

Research on Generative Design for Packaging of Shanxi Mature Vinegar Based on Artificial Intelligence

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Abstract. In the context of fast development of artificial intelligence technology, the design industry is currently actively involved in the process of AI integration and use. Nevertheless, systematic design approaches and studies focused on generative AI are comparatively limited in packaging design. This paper uses the case study of Shanxi Mature Vinegar a traditional Chinese product to discuss the new opportunities of applying generative AI in the cultural and creative sector through innovative application channels. The first suggestion made in the paper is an integrated AI-based methodology of packaging design. With the help of AI-assisted tools, data mining and analysis of consumer preferences, market trends, and regional cultural factors can be done to make intelligent initial researches of design needs. Then, according to the results of the research, style positioning and element extraction are carried out with the help of generative AI multi-round design generation and iterative optimization. Lastly, representative solutions are chosen and optimized by means of extensive assessment and contemplation on various dimensions such as cultural relevance, aesthetic expressiveness, and market adaptability. The importance of this study can be seen in two points, First, it offers a human-machine collaborative innovation model of packaging design of traditional products that have deep-rooted cultural implications, including Shanxi Mature Vinegar, which improves the efficiency of design and accuracy of cultural expression. Second, by actualizing design practice, it develops a transferable AI-assisted packaging design procedure and method. It provides theoretical basis and practical examples of how to further develop the profound implementation of AI technology in the cultural and creative field, helping traditional industries to realize dual goals of brand upgrading and cultural value diffusion in the digital age.

Keywords: Artificial Intelligence (AI), Packaging design, Generative design.

1. Introduction

Artificial Intelligence is a new science of technology that combines the study and development of the theories, methods, technologies, and application systems to simulate and expand human intelligence. The first idea was introduced in 1956 by John McCarthy and others [1] (Zhao and Zhang, 2023). It is a high-tech discipline, which is multidisciplinary and mainly focused on computing, psychology, philosophy, etc. AI has been developed as an extension and augmentation of human intelligence, as well as an evolution of machines, so that they can learn on their own and even replace people in doing tasks. Intelligent transformation of the creative processes of designing products and services is also taking place due to the deep connection between design disciplines and AI [2] (Yu et al., 2025). This is one of the most important technologies that have become part of social life and economic activity [3] (Lu et al., 2018). Recently, AI has proved to be unique in the healthcare, transportation, finance and manufacturing industries. As an example, it is worth mentioning that medicine is not the only area where AI is used extensively, including medical image processing, drug interaction recognition, determination of patients with high risk, and coding medical records [4] (Lee et al., 2023). Artificial intelligence helps doctors to process the huge amount of medical information and discover patterns that are hard to see with the naked eye, which will help the doctor to make a better diagnosis [5] (King, 2023). AI is a great tool of learning in education since it is capable of providing teachers with less workload and at the same time students can gain effective learning [6] (Zhai et al., 2021). Now, there exists an instrument called Graide, which is an evaluation tool that helps teachers in assessing the student performance, thus saving the time of the teacher [7] (Holmes and Tuomi, 2022). In economics and financial sector, next generation of AI is being introduced and this is leading to a shift in the economy and the financial sector into the modern era [8] (Cao, 2022).

Payment (P2P lending) through machine learning models, asset management (robo-advisors), and blockchain payments are all examples of machine learning models that have relatively high accuracy but low interpretability [9] (Giudici and Raffinetti, 2023). Financial technology products based on the concept of big data analysis, artificial intelligence and blockchain are developing very fast [10] (Giudici et al., 2019).

Also, the design is a field that has been revolutionized by artificial intelligence. The AI in fashion design has also transformed the art of design and the creative industry like theater to new heights with the help of tools that will assist in the design process as well as artistic expression [11] (Gabriel and Ashaver, 2025). Li suggests that diffusion models should be designed using LoRa, which can transform qualitative styles of theatrical and film costumes and certain design characteristics into quantitative measures. It results in designing the costumes according to the requirements of theatre and cinema, hence making styling more effective [12] (Li, 2024). Liang developed a new product design based on AI technology, combining Variational Autoencoders (VAE) and Reinforcement Learning (RL), to make the design process of cultural products and creative products more efficient and innovative. The quality of the designs was much enhanced, and it was creative as well as satisfactory to the users [13] (Liang, 2024). The paper suggested an image post-processing system where Generative Adversarial Networks (GANs) were combined with computer vision by Zhang et al. This technique creates Yangliuqing New Year paintings of excellent pop art quality, and this was applied in the creation of cultural and creative products. The project was successful among young people, and the company can use the project to create a new way of advertising the traditional painting of New Years [14] (Zhang and Romainoor, 2023). The study of generative design (GD) done by Tang et al. in the context of environmental architecture enables architects to explore the world of replicated design spaces and optimize its performance through the application of algorithms [15] (Chew et al., 2024). Zhang et al. presented human-machine hybrid imagination paradigm of translation of culture in the jewelry design. Such a method minimizes the amount of work needed to do the detailed design but ensures the correct representation of the cultural stories and metaphors, and it is very important at both stages of the design [16] (Lyu et al., 2024).

Guo et al. have suggested a packaging design aesthetic quality assessment technique (CGA-GNN) in the area of packaging design, which combines image compositional features with graph neural networks to make the objectivity and intelligence of the evaluation of packaging images more objective. It offers technical assistance in standardized design evaluation, individual suggestions, and creative help [17] (Guo et al., 2025). Wang has suggested an AI-based innovation identification approach to interactive packaging visual communication design by examining interactive packaging designs of best-selling food online. The method uses weighted fusion rules to naturally combine electronic information technology and news media technology to give the packaging of the most popular food on the Internet new meaning [18] (Wang, 2022). Zghair et al. created a Random Forest (RF) machine learning model to maximize the design of packaging, minimize operational costs, and improve e-commerce sustainability. This model can forecast the best packaging configurations using major characteristics like product weight, volume, and fragility, allowing virtual testing of material properties, space efficiency, and damage risk [19] (Zghair & Konathala, 2025).

The National Geographical Indication Product is the Shanxi Mature Vinegar, which is the best of the Four Famous Vinegars in China. It has been over 3,000 years since it was created and has always been hailed as the finest vinegar in the world. Thousands of vinegar enterprises manufacture Shanxi Mature Vinegar that is globally known to have five characteristics: color, aroma, mellow flavor, richness, and acidity. The overall value of the industrial chain output was above 12 billion yuan in 2023. Popular brands such as Donghu have adopted digital transformation to innovate and modernize. Nevertheless, there are still problems with the packaging design of Shanxi Mature Vinegar, a traditional specialty, including rigid imagery and outdated visual language. This does not represent its cultural position as the premier among the four famous vinegars and does not satisfy market expectations. The probable reason behind this is the existence of entrenched traditional packaging design thinking without innovation and efficiency. Hence, this paper will reform the packaging design

of Shanxi Mature Vinegar through artificial intelligence and design methodologies. In the process of engaging in innovative design practices, this study investigates the possibility of integrating AI technology with design methodology. It does not only suggest new design solutions for the packaging of Shanxi Mature Vinegar but also examines hybrid design solutions based on the combination of AI and design, providing new directions to the contemporary transformation of well-known traditional products.

2. Method

2.1. Overall Design Thinking

The general scheme of the research is shown in Figure 1. The first step is to conduct some study and analysis. It has been done by reviewing references, competitive analysis, field work and interviews, as well as AI-based tools to provide extensive information on a subject and extract design requirements. In the second phase there is convergence and positioning. The position of designs and the directions of input are defined and mood boards with visual representation of the design are gathered and finally a definite design plan and direction of style are developed. The third step is the generation and assessment of AI. We employed Midjourney to come up with and develop ideas of design, then we evaluated them quantitatively and selected the most promising ones with the help of the Likert scale. The fourth stage is refinement and output. The best possible design proposal will be further optimized and perfected before the rendering process will be finalized and the entire design deliverables will be provided.

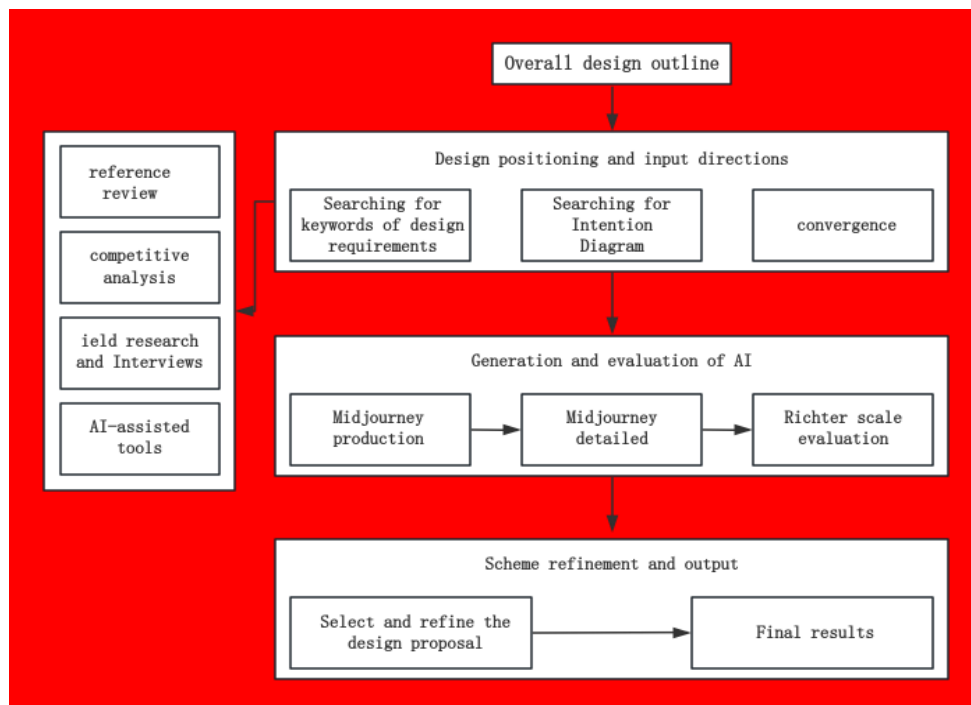


Fig 1. Overall design outline.

2.2. Research Methods of Design Requirements

To gather data in literature and competitive analysis, we used Python web crawling technology with the following specific steps: In Google Search and Google Scholar platforms, we crawled and parsed web pages using requests and BeautifulSoup libraries, then stored the relevant content as PDFs using pdfkit. At the same time, such tools as pandas were applied to get detailed information about literature. We used Baidu Search and CNKI in Chinese literature. Following manual filtering of keywords, we obtained pertinent PDFs in decreasing order of citations. The process was entirely

automated and created a basis of data on which further high-frequency term extraction and content analysis could be done.

Field investigation and interview: Firstly, determine the research goals and develop instruments and outlines, then go to the field to visit the workshops of intangible cultural heritage, shops, folk cultural sites and scenario of users. At the same time conduct individual or group interviews with company managers, salesmen, target users and cultural experts, take notes of the key information, organize and refine them. After validating the requirements, transform them into measurable design indicators to give accurate direction to packaging design.

For the keywords research of the packaging design requirements of Shanxi Mature Vinegar, Deepseek was first instructed from the perspective of a professional packaging designer to list research directions, with the design task defined as Shanxi Mature Vinegar packaging design. Subsequently, based on the directions given by Deepseek, keywords were extracted from dimensions like cultural essence, functional utility, visual expression, and user experience. At the same time, the content generated by Deepseek was screened for relevance and accuracy. More detailed inquiries were made about the main directions, and finally, a keyword system matching the design requirements was synthesized.

The packaging design of the Shanxi Mature Vinegar was gathered in a systematic way and it was done with the help of technical scraping as well as the expert screening: On the one hand, the Python web crawler was used to gather information about the visual examples that are characteristic of the market on the websites of the mainstream design and e-commerce services based on the keywords like Jin merchant culture packaging, high-end vinegar bottle design, etc. Meanwhile, the team of designers made use of the keyword system and the criteria of the experts to find out the relevant academic literature sources to get the representative samples of the market in terms of the design and its appearance, which would be high-quality, culturally appropriate, technically suitable and available to the local setting of the project. All these were put together into an archive library of concepts, which could be seen as a concept library that is balanced between cultural expression and practicality, functionality and trends.

2.3. Extraction and Evaluation of Key Requirements

Based on the above analysis, the Requirements Analysis Table for Packaging Design of Shanxi Mature Vinegar was created. Five experts (brand strategist, packaging engineer, scholar of Jin business culture, consumer behaviour researcher and visual designer) were invited to evaluate it. The experts scored the design items under five dimensions: cultural relevance, practicality, market differentiation, production practicability and innovative presentation. Giving priority to the elements with high user requirements, strong cultural expression and market competitiveness, we absorbed the main conclusions of the previous high frequency term analysis (such as Jin business culture, sustainable development, leak proof design, elegant bottle shape). The elements with high technical implementation difficulty and unclear market demand were optimised or phased out. The final design target was established: to develop a high-grade packaging system for Shanxi Mature Vinegar which carries the spirit of Jin business culture and Shanxi local features, meets the modern aesthetic and using habits, provides good freshness preservation, portability and differentiation.

The Shanxi Mature Vinegar Packaging Design Concept Evaluation Form was the result of the analysis of the needs that were mentioned above. The initial concept design was to be evaluated systematically by five experts, including a scholar of the culture of Jin merchants, a designer of packaging materials, a designer of brand marketing and an expert in visual communication. Five dimensions were used as the core dimensions: cultural compatibility, aesthetic value, functionality, manufacturability, and marketability. Cultural fit (30% weight) is one of the main aspects which involves how well the idea is communicated and how well it incorporates the Jin merchant culture and the culture of the region of Shanxi; aesthetic expression (20 percent weight) is the aspect which determines whether or not the idea is aesthetically pleasing and balances the modernity with the traditional aesthetics; functional guidance (20 percent weight) is the dimension which evaluates the

solutions to the pain points such as leak prevention and portability; craftsmanship feasibility (15 percent weight) is the measurement of the mass production potential of the materials and techniques used in the design; market differentiation (15 percent weight) is the measurement of the difference between the product and other products on the market. With the help of a weighted scoring system, it will be prioritized to create concept designs with high levels of cultural sophistication, accuracy of quality, pain point satisfaction and technical feasibility. It is also possible to optimize concepts too far ahead of what can be produced at the moment or even those whose style is too much, but their culture cannot be clearly expressed. This will make sure that the concept designs chosen are able to offer clear instructions in terms of future improvement of the overall design direction towards the cultural heritage, market competitiveness and user-friendly experience.

2.4. Midjourney Generation Method

Midjourney is a program that produces the image in digital form on the basis of text parameters [20] (Jaruga-Rozdolska, 2022). It is an AI-based image generation software which can be used to create images based on huge number of images and texts and then convert them into images. The quality and effects of the image are refined by the users as they go through several iterations of the text, and it has the fundamental features of text-to-image conversion, style modification, and editing of the image. It allows multiple parameterized limitations like aspect ratio and artistic style to increase control over output. Its logic of operation is as follows: Users enter the prompts in textual form, and the model initially deciphers the meaning. The description will be gradually drawn by means of iterative denoising process with random noise being the starting point. The whole procedure is cloud-based. Through Discord or a web interface, the user can interact with the bot to quickly come up with various visual solutions, which can be used to create art, design, and conceptualize ideas. This is done very fast as the idea is converted into textual designs and the design ideation process becomes much faster [21] (Zhang & Liu, 2024). MidJourney is not just a tool to visualize, but rather a thinking partner, and active member, who can improve conceptuality and promote aesthetic creativity [22] (Aini et al., 2025).

2.5. Design Effect Evaluation and Selection

The questionnaire survey (Human Rank) was used to evaluate the packaging design proposals of Shanxi Mature Vinegar. The evaluation metrics and weights were standardized according to three fundamental packaging design dimensions, including cultural awareness, cultural identity, and market appeal. The questionnaire subjectively measured five key indicators through comprehensive evaluation: Heritage (Traditional Element Restoration), Visual (Visual Presentation), Culture (Cultural Communication), Function (Functional Utility), and Market (Market Appeal). The indicator of Heritage (H) is the measurement of whether the packaging has cultural features that are typical of Shanxi Mature Vinegar; the Visual indicator (V) measures the harmony and aesthetic value of visual elements such as color and layout; the Cultural Communication (C) indicator measures how well the packaging communicates the culture of the region of Shanxi and vinegar-making history; the Functional Utility (F) indicator measures practical functions such as sealing, portability, and pouring; the Market Appeal (M) indicator measures consumer purchase appeal and adaptability in the market. Considering the characteristics of the Shanxi Mature Vinegar packaging, traditional element restoration and cultural communication are more important than visual presentation, functional utility, and market appeal. Thus, the weighting ratio of the five indicators is 3: 2:2:2:1:2. Suppose that the scores of traditional element restoration, visual presentation, cultural communication, functional utility, and market appeal are a, b, c, d, and e respectively. This paper calculates the weighted average score of each indicator to get the final score of each group, i.e., $W = 0.3a + 0.2b + 0.2c + 0.1d + 0.2e$.

This paper is able to determine the strengths and areas of improvement in Shanxi Mature Vinegar packaging design by using both objective and subjective assessments on dimensions like cultural heritage, practical functionality, and market performance. This gives a reference point on how to choose and polish the final packaging design results.

3. Results

3.1. Analysis of Design Requirements Research Findings

In the analysis of keywords in the Python web crawler literature, the first table 1 shows that the term with the highest frequency is the regional culture and Shanxi Merchant Culture, which are distributed in three aspects, i.e. culture, quality and brand. The less frequent words used include packaging fragrance and travel pack where they may be niche related or new trends. The spiritual core of the design selection should be based on the concept of Jin merchant culture and local features, and the image of the product can be created by using the high-end brand image and the form of a bottle as an aesthetic carrier. It will also combine the sustainability principles with practical functionality to develop a system of packaging which is both culturally rich and marketable. In terms of Python crawler competitors keyword analysis (Table 2), the most popular words were Tracing the origins of local customs, City Business Card, which focused on cultural identity, functional performance, and the development of the consumption situation. Such terms as Dosage guidance and Fragrance release were not mentioned as much, but these were mostly niche products or exploratory ones. The design choices must be made so that the cultural richness is developed by the tracing of the local customs and city business cards, and the trustworthiness of the product is increased by leak-proof necks and easy storage. At the same time, it should add value to the market and competitive advantage by increasing the sense of aesthetics and gift qualities. The results of field research and interviews (Figure 2) showed that the most frequent frequencies were observed at the regional culture, beautiful and high-end, and brand awareness. There were some functionalities like the visualization of remaining quantity, weight of the bottle, and ease of wiping off, which were not common. The designs must be designed with the spiritual core being the regional culture and the visual language of aesthetic and high end, and the product image should be defined through the unique branding characteristics. Meanwhile, the unboxing and usage experience needs to be enhanced with the feeling of ritual, and the guarantee of product reliability is provided by seal security. According to the results of the keyword analysis conducted by Deepseek (Table 3), there were a large number of occurrences of such words as the Shanxi symbol and the Shanxi Merchant Culture, which means that the company is engaged in the creation of the symbolic and cultural values and the brand values. Other words such as vintage distressed and Calligraphy and Seal Carving are used more rarely, which can be viewed as refinements of style or even deeper meanings of cultural components. The design should focus on the idea of the Jin merchant culture as its spiritual essence, developing a visible identity of the product, which would be recognizable under the name of the Shanxi symbols and New Chinese aesthetics. It ought to pursue the extension of narrative and imagery through brand IP-ization. At the same time, it is necessary to consider the bottlenecks of leakage prevention and the rates of flow control, as well as the issues of engineering solutions. This will create social value and a sense of responsibility towards the modernity of the product by incorporating the attributes of gifts and sustainable design.

Table 1. Keyword Analysis Results for Python Web Crawler Literature.

Serial Number	Vocabulary	Frequency	Serial Number	Vocabulary	Frequency
1	regional culture	416	11	Sustainable development	251
2	Shanxi Merchant Culture	398	12	Easy to carry	239
3	Brand Features	375	13	Durable for transportation	228
4	Packaging materials	361	14	People-oriented	216
5	High-end and sophisticated	328	15	The logo is eye-catching	207
6	Elegant bottle design	312	16	Vibrant colors	195
7	Cultural carriers	298	17	Leak-proof bottle neck	184
8	Long-term preservation	285	18	International Trends	173
9	Modernity	276	19	Packaging fragrance	162
10	Preserve the original flavor	264	20	travel pack	151

Table 2. Python Web Crawler Competitor Keyword Analysis Results.

Serial Number	Vocabulary	Frequency	Serial Number	Vocabulary	Frequency
1	Tracing the origins of local customs	145	11	Modernization of Color	89
2	City Business Card	132	12	Precise quantity control	85
3	Cultural conformity	128	13	Natural Health	82
4	Easy to store	120	14	Small-sized repackaging	78
5	Anti-drip bottle neck	115	15	Rich in history	75
6	International Aesthetics	110	16	Fragrance release	72
7	Gift Attributes	105	17	Acidity visible	70
8	Collection attributes	98	18	Dosage guidance	68
9	Smart Tags	95	19	New Chinese Aesthetics	65
10	Environmentally friendly and convenient	92	20	Transparent and trustworthy	62

**Figure 2.** Field Research and Interviews.**Table 3.** Results of Deepseek Keyword Analysis.

Serial Number	Vocabulary	Frequency	Serial Number	Vocabulary	Frequency
1	Shanxi Merchant Culture	230	11	Easy to open and close	88
2	Shanxi symbol	211	12	Intangible cultural heritage crafts	75
3	Brand IPization	175	13	Transparent and visible	70
4	New Chinese Aesthetics	163	14	Interactive Narrative	67
5	Leak-proof bottle neck	140	15	Loess Plateau	65
6	Controllable flow	122	16	Year label	60
7	Gift attributes	115	17	Vintage distressed	54
8	Sustainable Design	100	18	Minimalist Chinese Style	51
9	Sealed for freshness	93	19	Calligraphy and Seal Carving	48
10	Comfortable to hold	90	20	Ecological and simple	44

Table 4. Intention image scoring sheet.

Intention	Cultural fit	Aesthetic expression	Functional clarity	Manufacturing feasibility	Market differentiation	Weighted total score
	3.8	4.0	3.8	4.0	3.9	3.905
	4.3	4.0	4.1	4.3	3.9	4.14
	4.2	4.2	3.7	3.8	4.0	4.01
	3.5	3.6	3.0	3.9	3.5	3.48
	4.5	4.0	3.7	3.8	4.0	4.06
	3.7	3.5	3.0	3.8	3.5	3.505

3.2. Design Requirements Convergence Results

Table 5. Keyword Analysis Results.

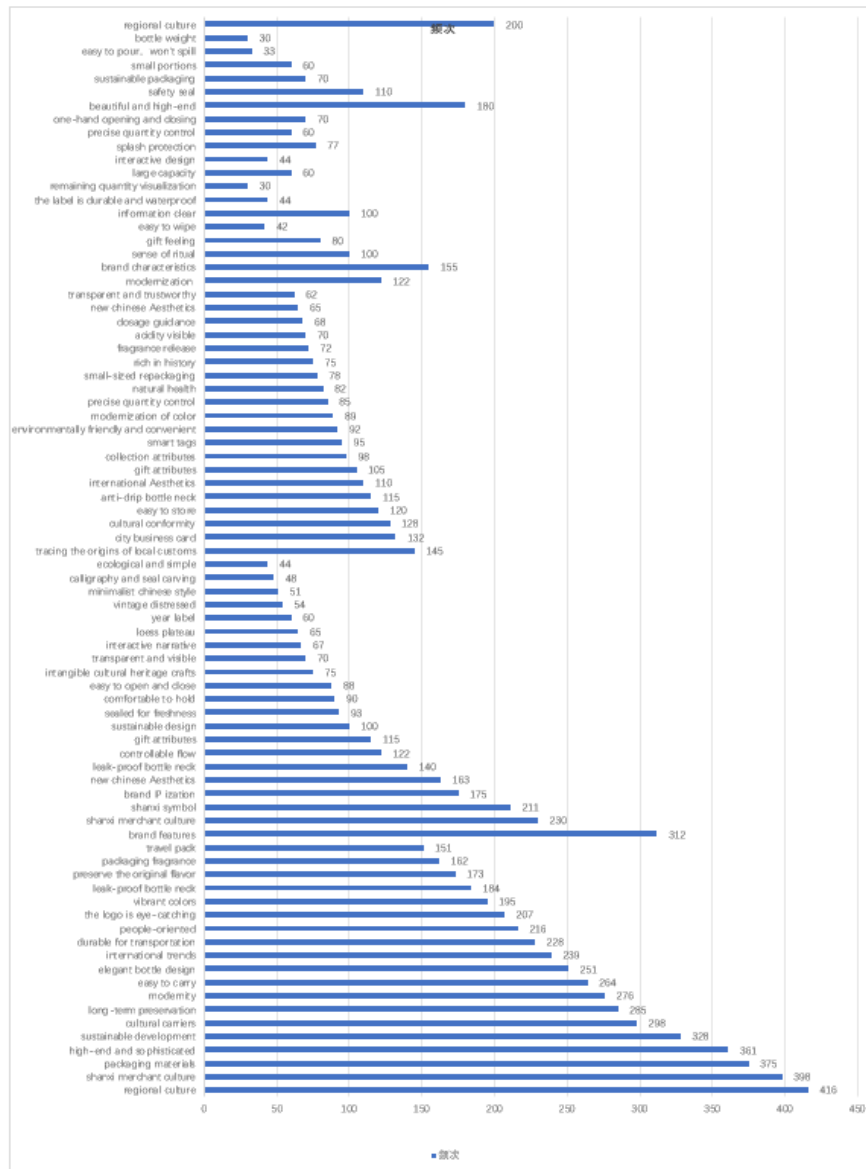


Table 5 shows the results of the keyword analysis, which was conducted by the keywords: high-end (375 times), cultural (416 times) and materials (375 times). These are some of the most used words that show that the design is to be done at once with the following main features: it should meet the needs of the core: produce a top quality appearance, reflect the culture of the region, and provide the services of practicality like durable and leak-proof. As the intention diagram scoring outcomes in Table 4 have shown, the proposal on Jin merchant courtyard visuals had the highest scores in terms of cultural fit and workability (weighted total score: 4.14) as well as having the highest scores in terms of the design proposal that has been put forward as an ideal solution to the problem. On this basis, we were able to obtain the design essentials using the DeepSeek program as illustrated in Table 6. The design of the visual will focus on the architectural elements of the courtyards of the Jin merchants with the use of traditional red and tile-gray hues. It is made of specialty paper, foil stamping, and magnetic closure. The leak resistant and durability improvements would be enhanced and still maintain portable designs including handles. This proposal is based on the concept of architecture of the courtyards of the Jin merchants as its aesthetic background and the use of the colors of crimson and tile gray as its aesthetic background. Silver foil stamping will be applied on the eaves of the buildings, and wheat straw fiber paper will be eco-friendly and magnetic closures will be provided so that they can prevent any leakage. It makes the local cultural experience of Shanxi experienced by the users when unboxing.

Table 6. Key considerations for packaging design of shanxi mature vinegar.

Demand	Design Direction	Scheme Configuration
As a local specialty, Shanxi Mature Vinegar should emphasize its regional cultural characteristics.	The packaging design incorporates elements of Shanxi's regional culture, such as Jin merchant culture, ancient architecture, and paper-cutting art.	The packaging features paper-cut style patterns; the bottle design centers on architectural motifs from Jin merchant courtyards.
Consumers focus on vinegar's quality and freshness, so product storage safety must be ensured.	Using packaging materials with excellent sealing properties to prevent vinegar from evaporating and deteriorating.	Bottle caps are equipped with food-grade silicone seals; Bottle bodies are made of oxygen-barrier glass or plastic materials.
For household use, vinegar should be accessible and easy to measure precisely to prevent waste.	The vinegar bottle is designed with a pouring structure that facilitates precise control of the amount dispensed, and the bottle cap opens and closes easily.	Equipped with a graduated spout for precise volume control; magnetic snap-open mechanism.
When vinegar is presented as a gift, it must possess the premium gift appeal.	Exquisite gift box packaging elevates visual appeal and enhances the sense of occasion.	Introducing our artisanal gift box; featuring a silk-textured lining and exclusive gift pouch.
Consumers should clearly understand the product information of vinegar (ingredients, shelf life, brand, etc.).	Ensure label information is clearly legible and durable against wear and tear.	Features waterproof and scratch-resistant UV-printed labels; key information (such as acidity and origin) is enlarged and prominently displayed.
Diverse needs across different consumption scenarios (daily household use, commercial catering, gift-giving).	Available in multiple capacity options to suit various usage scenarios.	Large-capacity and gift box packaging.
Today's consumers emphasize environmental protection and tend to choose sustainable packaging.	Use recyclable and biodegradable packaging materials to reduce resource waste.	The bottle is made of recyclable glass; the outer packaging features eco-friendly paper made from wheat straw fiber.
Some consumers have high aesthetic expectations for packaging appearance, seeking modernity and visual appeal.	Combining modern design elements, the packaging achieves both aesthetic appeal and a premium feel.	Featuring a minimalist bottle design paired with a metallic-finish cap.

3.3. Analysis of Image Generation Results

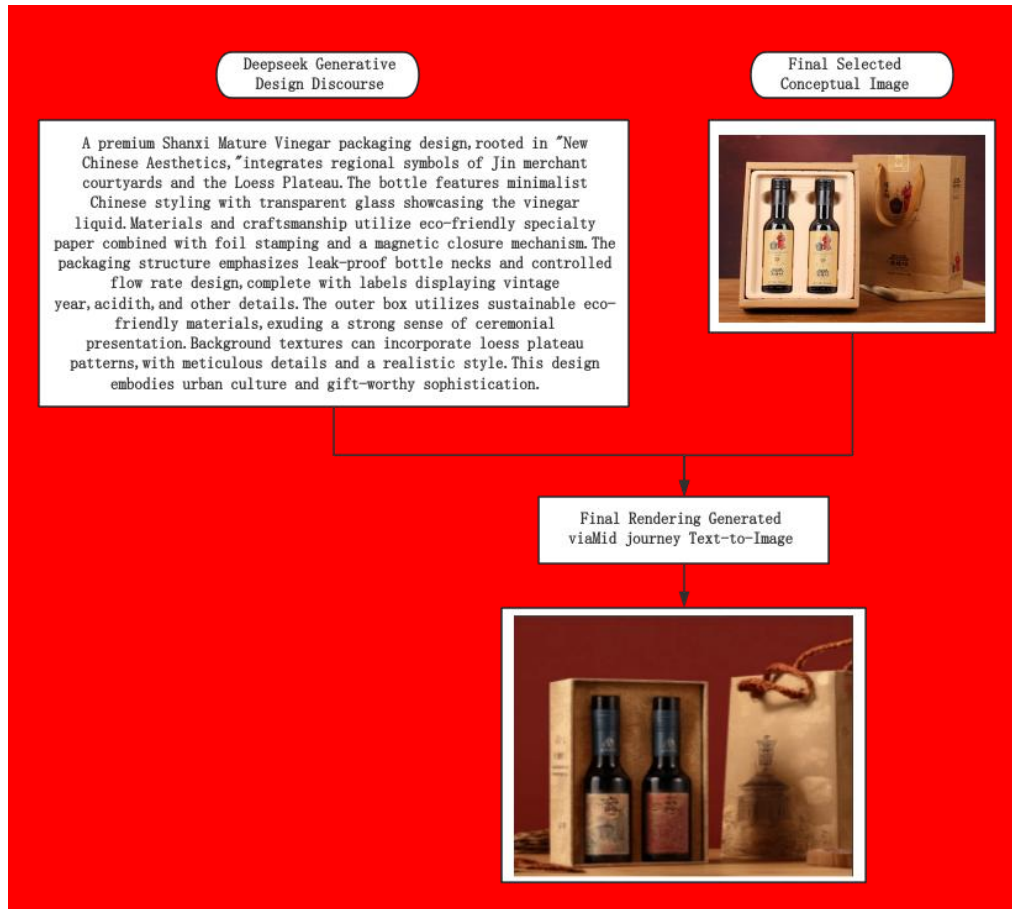
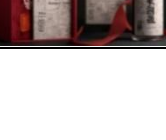


Figure 3. Image Generation Process.

Figure 3. To begin with, the scene and atmosphere should be described in detail using DeepSeek to describe what it is that you want to design. Secondly, choose the most expressive words as main prompts and use them with the corresponding images of the desired style. Lastly, put this text into Midjourney. The image-to-text hybrid mode makes the AI more precise and can combine the text-based ideas and visual styles together in a number of iterations to produce the final renderings. In Table 7: Option 1 has high manufacturing performance but moderate cultural alignment and market differentiation; Option 2 has low aesthetic appeal and functional cues; Option 3 has good aesthetics and functionality; Option 4 has weak aesthetics and poor market differentiation; Option 5 has an average aesthetic and functionality and an average market differentiation; Option 6 has a high cultural alignment and market differentiation and excellent overall performance; Option 7 has high overall performance; Option 8 has an average overall performance and market differentiation; Option 9 has a high overall performance and a high level of market differentiation; Option 10 has a high level of overall performance and a high level of market differentiation; Option 11 has a high level of overall performance and an average level of market differentiation; Option 12 has a high level of overall performance and an average level of market differentiation; Option 13 has a high level of overall performance and an average level of market differentiation; Option 14 has a high level of overall performance and an average level of market differentiation; Option 15 has a high level of overall performance and an average level of market differentiation; Option 16 has a high level of overall performance and an average level of market differentiation. It was found out that Design 14 is one of the best designs in terms of culture alignment, aesthetics, market segmentation, and technical feasibility. Its weighted score is also very high, and this gives it strong marketability and competitiveness in the market. This design fits best to the full demands of packaging of Shanxi Mature Vinegar in its cultural expression, recognition on the market and practical application. Thus, it will be chosen as the solution.

Table 7. Rendering image evaluation score sheet.

Serial Number	AI-generated results	Cultural fit	Aesthetic expression	Functional clarity	Manufacturing feasibility	Market differentiation	Weighted total score
1		3.5	4.0	3.7	4.3	3.5	3.76
2		3.8	4.4	3.5	4.0	3.7	3.875
3		4.2	4.0	3.8	4.1	3.6	3.975
4		3.8	3.6	3.8	4.0	3.5	3.745
5		4.1	4.0	3.6	3.8	3.7	3.875
6		4.4	4.0	4.0	3.9	3.9	4.09
7		4.2	4.1	3.8	3.8	3.9	3.995
8		3.9	4.0	3.7	3.7	3.9	3.85
9		3.7	3.5	3.8	3.8	3.6	3.68
10		3.8	3.6	3.6	3.9	3.6	3.705
11		4.0	3.7	3.9	3.8	3.8	3.86
12		4.5	4.0	3.9	4.2	4.0	4.16

13		3.8	4.0	3.8	3.9	3.9	3.87
14		4.5	4.4	4.0	4.1	4.2	4.275
15		4.1	3.8	3.7	3.9	3.9	3.9
16		4.4	4.0	3.9	4.0	4.2	4.13

3.4. Detailed Design

According to the last sketch proposal chosen, the design was optimized in three aspects: visual expression, material adaptation and interactive experience. In case of visual expression, local cultural features of the sketch were refined by vector but retained the texture of hand-drawn brushstrokes. At the same time, silver foil stamping was used to mark the architectural eaves giving the feeling of aged heritage that the premium vinegar has. The main color of the label maintained the palette of the sketch with an increase in chromaticity, so traditional patterns would be more visible due to contemporary printing technology. In terms of material adaptation, kraft paper used in the sketch was replaced with eco-friendly paper. This is in line with the sustainable design trends as well as communicating the rustic feel of local culture through touch sensation. Hemp handles on the tote bag were transformed into a braided three-strand design based on the conceptual lines of the sketch, which enhanced comfort and strength of grip. To make the interactive experience smooth, the structure of the sketch (double-bottle split-opening) was improved by introducing a concealed magnetic closure to open the lid easily. The bottle labels have architectural designs that reflect the silhouette of the city walls on the outer box, creating a sense of cultural resonance between the visual perception and tactile experience of unboxing is shown in Figure 4.



Figure 4. The final scheme diagram generated by AI.

4. Conclusion

The article is a case study of the new design approach to the traditional packaging of food products in the age of artificial intelligence, which is based on the example of Shanxi Mature Vinegar. It systematically examines how AI can be applied and how it will be used during the whole process of designing the packaging. To begin with, it reviews the literature and market analysis, as well as the current shortcomings in the packaging of Shanxi Mature Vinegar concerning cultural aspects, appearance, and experience of the consumers. It also describes the technical specifications and the trends of using AI in the design sphere. Second, there was a four-step design: AI-assisted research - translation of requirements - generation of styles - iterative optimization. The emotional preferences of users, regional culture specifics and visual language of brands were taken into account by AI tools that were used to derive and combine them. Third, after an initial evaluation, the image generation model was used to create multi-style, multi-version packaging visuals. They were filtered and optimized by means of a system of design assessment, and the result was the proposal of the packaging designs of the Shanxi Mature Vinegar that combined both the Jin merchant culture and the modern taste. This paper contributes to the creative effectiveness and expression of the packaging design as it is able to incorporate the application of AI in the design work and thus provides the methodology reference of the brand renewal of the visual aspect of the traditional product of the region. As shown by practice, the AI can be used to generate a great number of options for exploring the style quickly and help designers to overcome the rigid thinking mode. It also has its peculiarities of the potential of the translation and retranslation of the symbols of culture. Nevertheless, this study has some drawbacks. On the one hand, the randomness of the outcomes produced by the AI systems should be balanced out with their controllability, especially when it comes to the accurate description of the meaning behind the culture, since this still needs a lot of intervention of the designer to make it better and more meaningful. On the other hand, the present studies are limited to the generative exploration of the visual element, whereas the integration of such elements as materials, structures, and sustainability of the packaging should be explored further in future studies.

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