Kano-DEMATEL-TRIZ-based Product Design for Nail Tables and Chairs: A Two-Category User Study

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This paper aims to optimize the product design of nail tables and chairs and enhance user satisfaction. It proposes a comprehensive and visualized design process for developing dual-category user products that balance the needs of two distinct user groups: nail technicians and customers. Leveraging the Kano model, DEMATEL method, and TRIZ theory, the process includes four key steps: gathering dual-category user requirements, categorizing requirement attributes, analyzing the interrelationships between requirements, and resolving design conflicts. Using the design of nail tables and chairs as a case study, the paper empirically demonstrates how to balance the operational efficiency of nail technicians with the customer experience. This approach not only optimizes the design of nail tables and chairs but also offers valuable insights for requirement prioritization and iterative development of other dual-category user products.

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Keywords: User requirements model; KANO model; DEMATBL method; TRIZ theory; Nail table and chairs

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INTRODUCTION

With the rapid development of society and technological progress, products provide users with more diversified services and new experiences, and the needs of different categories of user groups for the same product become more and more diverse. The key issues to enhance user satisfaction and market competitiveness are to balance the needs of the two categories of users in product design: service providers (*e.g.*, nail technicians), who want to improve work efficiency, and service recipients (*e.g.*, nail customers), who want to optimize the experience. The design of nail tables and chairs, as a core product, is especially important in meeting these two types of needs.

Many researchers (Sheng and Li 2018; Lan 2019; Wang 2024; Zhang and Zhang 2024) have conducted studies around the construction of dual-category user models to optimize product design through in-depth analysis and integration of the needs of different user groups. In the fields of medical devices, elderly care products and commercial equipment, researchers have extracted and analyzed user demand characteristics based on user research and service design concepts, and constructed dual-category user models by focusing on typical dual-category users such as doctors and patients, caregivers and the elderly, and shopkeepers and customers, and applied them to product design and optimization, which have significantly improved user experience and product performance.

Although the above research has achieved certain results in the analysis of dual-category user needs, there are still the following shortcomings: 1. In the stage of collating and analyzing user needs, the qualitative research method is mainly adopted, and there is a lack of relatively objective quantitative research support; 2. Insufficient consideration is given to the mutual influence relationship between the needs of different categories of users, and it fails to realize the visualization presentation, and it does not reveal its intrinsic correlation; 3. In the process of user needs design and transformation, there is a lack of systemic approach. In the process of user requirements design and transformation, there is a lack of systematic theoretical basis for analyzing the contradictions between them.

Therefore, exploring an efficient and visualized product development and design process for dual-user products not only can provide scientific guidance for product development, but it also has significant practical implications. This is particularly true in the design and optimization of nail tables and chairs, which has direct application value.

EXPERIMENTAL

Integration of KANO-DEMATEL and TRIZ Theory

In dual-category user product design, especially for products like nail tables and chairs, addressing the complex and often conflicting needs of two user categories (nail technicians and customers) presents significant challenges. A single analytical method is often insufficient to handle the interactions and contradictions between these diverse needs effectively. Thus, this study combines the Kano model, the DEMATEL method, and TRIZ theory to propose a systematic framework for analyzing and integrating the requirements of dual-category users.

The Kano model, introduced by Noriaki Kano in 1984, is a qualitative analysis tool that categorizes user needs into "Mandatory Needs (M)," "Unitary Needs (O)," "Attractive Needs (A)," "Indifferent Needs (I)," and "Reverse Needs (R)" (Cheng *et al.* 2020). This model helps prioritize and analyze user expectations. In this study, the Kano model was utilized to differentiate the needs of the two user categories and analyze their expectations for the product. Unlike traditional single-user analysis, this research employed two customized questionnaires tailored to the characteristics of the dual-category users, ensuring accurate identification of their needs and a clear distinction between shared and unique requirements.

DEMATEL (Decision-Making Trial and Evaluation Laboratory) is a methodology based on graph theory and matrices, used to quantify the relationships between needs by constructing influence matrices and causal influence network relationship maps (INRM) (Zhou *et al.* 2024). In this study, DEMATEL was applied to analyze the interactions and influences among the requirements of the two user groups, aiding in requirement prioritization and optimization. To enhance the accuracy of the analysis, the questionnaire design accounted for the distinct characteristics of each user group, and expert selection was guided by the diversity in user roles to ensure consistent scoring criteria and reliable data.

TRIZ (Theory of Inventive Problem Solving), developed by Genrich Altshuller, is widely used in technological innovation and industrial design (Altshuller 1979; Chang *et al.* 2016). TRIZ addresses technical and physical contradictions in design, offering creative solutions for resolving conflicts (Rong *et al.* 2024). In this study, TRIZ was used to resolve the technical and functional contradictions among the top-priority requirements identified through Kano and DEMATEL analyses, thus providing innovative solutions to address potential conflicts in product design.

The effectiveness of the combined Kano-DEMATEL method in the analysis of the needs of a single user group has been verified in several ways (Wu *et al.* 2022; Qiang *et al.* 2024; Lv *et al.* 2024), but it is difficult to deal with the integration of the needs of dual users. To address the challenge of balancing dual-user needs in nail table and chair design, this study optimizes the Kano-DEMATEL method, especially making careful adjustments in design of the questionnaire, research object selection, and expert opinion collection to better adapt to the analysis of dual-category users' needs. Combined with the TRIZ method, this study provides a systematic reference for product innovation design by resolving technical and functional conflicts in design (Soo *et al.* 2011). Du *et al.* (2024) and Zhang and Miao (2024) verified the effectiveness of TRIZ in the areas of wooden baby crib and home office furniture design, respectively. Through the combination of Kano-DEMATEL-TRIZ, this study constructed a complete dual-category user product development process. This approach included requirements classification, sequencing, relationship analysis, and technical contradiction resolution. The goal was to enable precise identification and integration of the needs of nail technicians and customers to optimize product design and enhance user satisfaction. The design process for the dual-category user development of nail tables and chairs is illustrated in Fig. 1.

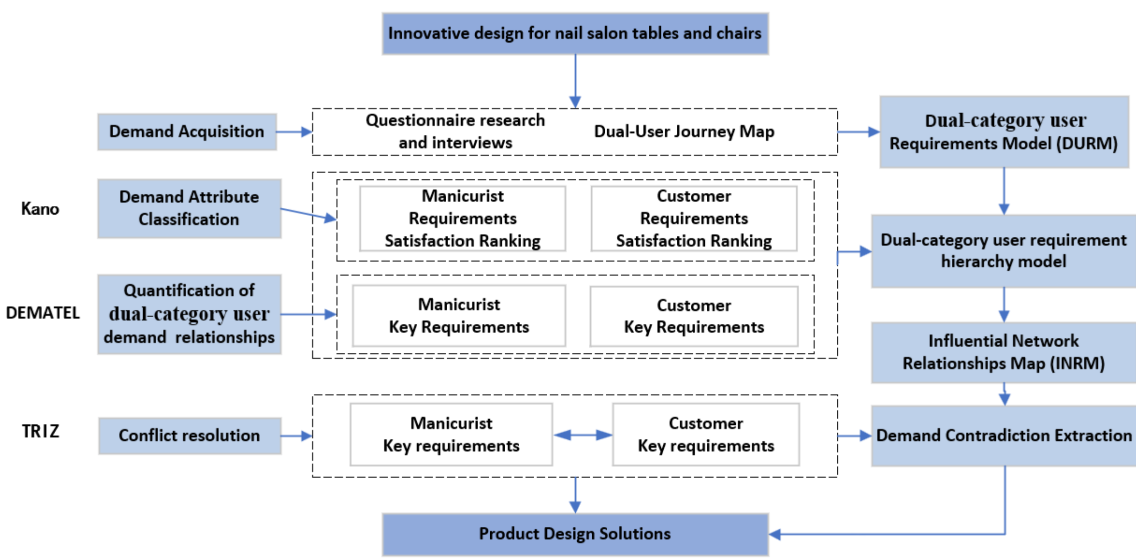

Fig. 1. Design process for dual-category users of nail tables and chairs

Requirements Acquisition and Coding for Nail Tables and Chair

The requirements acquisition phase is based on service design theory, where the demand information from two user categories—nail technicians and customers—is systematically gathered through questionnaires, interviews, and field observations. Unlike traditional single-user analyses, this study emphasizes both the common and unique needs of the two user groups. The questionnaire was designed in two versions: one for nail technicians and one for customers. It covered basic information, occupational/consumption characteristics, and expectations regarding table and chair usage. During the survey, the questionnaires were distributed *via* online social platforms and offline stores, supplemented by interviews and field observations, to comprehensively gather user feedback.

Kano Requirements Attribute Classification

The Kano model is applied to classify and prioritize the attributes of dual-category user requirements for nail tables and chairs through the following process:

Step 1: Questionnaire design

The user requirements identified in the earlier stage were developed into positive and negative Likert-scale questionnaires tailored separately for nail technicians and customers. The gathered responses were categorized by attributes, with reverse needs being excluded. Berger *et al.* (1993) proposed the Better-Worse satisfaction coefficient formula to calculate the satisfaction index (SI) and dissatisfaction index (DSI) for each need, as shown in Eqs. 1 and 2,

$$SI = \frac{(A' + O')}{(A' + O' + M' + I')} \tag{1}$$

$$DSI = -\frac{(O' + M')}{(A' + O' + M' + I')} \tag{2}$$

where A' represents the number of Attractive Requirement options, O' represents the number of One-Dimensional Requirement options, M' represents the number of Must-Requirement options, and I' represents the number of Indifferent Requirement options.

Based on the SI and DSI values, the four-quadrant diagram of the requirements of the dual-category users is plotted separately, and the criteria for ranking each quadrant are: Must-Requirement (M) > One-Dimensional Requirement (O) > Attractive Requirement (A) > Indifferent Requirement (I) (Huang 2018).

Step 2: Requirement importance ranking

Multiple requirements attributed to the same quadrant are ranked in terms of their internal importance, where undifferentiated attributes are not involved in the ranking if they have less influence. The initial weight (w_i) of the i^{th} requirement of dual-category users is calculated separately using the fuzzy transformation semantic method (Li 2023), and the requirement weighting weight (w_i') is further calculated afterwards to finally obtain the preliminary priority ranking of the respective requirements of nail technicians and customers. The calculation formula is shown in Eq. 3, where k_i is the value of the adjustment coefficient of the Must-Requirement, One-Dimensional Requirement, Attractive Requirement, and Indifferent Requirement attributes, which is 1, 2, 4, and 0 in that order.

$$w'_i = \frac{w_i k_i}{\sum_{i=1}^{n} w_i k_i} \tag{3}$$

DEMATEL User Requirements Impact Relationship Analysis

Quantitative analysis of dual-category user demand influence relationship using DEMATEL analysis method and expert opinion (Neira *et al.* 2020).

Step 1: Generate the direct-influence matrix D

The attribute-categorized and ranked needs of nail technicians and customers were combined into an n-item list, and m experts were invited to perform pairwise comparisons of these needs (Šmidovnik *et al.* 2023). An integer scale ranging from "0 - no impact" to "4 - very large impact" was used to construct a direct impact matrix D^K, based on the degree of impact that one need has on another. D^K is an n×n matrix that represents the direct impact of need *i* on need *j,* as assessed by expert *K*. The final direct impact matrix $D=\left[d_{ij}\right]$. $D=\left[d_{ij}\right]$ is obtained by averaging the results from all the experts. The element of this matrix d_{ij} represents the arithmetic mean of the individual experts' assessments of the impact of need *i* on need *j*, as shown in Eq. 4:

$$D=d_{ij}=\frac{1}{m}\sum_{k=1}^{m}d_{ij}^{k} \tag{4}$$

Step 2: Derive the normalized direct-relation matrix X

Based on the direct impact matrix *D*, the normalized direct impact matrix $X=\left[x_{ij}\right]$ is derived using Eq. 5:

$$x_{ij}=\frac{d_{ij}}{\max\limits_{1\le i\le n}\sum_{j=1}^{n}d_{ij}},i,j=1,\ldots,n. \tag{5}$$

Step 3: Derive the total relation matrix T

According to the normalized direct impact matrix *X*, the total impact matrix *T* can be constructed using Equation 6, $T=\left[t_{ij}\right]$,

$$T=X(I-X)^{-1} \tag{6}$$

where *I* is denoted as the identity matrix.

Step 4: Solve the sum of rows and columns and graph the influence network

By calculating the row sums and column sums of the total impact matrix *T*, the extent to which each demand is impacted and affected can be identified. The row sum *Ri* represents the direct and indirect influence of factor *i* on other factors, and the column sum *Cj* represents the direct and indirect influences that factor *j* receives from all other factors:

$$R_i=\sum_{j=1}^{n}T,i=1,\ldots,n. \tag{7}$$

$$C_j=\sum_{i=1}^{n}T,j=1,\ldots,n. \tag{8}$$

Ri + *Ci* is known as the Prominence Value of the factor, which indicates its importance. *Ri* - *Ci* is known as the Relations Value, which reflects the net contribution of factor *i* to the system. If *Ri* > *Ci*, then the factor is considered a causal factor, whereas if *Ri*<*Ci* , the factor is considered an effect factor.

The Influence Network Relationship Map (INRM) was created to represent the relationships between the demands. The four quadrants of the INRM were plotted using the prominence value (R+C) as the horizontal axis and the relations value (R−C) as the vertical axis. This categorizes the demands into core (I), driver (II), independent (III), and influence (IV) demands. Figure 2 shows the four quadrants (Si *et al.* 2018).

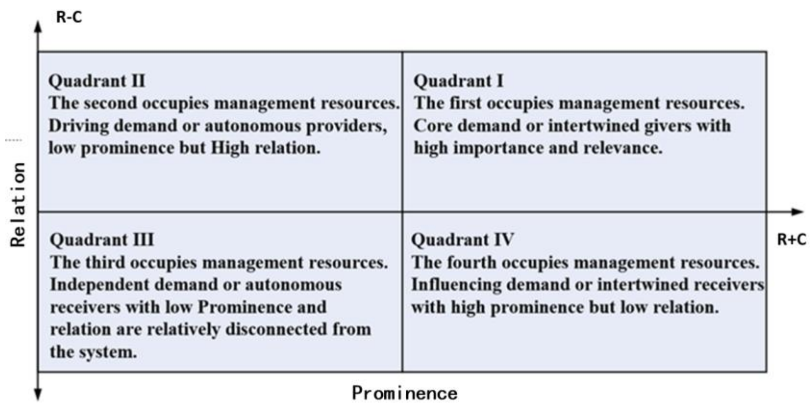

Fig. 2. INRM four-quadrant diagram of requirements division

User Requirements Sequencing Analysis

The hierarchical model for product demand sequencing includes the following elements: the first criterion level represents the demand objectives of nail technicians and customer users; the second criterion level classifies and preliminarily sequences the attributes of dual-category user demands for nail tables and chairs according to the Kano model; and the third criterion level uses the DEMATEL method to comprehensively sequence the overall product demands. The hierarchical model for nail table and chair dual-category user requirements is shown in Fig. 3. Through this requirement hierarchy model, a comprehensive priority list of dual-category user requirements is developed, clarifying the ordering relationships between the different user requirements of nail technicians and customers.

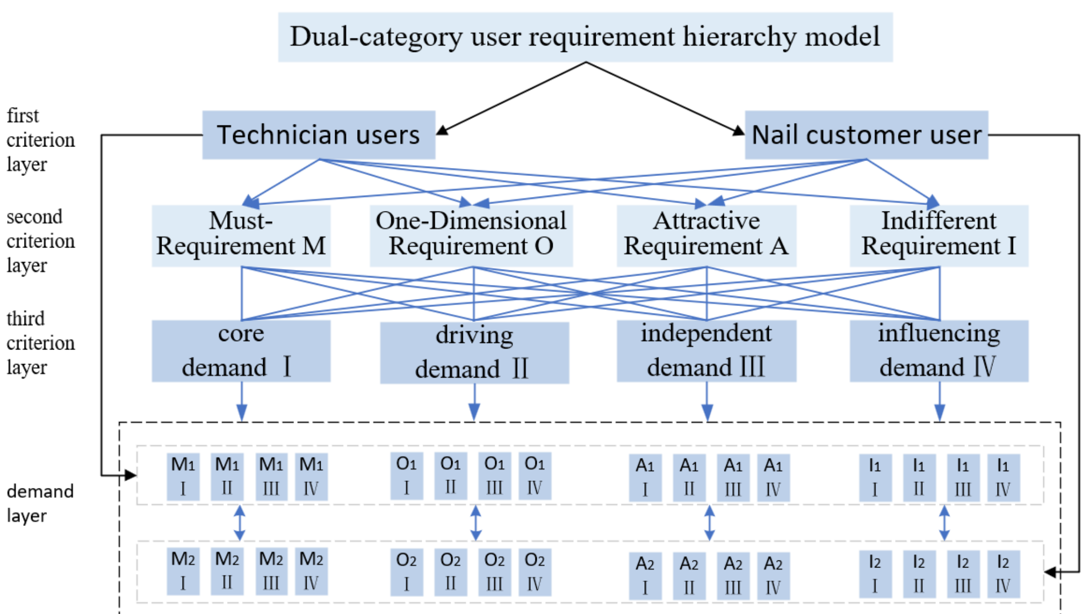

Fig. 3. Dual-category user requirement hierarchy model for nail tables and chairs

Requirement Contradiction Analysis and Solution

Based on the dual-category user requirement hierarchy model for nail tables and chairs, the requirements are sorted and analyzed to identify the main contradictory requirements in the product design process and clarify the design elements that need to be optimized. The 39 standard parameters in TRIZ theory are utilized to match the contradictory requirements and screen the corresponding invention principles. Finally, oriented by the design goal, the most suitable invention principle is selected to carry out the program design, which provides effective guidance for product innovation.

RESULTS AND DISCUSSION

By investigating the materials, sizes, functions, and user experiences of existing nail art tables and chairs in the market, it was possible to broadly classify them into three types (see Fig. 4 for representative examples) and analyze their respective characteristics and shortcomings. Existing products generally lacked sufficient professionalism and were unable to meet the needs of both nail technicians and customers.

Type I Type II Type III

Fig. 4. Examples of existing nail table and chair types

Type 1: Modern, minimalist nail tables and chairs are typically made from composite wood, glass, metal, or high-quality plastics, with chairs matching the table material or upholstered in fabric or leather. Table dimensions range from 70 to 130 cm in length, 40 to 50 cm in width, and 75 cm in height, while the chair height is around 45 cm. These designs are simple and aesthetically pleasing, meeting basic storage and seating needs. However, feedback from nail technicians highlighted limited storage and workspace, reducing work efficiency, while customers appreciated the look but found long-term comfort lacking, leading to fatigue.

Type 2: Function-oriented nail tables and chairs prioritize practicality, often using solid or artificial wood. Table sizes range from 80 to 200 cm in length, 45 cm in width, and 78 cm in height, with chairs at 45 cm sitting height. These designs typically feature drawers, shelves, built-in vacuums, and adjustable backrests to improve storage and workspace, enhancing technician efficiency. While customers found the plain wooden style neutral and uncomfortable, nail technicians rated its functionality highly.

Type 3: Reclining sofa-type nail tables and chairs focus on customer comfort, using materials such as metal, upholstery, and leather. The dimensions are 75 cm in width, 85 cm in depth, 113 cm in height, with a 60 cm sitting height and 48 cm sitting depth, plus an adjustable backrest. This type is ideal for hand, foot, and eyelash treatments. Customers praised its comfort, but nail technicians found it difficult to adjust customers' hands, with insufficient support, leading to fatigue and reduced work efficiency.

While these three types address different functions and designs, they share a common issue: design homogenization and lack of professionalism. Further optimization is needed to better meet the diverse needs of both nail technicians and customers.

Acquisition of User Requirements for Nail Tables and Chairs

In the data collection stage, 128 nail technician questionnaires and 189 customer questionnaires were collected, with valid data obtained after screening. Based on the statistical analysis, 6 nail technicians and 10 customers were selected for semi-structured interviews to further explore users' implicit needs and construct user role models. During the interviews, the nail technicians discussed their experiences using nail tables and chairs, while the customers recalled their recent or memorable nail experiences. The interviews were recorded to extract key information.

Table 1. Classification of Manicurist and Nail Customer Needs

Category	Manicurist Needs		Customer Needs	
	No.	Item	No.	Item
Personal Characteristics	a1	Structural stability	a'1	Structural stability
	a2	Comfortable material feel	a'2	Comfortable material feel
	a3	Styling is aesthetically pleasing	a'3	Styling is aesthetically pleasing
	a4	Harmonious colors	a'4	Harmonious colors
	a5	Seat height adjustable	a'5	Seat height adjustable
	a6	Adjustable table height	a'6	Adjustable table height
	a7	Backrest support when sitting or standing	a'7	Backrest support when sitting or standing
	a8	Functional layout	a'8	Functional layout
	b9	Seats are removable	c9	Accompanying items can be placed
	b10	Easy maintenance and cleaning	c10	Convenient for eating and drinking
	b11	Multi-mode eye-care lighting	c11	Recreation and entertainment
Occupational elements/ participation elements	b12	Small footprint	c12	Intelligent massage function
	b13	Customer discomfort feedback	c13	Flexible hand support
	b14	Extension of operating space	c14	Space for leg extension
	b15	Easy access and storage of tools	c15	Laying down of limbs
	b16	Flexible arrangement of operating space	c16	Learning about nail care
	b17	Easily manipulate the angle of the customer's nails	c17	Take photos of the process or finished product
	b18	Customized style communication display	c18	Personalized customized service
	b19	Hand-held Lighting Equipment	c19	Manicure time schedule presentation
	b20	Sound-activated intelligent manicure lamp	c20	Nail surface temperature control when shining the lamp

Additionally, the research team conducted field observations of the nail environment using the user journey mapping tool to analyze user behaviors, interaction processes, and potential problems. This ultimately led to the compilation of a list of user needs, providing a solid foundation for the subsequent design of the Kano questionnaire and DEMATEL analysis. Based on the categorized demand types, 20 demand items for nail technicians and customers were compiled and coded according to common demands (numbered *ai* and *ai'*) and specific demands (numbered *bi* and *ci*). The specific demand items are shown in Table 1.

Nail Tables and Chairs User Requirements Attribute Classification

The results of the above demand numbering statistics were used in the designing of the Kano questionnaire, taking into account the differences in the needs of the two user types. This not only effectively differentiated the priorities of the needs for both groups but also helped identify the common core needs, as well as those that might be important only to specific groups of users. The questionnaire was distributed to nail technicians and customers through online social media platforms and offline stores, respectively. After screening and eliminating invalid questionnaires with too short a filling time or contradictory answers, as well as those with contradictory answers to positive and negative questions, 191 valid questionnaires from manicurist users and 284 valid questionnaires from nail customer users were finally collected. The reliability of the questionnaire was examined using Cronbach's consistency coefficient, which showed that the coefficient values of both positive and negative questions were higher than 0.8, indicating that the data had a high level of reliability. The validity of the data was verified by KMO and Bartlett's test, and the KMO values were higher than 0.8, indicating that the research data were very suitable for information extraction.

The satisfaction index (SI) and dissatisfaction index (DSI) of the user needs of manicurists and nail customers were calculated based on the satisfaction formulas (1) and (2) of the Kano model, respectively. According to the calculation results, each demand was categorized by attributes. Manicurist user needs were classified as 5 Must-Requirements, 6 One-Dimensional Requirements, 6 Attractive Requirements, and 3 Indifferent Requirements. Nail customer user needs were categorized as 5 Must-Requirements, 5 One-Dimensional Requirements, 5 Attractive Requirements, and 5 Indifferent Requirements. A four-quadrant diagram of the needs was drawn, as shown in Fig. 5.

Equation 3 was used to calculate the importance of the two users' needs and rank them separately, as shown in Table 2.

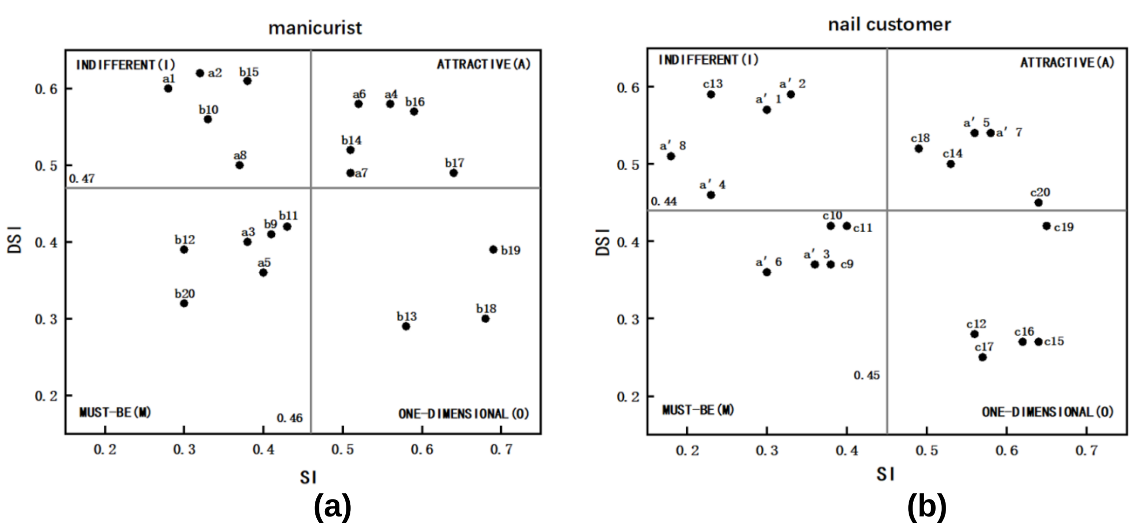

Fig. 5. Better-Worse coefficient diagram for (a) manicurists and (b) nail customers

Table 2. Manicurist and Nail Customer Demand Importance Ranking

Manicurist Needs						Nail Customer Needs				
No.	type	w_{i*}	w'_{i*}	Ranking		No.	type	w_{i*}	w'_{i*}	Ranking
a1	M	0.651	0.030	3		a'1	M	0.665	0.026	1
a2	M	0.622	0.029	5		a'2	M	0.620	0.024	3
a3	I	0.649	0.000	/		a'3	I	0.648	0.000	/
a4	O	0.758	0.070	8		a'4	M	0.618	0.024	4
a5	I	0.664	0.000	/		a'5	O	0.757	0.058	7
a6	O	0.754	0.069	9		a'6	I	0.621	0.000	/
a7	O	0.753	0.069	10		a'7	O	0.753	0.058	8
a8	M	0.660	0.030	2		a'8	M	0.595	0.023	5
b9	I	0.653	0.000	/		c9	I	0.656	0.000	/
b10	M	0.635	0.029	4		c10	I	0.651	0.000	/
b11	I	0.677	0.000	/		c11	I	0.660	0.000	/
b12	I	0.615	0.000	/		c12	A	0.774	0.119	11
b13	A	0.780	0.143	13		c13	M	0.623	0.024	2
b14	O	0.751	0.069	11		c14	O	0.751	0.058	9
b15	M	0.678	0.031	1		c15	A	0.757	0.116	15
b16	O	0.767	0.070	7		c16	A	0.771	0.119	13
b17	O	0.796	0.073	6		c17	A	0.757	0.116	14
b18	A	0.770	0.142	14		c18	O	0.736	0.057	10
b19	A	0.784	0.144	12		c19	A	0.773	0.119	12
b20	I	0.648	0.000	/		c20	O	0.785	0.060	6

Analysis of the Impact of User Requirements for Nail Tables and Chairs

To ensure validity and reliability of the DEMATEL data, 12 experts were invited to participate. These included four practitioners from the customized furniture industry, four experienced nail technicians, and four graduate students with a background in furniture design who regularly performed nail art. These experts completed the DEMATEL questionnaire to assess the interplay between different needs.

Prior to the formal experiment, the research team designed a simplified 5×5 needs matrix questionnaire and organized a trial session with the experts to help them familiarize themselves with the DEMATEL methodology and scoring criteria. The purpose of this session was to ensure that the experts accurately understood the requirements of the questionnaire, to reduce scoring bias, and to improve the validity of the data.

In the formal experiment, the study incorporated 8 common needs (numbered ai) and 12 specific needs (numbered bi, ci) for both nail technicians and customers, totaling 32 needs. A 32×32 matrix was constructed to score the influence relationship between each pair of needs. The comprehensive influence matrix T was calculated using Eqs. 4 to 6. The influence degree (R_i) and the influenced degree (C_i) of each element were then obtained using Eqs. 7 and 8. Additionally, the INRM coordinate information for the 32 user requirements, specifically the centeredness (Ri + Ci) and the cause degree (Ri - Ci) of each requirement index, was derived. The results of the DEMATEL calculation for the user demand elements of the nail table and chair were obtained, as shown in Table 3.

The previous Kano model demand attribute classification results were combined with the DEMATEL analysis impact relationship results for visual graphical presentation. In Fig. 6, different attributes of the requirements are distinguished by four colors. The influencing and influenced relationships between some of the important requirements are labeled with arrows. This visual presentation helped designers and developers identify critical requirements and provided clear direction and guidance for product development.

Table 3. DEMATEL Results of Nail Tables and Chairs Requirements

Needs	Influence degree (R_i)	Influenced degree (C_i)	Centered-ness	Cause degree	Categorization
a1	0.56041	0.1097	0.67011	0.45071	II
a2	0.53876	0.12035	0.65911	0.41841	II
a3	0.04809	0.33825	0.38634	-0.29016	III
a4	0	0.24768	0.24768	-0.24768	III
a5	0	0.33466	0.33466	-0.33466	III
a6	0.69394	0.03125	0.72519	0.66269	II
a7	0.95548	0.1097	1.06518	0.84578	I
a8	0.81163	0.11541	0.92704	0.69622	I
b9	0	0.37386	0.37386	-0.37386	III
b10	0	0.30636	0.30636	-0.30636	III
b11	0	1.10394	1.10394	-1.10394	IV
b12	0.4901	0.11288	0.60298	0.37722	II
b13	0	1.24398	1.24398	-1.24398	IV
b14	0.84612	0.03125	0.87737	0.81487	I
b15	0.81487	0.03259	0.84746	0.78228	I
b16	0.87532	0.11339	0.98871	0.76193	I
b17	0	1.17826	1.17826	-1.17826	IV
b18	0	1.07859	1.07859	-1.07859	IV
b19	0.5224	0.07506	0.59746	0.44734	II
b20	0.50044	0.14092	0.64136	0.35952	II
c9	0.24982	0.40186	0.65168	-0.15204	III
c10	0.52272	0	0.52272	0.52272	II
c11	0.92195	0	0.92195	0.92195	I
c12	0.27301	0.36721	0.64022	-0.0942	III
c13	0.86617	0.04273	0.9089	0.82344	I
c14	0.4817	0.0336	0.5153	0.4481	II
c15	0.10767	1.14309	1.25076	-1.03542	IV
c16	0.06562	1.14315	1.20877	-1.07753	IV
c17	0.04657	0.46896	0.51553	-0.42239	III
c18	0.09565	1.10862	1.20427	-1.01297	IV
c19	1.09969	0.14564	1.24533	0.95405	I
c20	0	0.33519	0.33519	-0.33519	III

Product Requirements Sorting Analysis of Nail Tables and Chairs

Combined with the dual-category user needs hierarchy model, the initial ranking of the needs for nail technicians and customers was performed separately using the Kano model. This was followed by an analysis of the INRM coordinates of the nail tables and chairs to organize the relationships between the needs, ultimately leading to the final ranking (as shown in Table 4). The joint Kano-DEMATEL ranking results presented in the table were derived from further analysis based on the Kano model rankings, reflecting the complex relationships between the requirements.

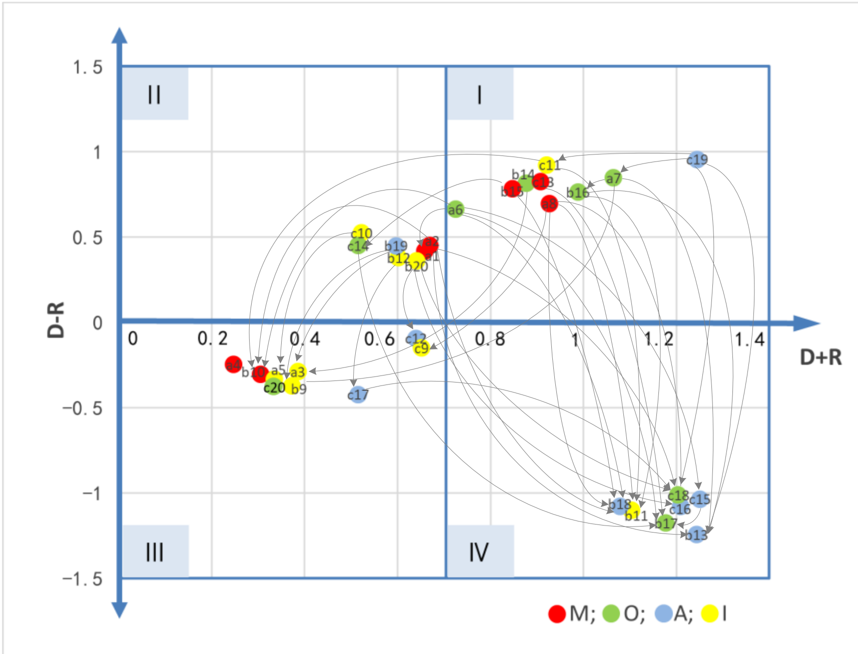

Fig. 6. Product requirements INRM diagram

Table 4. Nail Table and Chairs Demand Sorting

Demand Type	Sorting Type	Sorting Result
M	Manicurist Kano	b15 > a8 > a1 > b10 > a2
	customer kano	c13 > a8 > a1 > a2 > a4
	K-DEMATEL	(Ⅰ) b15, a8, c13> (Ⅱ) a1, a2>(Ⅲ) b10, a4
O	Manicurist Kano	b17 > b16 > a4 > a6 > a7 > b14
	customer kano	C20 > c14 > a5 > c18
	K-DEMATEL	(Ⅰ)b16, a7, b14 >(Ⅱ) a6, c14 >(Ⅲ) a4, c20, a5 >(Ⅳ) b17, c18
A	Manicurist Kano	b19 > b13 > b18
	customer kano	c12 > c19 > c16 > c17 > c15
	K-DEMATEL	(Ⅰ)c19 > (Ⅱ)b19 >(Ⅲ)c12, c17 > (Ⅳ)c15, b13, b18, c16
I	Manicurist Kano	a3, a5, b9, b11, b12, b20
	customer kano	a3, a6, c9, c10, c11
	K-DEMATEL	(Ⅰ)c11 >(Ⅱ)b12, b20, a6, c10 >(Ⅲ) a3, a5, b9, c9, b11

Must-Requirement (M): Common demand a8, manicurist demand b15, and customer demand c13 are core demands, related to the realization of other functional requirements, and represent the main development direction for nail table and chairs. A reasonable functional layout requires analyzing the nail operation process and equipment usage. The main functions include sitting and reclining, item storage, hand support, nail lamp irradiation, dust cleaning, lighting, and auxiliary communication. The ease of tool access is key to storage design, while the optimization of hand support not only improves customer comfort but also affects b17 in manipulating the nail surface angle. Driving demands a1 and a2 influence the realization of some other functions, such as a6, which needs to ensure structural stability, and the choice of comfortable materials must consider b10. As nail polish is difficult to clean and grinding produces dust, anti-fouling and easy-to-maintain materials should be selected. Independent demand a4 can harmonize with the store environment to enhance the brand's style.

One-Dimensional Requirement (O): Manicurist demands b16 and b14, along with common demand a7, are core expected demands. Their realization can significantly enhance user satisfaction, while failure to meet them will reduce satisfaction. Sit-to-stand backrest support is key to improving competitiveness due to back fatigue caused by prolonged operation. Flexible operating space and desktop extension are also common needs. Manicurists often use multi-layer trolleys to store tools to address the issues of insufficient desktop space and contamination of tools by nail dust. Optimizing these designs will greatly enhance the overall product. Driving demand c14 is highly appealing and has less impact on other demands, but improvements must consider the manicurist's leg space and posture changes. c18 is an influencing demand in the INRM causality and cannot be directly improved, with source demands including b18, c17, and c19. These demands enhance communication assistance functions and, after satisfying essential requirements, can further improve user experience and resource utilization through technical research and development.

Attractive Requirement (A): Attractive demands have strong appeal and are key to enhancing product brand positioning and competitiveness. c19 can alleviate customers' anxiety about not controlling their progress and help them choose their preferred manicurist. Although this requires more R&D resources, the presentation of intelligent data will improve the future experience of nail services, similar to c18 and b18. b19 can free hands and improve efficiency, but current products lack flexibility and require optimization. c12 and c17 are independent demands that can enhance the service experience and attract high-demand customers. However, c15, despite its high demand, affects the manicurist's operation and is unsuitable for direct implementation.

Indifferent Requirement (I): Although indifferent needs are not currently prioritized by users, as the nail service market matures, customer needs such as c11 may evolve into glamorous demands in the future. Additionally, demands such as c10 and c9 could enhance customer experience in future detail optimizations.

TRIZ Solution to the Contradiction Problem

Through the preliminary research and the analysis of the relationship between the impact of the requirements, the four pairs of sometimes contradictory problems that need to be solved in the design process of the nail table and chair are summarized as the key focus, and the core point of the contradiction is determined through specific points. Combined with the 39 standard parameters in Archie Schuler's contradiction matrix table, the corresponding invention principles are extracted, as shown in Table 5.

Conflict 1: manicurist demand b17 and customer demand c14. To ensure operability, manicurists require customers to keep their hands placed directly in front of them, which facilitates polishing, drawing, and adjusting. However, this setup results in manicurists and customers facing each other for long periods, with their legs positioned opposite each other. This can lead to collisions, restricted leg movement, and discomfort after prolonged sitting. The design must address the contradiction between the length of the stationary object and the area of the stationary object, which constitutes a technical contradiction.

Conflict 2: customer needs c13 and common needs a1. Nail customers need to frequently adjust the height and angle of their hands based on the manicurist's operations. The existing fixed support frame cannot flexibly adapt to changing hand postures and often occupies significant desktop space. Desktop support must remain stable while also flexibly adapting to hand support adjustments, creating a contradiction between operability and the volume of stationary objects, categorized as a technical contradiction.

Conflict 3: manicurist demand b14 and b17. Due to store space constraints, the footprint of the nail table and chairs must be minimized. However, certain operational steps require a larger workspace. Additionally, the width of nail tables and chairs must be moderate to enable manicurists to operate efficiently and access tools easily; if too wide, it reduces convenience. This conflict involves the contradiction between the volume of stationary objects and maneuverability, constituting a technical contradiction.

Conflict 4: customer demand c12 and both demand a1. Incorporating an intelligent massage function into the seat requires a complex mechanical structure and power system. However, this addition may impact the seat's stability and comfort, creating a physical contradiction.

Table 5. Principles of Conflict and Correspondence Invention

No.	Conflict	Conflict Type	Improvement Parameter	Deterioration Parameter	Corresponding Invention Principle
1	b17 (Easily manipulate the angle of the customer's nails) c14 (space for leg extension)	Technical conflict	4 Length of stationary object	6 Area of stationary object	17, 7, 10, 40
2	c13 (flexible hand support) a1 (structural stability)	Technical conflict	33 Maneuver-ability	36 Equipment complexity	32, 26, 12, 17
3	b14 (extension of operating space) b17 (Easily manipulate the angle of the customer's nails)	Technical conflict	33 Maneuver-ability	8 volume of stationary objects	4, 18, 39, 31
4	c12 （Intelligent massage function） a1 （Structural stability）	Physical conflict	Principle of separation of whole and part		3, 4, 5, 6, 10, 12, 17, 24, 35

For the above technical conflicts, the appropriate invention principle is selected to propose a solution. For physical conflicts, the most appropriate principle is selected to propose a contradiction solution according to the four principles of differentiation provided by TRIZ - spatial separation, temporal separation, conditional separation, and whole-part separation.

Conflict 1: The improvement parameter is the length of the stationary object, the deterioration parameter is the area of the stationary object, and the applicable invention principle is Principle 17 (the principle of excess to another dimension). It is suggested to raise the height of the seat sitting surface appropriately so that the legs can be placed diagonally downward naturally, and to set different heights of foot support points to increase the freedom of leg movement. At the same time, it is suggested to adjust the height of the desktop so that it forms an ergonomic height difference with the seat to improve overall comfort.

Conflict 2: The improvement parameter is maneuverability, the deterioration parameter is equipment complexity, and the principle of invention is Principle 17. The existing flat soft package support surface is changed to an elliptical curved soft package support surface, and the bottom bracket is connected to the bottom bracket by rotating the center axis, so that it can fit the arm with the angle change and provide stable multi-angle support.

Conflict 3: The improvement parameter is maneuverability, the deterioration parameter is the volume of the stationary object, and the applicable invention principle is Principle 4 (Principle of Asymmetry). Design L-shaped corner structure desktop, the operation area extends to the side of the nail technician's seat, making full use of the inner space, and at the same time, it is easy for the nail technician to place and take the temporary tools to improve the working efficiency.

Conflict 4: Adopting the principle of categorizing the whole and the part, the invention principle is chosen as Principle 6 (Segmentation Principle). Separate design of the overall stabilizing function and massage function of the seat to ensure the efficient operation of each of them. Designed as an external stand-alone massage unit that can be placed, for example, on the user's lumbar or shoulder area, separate from the seat function. When the massage is needed, it is operated by an external device, and when it is not needed, the original functionality of the seat is maintained. The goal is that the massage function will be completely independent of the seat structure, not only to meet the massage needs, but also so that it will not affect the overall design and stability of the seat.

In summary, through the sorting and visualization analysis of the needs of the two types of users for the nail table and chair, high-priority needs were identified. Nail technicians required a backrest that could support both sitting and standing positions, convenient access to tools, and a flexible operating space. Customers, on the other hand, prioritized features such as flexible hand support and a time display. To address the contradictions between the needs of nail technicians and customers in the design, an optimization solution was proposed based on TRIZ invention principles. This solution improved the adjustment of the nail surface angle and expanded the operating space, while also enhancing the leg extension and personalized experience for customers. These improvements not only increased the efficiency of nail technicians but also enhanced the overall user experience for customers.

CONCLUSIONS

1. This paper has presented an innovative dual-category user product development and design methodology that combines the Kano model, the DEMATEL method, and TRIZ theory to provide a comprehensive and intuitive analytical framework for balancing the needs of nail technicians and customers. The methodology provides systematic theoretical support for addressing inconsistencies, potential contradictions, and design conflicts between the needs of the two user types in the design of nail tables and chairs.
2. The study showed that there was incomplete consistency between the needs of nail technicians and customers, with potential contradictions and conflicts arising during the design implementation. By analyzing dual-category user requirements in depth, the Kano model was used to classify and prioritize the requirements based on their attributes. The DEMATEL method was then applied to quantify and illustrate the mutual influence relationships between the requirements, providing a quantitative basis for their prioritization.
3. In combination with TRIZ theory, this paper analyzed the contradictions present in the design process of nail tables and chairs and proposed targeted solutions. Through a systematic analysis of these contradictions, TRIZ theory provided theoretical support for the design team, helping to overcome technical and functional conflicts,

thus promoting product innovation and optimization.

4. The feasibility and effectiveness of the Kano-DEMATEL-TRIZ integrated method in the design of nail tables and chairs were verified through practical case applications. The results demonstrated that the method effectively balanced the needs of dual-category users, optimized product design, and enhanced user satisfaction. The method is not only valuable for the design of nail tables and chairs but also provides useful references and practical guidance for other product designs involving dual-category users. Future research could further validate the applicability of the method in other fields and product categories, while also exploring more accurate strategies for demand acquisition and conflict resolution.

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