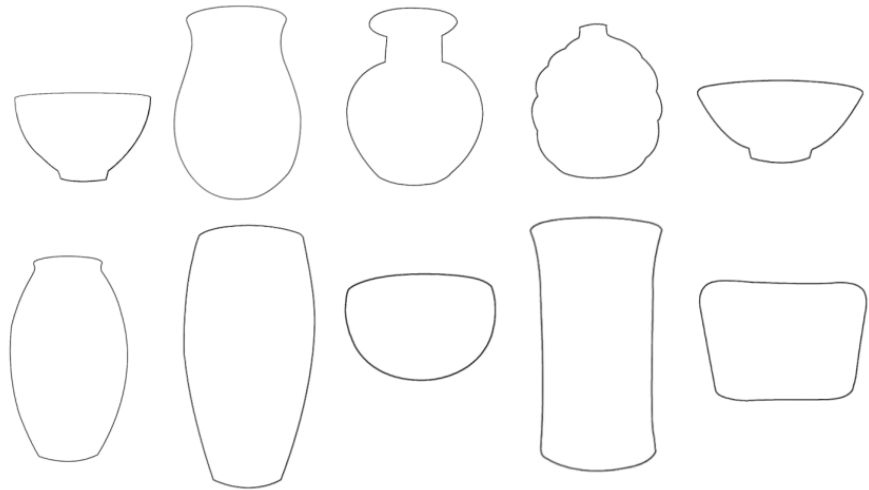
Figure 4. Outline extraction of twisted porcelain.

3.2.2. Porcelain colors

The color of ceramic products have an embedded "DNA" that acts as a local "geographical and sociocultural singularity" through the specific characteristics of raw materials, time and place (Lobo, 2020). Dangyang Valley in Xiuwu County has objective advantages in geographical conditions, including proper temperature and humidity, being backed by Taihang Mountain, and local porcelain clay raw materials for twisted porcelain firing. Such naturally endowed conditions as soils with high strength and good fire resistance, and rich mineral resources in Taihang Mountain are all conducive to the rebirth of the craft of twisted porcelain. However, in restoring the intangible cultural inheritance of twisted porcelain craft, the soil conditions in Dangyang Valley of Xiuwu County have restricted the development of twisted porcelain coloring.

Most initial finished products of twisted porcelain successfully fired at the kiln were black or white, with relatively single-color types. With the increasing demand of consumers for porcelain colors and the development of twisted porcelain firing technology, color matching was performed on the basis of black and white porcelain clay. With white used as a basic color, brown, dark red, and gray-black clay was added and laminated with each other in an orderly fashion and with different angles, thus

creating relatively distinct glaze colors. Then, molding bodies with different shapes were made and fired with the application of transparent glazing. Also, there are molding bodies that were fired with the application of yellow brazing or green glazing, which are called yellow glazing twisted porcelain or green glazing twisted porcelain.

3.2.3. Porcelain patterns

The ornamentation, known as the main means for the decoration of ceramics, is one of the key elements influencing the aesthetics of ceramic wares, and it, which can reflect peoples spiritual world better than modelling, has been highly thought of by designers ever since the emergence of ceramics (Liu and Zhou, 2020). The various decorative shapes of twisted porcelain are generated together with their molding bodies, and identical internal and external patterns can be seen on some fragments of broken twisted porcelain. Each molding body of twisted porcelain has a unique pattern, which has no duplicate and can not be copied. Therefore, every twisted porcelain is a unique and unparalleled work, which explains its relatively high artistic and collection values.

Artistic creation is performed on twisted porcelain before their molding bodies take shape. The pattern structure of coiled porcelain is similar, showing complex and diverse and natural characteristics. Among the plant modelings of twisted porcelain, such organic elements as plum blossoms, chrysanthemums, dandelions, and leaves are common. The following are ten typical representative patterns of coiled porcelain collected through field investigation, as shown in **Figure 5**.

(1) Feather pattern: a pattern similar to the feathers on animal wings. Most of the objects themselves are in the form of multiple feathers superimposed. The pattern covers the whole body and is very characteristic.

(2) Mat weaving pattern: the porcelain clay is superimposed on each other and arranged in different directions, like a straw mat weaving. The pattern is staggered and exquisite and elegant.

(3) Chrysanthemum pattern: one or two kinds of porcelain clay are mainly arranged radially around a certain central circle, and then repeatedly superimposed, like blooming chrysanthemums.

(4) Moire: no arrangement is required, and it is formed according to the shape of the object during throwing. Like the shape of clouds in the sky that changes with movement, clouds roll and clouds spread. This pattern has natural randomness and uncertainty.

(5) Grain of wheat: because wheat ears grow towards both sides, and the porcelain clay is continuously superimposed in the direction of both sides, the texture of the pattern is arranged according to the growth trend of wheat ears, and the wheat ears are named after this pattern.

(6) Curved pattern: there is no closure in the pattern, the pattern is always rotating and presenting a rotating posture, winding around the bottle body of the vessel, and its integrity and fluidity are its obvious manifestations.

(7) Diamond pattern: you can see obvious edges and corners, but the overall pattern is not a standard diamond, but has the obvious characteristics of a diamond. The pattern is arranged in parallel and does not have spiral superposition.

(8) Wood spiral pattern: similar to the cross-section of a tree, it is like a circle of

annual rings, and the plane features are full of interest and symbolism.

(9) Petal pattern: this pattern has the overall expression of the flower, extending around the arrangement, and also has the curves of the petals. Unlike the chrysanthemum pattern, the petals gradually tend to move upward.

(10) Grain of quicksand: Similar to the flowing cloud pattern, but its overall pattern curves are more floating and less dynamic, presenting a calm and solemn temperament.

Figure 5. Representative patterns of twisted porcelain.

The unique shaping methods of twisted porcelain are particularly special. Patterns made with these shaping methods, including rubbing, kneading, throwing, and beating, are lifelike. Also, ornamentation inside porcelain bodies is mainly composed of geometric shapes. With clear and smooth lines, these patterns are so fluid and sinuous that they look like they have been naturally created. The ornamentation types of Dangyangyu twisted porcelain have developed from several ones in the past to more than a dozen nowadays. Complex and diverse patterns can be created through the pressing and kneading of porcelain clay with different colors. Such patterns include flowing sand, spiral, and water wave patterns, as well as vivid patterns of chrysanthemums and feathers. The key overall style of twisted porcelain patterns is simple and elegant, and splendid yet not extravagant, with pure and warm colors generated.

4. Discussion and analysis

In the pre-design stage, accurately capturing the real needs of users, matching user aesthetics, and quickly matching user needs to deliver effective design solutions have become the focus of exploration in the fifield of product design (Zhu et al., 2018). that it is essential to understand the relationship between basic form and the product character so that designers can achieve the goals of design and target their user by focusing on semantic element and syntactic analysis (Raif et al., 2022). Words are an important and influential way to help consumers know products widely and quickly.

Not only using the language of the product obtained from the field survey, but also from 50 news articles and 50 related electronic literature published in recent years, different words such as the spiritual connotation represented by twisted porcelain itself, the contextual meaning of the creative emotion given by the craftsmen, and the conceptual imagery of aesthetics, etc., were selected in the expansion. Then, a

powerful standardised clustering method was used to summarise and filter the commonly used words, of which five representative image words were selected. These five image words are harmony, craftsmanship, refinement, modesty and protection. Multiple samples were chosen to prevent overly subjective evaluations of a single cultural concept or meaning of twisted porcelain and to maintain as much objectivity as possible.

In this study, an extension set under extension logic was established. In the set, the entity, event, and relationship elements refer to matter, action, and relationship, respectively, and meanwhile, these elements correspond to objects, features, and vectors of things, respectively. The cultural element of twisted porcelain design is defined as B, and a triple, with extension object, characteristic, and extension interval vector value defined as O, C, and P, respectively, is used to perform subjective analysis and objective evaluation of cultural characteristics and connotations. Thus, with qualitative and quantitative methods combined with each other, the internal relationship of twisted porcelain culture can be objectively expressed in an accurate and quantitative way. The formula of twisted porcelain cultural element is as follows:

$$B = O, C, P = \begin{bmatrix} O & C_1 & P_1 \\ & C_2 & P_2 \\ & C_n & P_n \end{bmatrix} \tag{1}$$

O is the only design object in the element formula of twisted porcelain culture. However, O can have countless design features, which can be represented with an extension interval P ($P = (Px, Py)$). P represents the vector space of twisted porcelain culture, and Px and Py are both values of feature vectors, with a higher value of extension interval vector indicating a higher design value of the corresponding feature. Px represents the correlation degree of the cultural object of twisted porcelain, and its value is positively correlated with the correlation degree, with a higher value of Px indicating a larger correlation degree. Py represents the social value of design feature C, with a higher value of Py indicating a greater value of social value. The design value of the object feature can be expressed with the conversion of Px and Py. Then, qualification can be achieved for easy judgment of weight and assisted elaboration of internal correlations, thus being conducive to the application of cultural connotations and the guidance of design methods.

With those five selected keywords of cultural elements, namely, harmony, craft, exquisiteness, demureness, and protection, substituted into the element formula described above, the cultural semantics of twisted porcelain was analyzed and quantified, and the extension interval was calculated.

the cultural semantics of twisted porcelain culture was investigated through an offline questionnaire method. With the first images, familiarity degrees and effective responses of questionnaire participants on twisted porcelain culture taken into account, their imagery demand and technical requirements were combined with each other to improve the demand adoption degree of cultural audience of twisted porcelain and facilitate the incubation of relevant products designed later.

A total of 300 participants aged between 20 and 60 were selected, with 150 male participants and 150 female participants. Also, participants with different understanding levels of twisted porcelain culture were selected to maintain the objectivity of the follow-up research. These selected participants were requested to

choose the semantic words representing the culture of twisted porcelain according to their understanding, with different scores indicating different representative degrees of these words. An interval of 1–5 points was used to represent the semantic evaluation scores from low to high, and the statistical results on the choices of participants are as follows **Table 1**.

Table 1. Score evaluation of extension semantics of imagery vocabulary.

Imagery vocabulary	1 point	2 points	3 points	4 points	5 points
Harmony	13	20	28	110	129
Craft	40	20	80	50	110
Exquisiteness	83	10	15	70	122
Demureness	30	44	70	85	71
Protection	48	7	36	45	164

Let the score of each imagery word be l points and the number of the corresponding participants be m. Therefore, the total score of the imagery word is $l \times m$, with $l \in [1, 5]$ and $m \in [1,300]$. Thus, the correlation value Px between the extension feature and cultural element of twisted porcelain can be calculated with the following formula:

$$Px = \frac{\sum_{n=1}^{5} lm_n}{300 \times \frac{5(5+1)}{2}} \tag{2}$$

Five students majoring in design were selected, and these students had a certain understanding of the internal culture of twisted porcelain. Through integrated consideration of connotations of cultural semantics with social relationship environment, evaluation was carried out with the combination of cultural semantics of twisted porcelain. The highest and lowest social values of the semantic in question were assigned with scores of 7 and 1, respectively. The statistical results are shown in **Table 2**.

Table 2. Social value evaluation of cultural semantics of twisted porcelain.

Number	Harmony	Craft	Exquisiteness	Demureness	Protection
1	4	5	5	3	6
2	3	6	5	2	4
3	1	4	4	2	5
4	5	4	3	1	5
5	4	5	5	4	6

Assume that the participant with a number of n scored the cultural semantic with t points, then the effectiveness score of the cultural semantic of twisted porcelain equals $t \times n$, with $n \in [1,5]$ and $t \in [1,7]$. Then, according to the above data, Py can be calculated with the formula as follows:

$$P_y = \frac{\sum_{n=1}^{5} t_n}{5} \tag{3}$$

Given the extension interval P of the cultural semantics of twisted porcelain,

through calculation, **Table 3** can be obtained as below with the obtained information data substituted in turn into the formula ($P = Px \cdot Py$) to calculate the required Px and Py.

Table 3. Design interval of the cultural semantics of twisted porcelain.

Calculation item	Harmony	Craft	Exquisiteness	Demureness	Protection
Px	0.2716	0.222	0.2307	0.2273	0.2533
Py	10.6	14	12.8	7.4	15.8
P	2.87896	3.108	2.95296	0.030716	0.01603

From the final results shown in **Table 3**, it can be seen that the word craft ranks first in the cultural semantics of twisted porcelain, indicating that craft is a relatively large design element that represents a relatively large extension interval or space of design. The above logical operations are based on the derivation of the theory of extensible primitives, with words transformed into quantified data.

These data be used as a design basis, but they also are to help the symbolization and signification of the cultural semantics of twisted porcelain. Meanwhile, the best semantics related to the twisted porcelain culture can be effectively sorted out to expand the extension influence of twisted porcelain culture and increase the derivative applicability of the intangible cultural heritage of twisted porcelain. These five words selected from the cultural characteristics of twisted porcelain art have certain limitations. Although they are representative words to a certain extent, these words can not fully represent the overall meaning. However, an extension interval of the cultural semantics of twisted porcelain has been provided in the design, which offers a new direction for the cultural innovation of twisted porcelain culture.

5. Conclusion

Cultural heritage is important as a source of memory and inspiration, while it contributes to national and local community identity, which is fundamental for sense of place and social cohesion (Communities and Local Government, 2009). The cultural heritage of twisted porcelain is a very valuable cultural resource. It is also the only type of porcelain in the world that is decorated with internal patterns. As traditional handmade products, they possess the dual properties of practicality and aesthetics, serving as an integration of the dominant features from appearance and the recessive connotations including craft, culture, and meanings (Zhang and Ren, 2024). Using semantic tags to match traditional cultural features helps collect and organize cultural heritage data and perform deep feature enhancement to enhance the semantic information of features (Zhao et al., 2024). There is very little cultural research on turned porcelain products, and there are almost no linguistic research articles on its manufacturing process and artistic characteristics, and it is rarely made available to the public. The methods and information data of this study not only promote the inheritance and development of twisted porcelain, but also help to provide new insights for the integration and innovation of other cultural heritages.

The results of this study use the extraction of product image language to analyze the twisted porcelain culture. Although the extension interval operations such as

refinement, quantification and fusion of twisted porcelain vocabulary data are established, there are research limitations. The number of samples needs to be supplemented, and the subsequent research data quantification needs to increase the degree of calculation and accuracy. The study conceptualizes the invisible and inconspicuous cultural factors in the product, further constructs a broad primitive model, calculates the extended design interval, and quantifies the relationship between twisted porcelain culture and characteristic vocabulary. At the same time, in the exploration of twisted porcelain craftsmanship and culture, the product language theory is used to express the culture behind it, test the evaluation of users and designers on vocabulary, calculate and quantify people's perception of new porcelain, and generate the final vocabulary drive to reconnect the communication between products and users, and use it as the structure of product concepts. It is conducive to enterprises, designers and technicians to carry out innovative product development. It provides research ideas for the theory and practice of twisted porcelain cultural resources and provides a reference for the future development of cultural heritage.

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