Research on User Needs Elicitation and Product Iteration Strategies for Home Postpartum Pelvic Floor Rehabilitation Devices Based on the Hybrid KANO-DEMATEL Model

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***Abstract*—Facing the universal trend of moving postpartum pelvic floor dysfunction (PFD) rehabilitation to home environment while "technology stacking" conflicts with user compliance, this paper offers an integrative hybrid demand framework from a joint perspective between users and technology — Kano Model & DEMATEL method integrated. In order to obtain at the 23 key design attributes, a multi-source existing data fusion. The Kano Model was used to categorize the non-linear aspects of requirements, and DEMATEL technique was employed for decomposing causal relations among these characteristics. Findings uncover an exclusive linkage mechanism: "physical safety= psychological compliance", proving that cognitive features and property attributes like the present solidity are thereby a source of causality leading investigations generate long-term individual commitment, whereas biofeedback visualization acts as breakpoint feature in alleviating user-centred cognitive stress syndromes. Results Through the analysis and evaluation of customer priority index (CPI), this study summarize a 3-stage iteraction product iteration strategy that including "trust-building phase", "visualization implementation phasel" adn emotional empowerment phase. Originality/value This study overturns the conventional linear relationship of user demand, thereby providing theoretical support and practical path for accurate transformation from “function-oriented” development to “experience-oriented” one in domestic household medical device enterprises.**

Keywords—Postpartum Pelvic Floor Rehabilitation; Household Medical Devices; Kano-DEMATEL Model; User Demand Mining; Product Iteration Strategy; Compliance

I. Introduction

A. Background: The Shift in Postpartum Rehabilitation Paradigms

Postpartum pelvic floor dysfunction (PFD) and stress urinary incontinence (SUI) have become significant public health issues worldwide. Epidemiological data show a high incidence of urinary incontinence among postpartum women. For example, studies have found that the incidence rates of urinary incontinence at 6 months and 12 months postpartum reach 27% and 23%, respectively, indicating a notable prevalence of pelvic floor dysfunction[1]. Pelvic floor injury is mainly associated with vaginal delivery, with mechanisms including damage to the pelvic floor muscles, destruction of fascial support structures, and obturator nerve injury; although cesarean section reduces the risk, it cannot completely prevent it[2]. Additionally, stress urinary incontinence—being the most common type of postpartum incontinence—is closely related to defects in the urethral sphincter and impaired urethral support. The rates of urinary incontinence increase significantly during pregnancy and the postpartum period, and are correlated with factors such as age, body mass index, and parity[3]. According to epidemiological reviews, approximately one in four women is affected by pelvic floor dysfunction, with the overall prevalence of urinary incontinence ranging from 15% to 17%. Pelvic floor dysfunction not only negatively impacts quality of life but also poses a heavy economic burden, which is expected to intensify as the population of women ages[4]. These data fully demonstrate that pelvic floor health is not only an individual medical issue but also a broad public health challenge, urgently requiring effective interventions to improve the pelvic floor health of postpartum women.

Over the last years, postpartum rehabilitation models have been slowly changed from traditional hospital or clinic based care to home self-care due to several reasons. First, the COVID-19 pandemic has resulted in resource constraints within healthcare systems consequently leading to advances in telemedicine and approaches for home-based rehabilitation aimed to offload demand on health services while maintaining patient safety[5][6]. Mothers may be home on the day of childcare and have an episodic schedule that would make it impossible to go weekly or even every other week. The flexibility provided by remote rehabilitation programs helps increase adherence [7]. It also uses technology to utilise telemedicine[8][9]for private patient protection purposes reducing embarrassment and privacy concerns where sensitive areas are treated. Use of remote monitoring and home based rehabilitation devices have advance the postpartum self-care model which allows mothers in the safe, effective way to restore training activities at home environment as well cope with escalating preference for recovery from their own homes[10][11].

Currently, there exists a contradiction between technology-driven and needs-driven approaches in the design of postnatal rehabilitation products on e-commerce platform. In conclusion, postpartum anxiety is a common complication

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in recently delivered women which exerts negative effects on their mental health and rehabilitation compliance [12][13]. Moreover, shame also has a strong influence in the behavior and mental coming of postpartum women given that it is an important negative emotional state [14][15]. Many existing technology-based rehabilitation devices ignore this issue and fail to effectively consider the psychological needs, which also lays a heavy burden on users emotionally [16]. Shame often stems from anxiety and other emotions, caused by the psychological burden of having a beautiful child but under-performing in physical appearance; this creates barriers to changing results with rehabilitation products through consistent usage.

B. *Research Gaps and Objectives*

Most existing literature on needs analysis for medical devices suffers from a number of theoretical and practical limitations. However, most studies use traditional linear analysis methods via standardized questionnaires and simple interviews that are based on an implicit assumption of a direct relation between the characteristics of products or services and user satisfaction — "the more features, the higher level of consumer satisfaction". Yet human needs are by nature not linear but complex. The straightforward example the Kano model provides is basic attributes (must-be requirements) which show their vital expectations of users. Note, that the appearance of these basic attributes is hardly adding anything to satisfaction, but their dis-appearance leads easily to dissatisfaction- an asymmetry which traditional linearity based models may not catch so easily [17]. Thus, linear analysis alone could be misleading in product improvement evaluations and fails to differentiate core care features from "excitement factors", which omits the compound and multistage needs of postpartum women for rehabilitation into design.

In order to fill this void in the methodology, this study offers an approach which integrates the Kano model and Decision Making Trial and Evaluation Laboratory (DEMATEL) method. The Kano model, which helps to understand the non-linear nature of user needs and classifies three types must-be, one-dimensional and attractive features; DEMATEL can clarify complex relationships between factors in system service models as well so that it is possible draw meaningful insights by finding core-driven or outcome related root elements. Combining both methods (F7 − 112 − 4) enables a more systematic understanding of the interdependencies as well as cause-effect relationships between user needs[18][19][20]. The hybrid framework elucidated here provides a robust theoretical and methodological underpinning for appraising user needs, refining the design of household postpartum transvaginal pelvic floor rehabilitation devices(Figure 1).

Therefore, this study has three main objectives:

- Identify the multi-level user needs of household postpartum pelvic floor rehabilitation devices, including physiological efficacy level to meet functional requirements; psychological comfort and ease-of-use levels.
- Develop an Impact Network Relation Map (INRM) as to uncover the causal logic which underlies the actions and results, differentiating definitional criteria from impact criteria
- Suggest evidence-based design strategies across different product life cycles that replaces the blind agglomeration of features with accurate innovation geared by real demand.

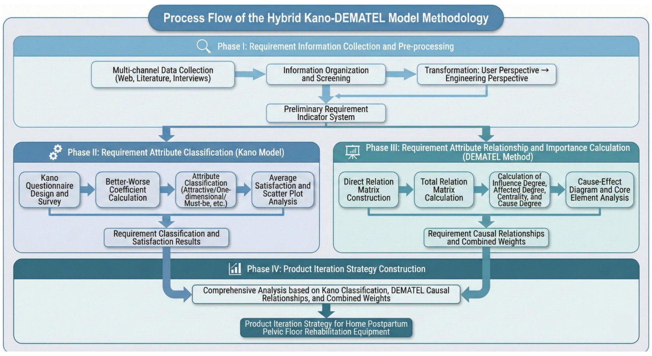

Fig. 1. Research workflow digram

II. METHODOLOGY

A. *Qualitative Phase: Extraction of Requirement Attributes*

This study adopted a dual-channel data analysis method of semi-structured interviews and text mining online in order to more fully capture the multidimensional needs of newly delivered women. Participants were women 6 weeks to 12 months postpartum, who had either been diagnosed with pelvic floor dysfunction (PFD) or participated in pelvic floor muscle training. We chose this particular time range to catch the most critical span in the recovery process when anxiety and physiological changes are typically at their worst.

Data collection occurred in two phases. Second, interviewed in-depth to find out the real psychological needs and usage scenarios deep behind (which won't be expressed freely openly). During the interviews, women mentioned two main themes: "physiological discomforts" and in particular—insertion of vaginal probe — due to which they experienced as foreign body sensation; feeling cold when contacted with a vagina proc. This feedback is not uncommon among the women using pelvic floor muscle training devices. These types of sensations are typically indicative of muscle tension and probe pain sensitivity that are analogous to the physical experiences reported by patients with pelvic floor dysfunction during training[21]. Furthermore, it has been pointed out that the user's anxiety of "not knowing whether the muscle contraction position is right" revealed current pelvic biofeedback devices have a limitation in providing an intuitive and effective biosignal. Secondly, this study validated the results of interviews by using Python-based text mining techniques to collect and analyze more than 2,000 genuine user reviews on major e-commerce or online sales platforms for best-selling rehabilitation devices in order to support interpretation beyond individual isolated contacts with customers. The original "Voice of Customer" (VOC) data was translated into a common standard for quantitative analysis at this stage. Industrial designers and gynecologists came together in a series of expert review meetings, translating the vague user statements into clear design specs which are more countable. A qualitative need of relief from "cold discomfort during insertion" was linked to the tech factor, 'temperature-controlled probe design', while a demand for an answer not to be that you have "boring exercise routines", concretely manifested in a 'gamified training interface'. In the end, this phase led us to identify 23 unique design facets that encompassed thousands of user needs across three dimensions: physical ergonomics medical effectiveness software interaction(Table 1).

TABLE I. LIST OF 23 DESIGN ATTRIBUTES

Dimensionalization	Number	Property Name	Attribute Definition and Source (Based on Qualitative Interview and VOC)
I. Physical Ergonomics (P) Focus on the comfort of hardware wear adaptability to family context	P1	Prober material biocompatibility	Among these is the use of hypoallergenic materials like medical-grade silicone gel to help mitigate that foreign body feel upon implantation.
	P2	Design of Temperature Probe	Configure constant temperature or warming function, alleviate the "cold stimulation" feeling, and have a human oriented design.
	P3	probe curvature	Ergonomic curves conforming to the anatomical structure of the female pelvic floor enhance fit.
	P4	Portable storage design	The compact dedicated storage box is designed for discreet home use.
	P5	Run in silent mode	Control motor vibration and noise to protect user privacy.
	P6	Convenience of fuselage cleaning	The product features high waterproofing performance and is easy to clean and disinfect.
	P7	Anti-slip and slip-resistant design	Optimize the structural center of gravity to prevent probe slippage during standing or slight movement.
	P8	Wireless charging method	The magnetic or base charging reduces the cable binding.
II. Medical Efficiency (M) Focus on the safety of therapeutic functions core validity	M9	output current stability	Ensure stable electrical stimulation output without sudden current fluctuations or tingling sensations.
	M10	overload power-off protection	Automatically cut off power when abnormal current or connection interruption is detected.
	M11	real-time error correction	It can identify incorrect muscle activation patterns such as abdominal muscle compensation and provide timely corrective feedback.
	M12	Adjustable shrinkage strength	Multiple intensity levels are provided to accommodate muscle strength tolerance at different rehabilitation stages.
	M13	Assessment of pelvic floor muscle strength	Equipped with a muscle strength testing module, it can quantitatively classify the current muscle strength level.
	M14	Multiple treatment modalities	Various waveforms including pre-set analgesia, repair and exercise were available for selection.
	M15	Bluetooth connection stability	Ensure real-time and loss-free data transmission between the device and the mobile terminal.
	M16	Emergency brake button	The one-button emergency stop feature with physical or software interface ensures controllability.
III. Software Interaction (S) Psychological experience of adherence and compliance Service Support	S17	visualized biofeedback	The mobile APP displays real-time electromyographic waveforms, making the rehabilitation effects visible.
	S18	Gamified Training Interface	Transform the boring Kegel exercises into fun interactions to control the game characters.
	S19	Community Check-in	Provide a community platform for users and a check-in incentive system.
	S20	Training data history	Automatically generate interim rehabilitation reports to document the trend of muscle strength changes.
	S21	telemedicine guidance	Supports data upload, enabling professional physicians to conduct remote monitoring and provide recommendations.
	S22	Personalized plan recommendations	Intelligent recommendation based on evaluation data for the users current training plan.
	S23	Voice/video sync guidance	Provide live demonstrations or voice companionship to lower the learning threshold and ease loneliness.

B. Kano Model Implementation

In order to systematically categorize the nonlinear impact of design attributes on user satisfaction, this study constructed a structured Kano questionnaire. For the 23 attributes extracted during the qualitative phase, a set of bipolar questions was designed for each attribute: a positive question (i.e., how users feel if the device has that feature) and a negative question (i.e., how users feel if the device lacks that feature). For example, regarding the "gamified training" attribute, the positive question was: "How would you feel if rehabilitation exercises were presented in a game format?" The negative question was: "How would you feel if the exercises were purely mechanical with no game elements?" Responses were measured using a standard five-point Likert scale: "I like it," "It must be this way," "I am indifferent," "I can tolerate it," and "I dislike it."

A cross-analysis table based on answers to both forward and reverse questions classifies each attribute into one of the following categories: Must-be attributes (M), which are basic requirements that lead to dissatisfaction if missing; One-dimensional attributes (O), whose degree of completeness is linearly proportional to user satisfaction; Attractive attributes (A), which refer to unexpected features that delight users; Indifferent attributes (I), which have minimal impact; and Reverse attributes (R), which are features the user does not want[22].

This study uses the Better-Worse coefficient analysis method to not only categorize qualitative but also quantify users' sensitivity of satisfaction with each attribute. Here are the formulas to calculate satisfaction coefficient (Better) and dissatisfaction coefficient (Worse):

$$Better=\frac{A+O}{A+O+M+I} \quad (1)$$

$$Worse=-\frac{O+M}{A+O+M+I} \quad (2)$$

In them, A, O, M and I shown the response frequencies for Attractive attribute (A), One-dimensional attributes (O); Must-be attributes(M) ;and Indifferent Attributes.

Better — has a value range from 0 to 1, with higher values corresponding to more influential ways in which this attribute contributes/afects increased user satisfaction (one might say: beauty-full needs). Contrariwise, the value range for the Worse coefficient is -1 to 0; being its nearest border as possible negative represents how much dissatisfaction of absence this attribute causes which distinguishes and underpins that requirement within a most fundamental baseline (usually it is related with must-have requirements).

C. Integration with DEMATEL

Whereas the Kano model organizes characteristics based on user contentment, it falls short by assuming that every characteristic is being individually operated. This research combines these attributes through the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to decipher complex causal interrelations. An expert panel of three senior obstetricians and gynecologists, three certified pelvic floor rehabilitation therapists, and four industrial designers was established in order to assess the relationships between attributes.The specific mathematical implementation steps are as follows:

Step 1: Build the direct influence matrix **H**.

Experts used integers from 0 (no impact) to 4 (very high impact) to score and evaluate the direct impact of attribute **i** on attribute **j** . The average of the experts' scores constituted the initial direct impact matrix $H=[h_{ij}]_{n\times n}$

Step 2: Normalize the direct impact matrix **X**.
To ensure the convergence of subsequent matrix operations, use the following formula to normalize matrix **H** to obtain matrix **X**:

$$X=\frac{H}{\max\limits_{1\le i\le n}\sum_{j=1}^{n}h_{ij}} \quad (3)$$

Step 3: Derive the total influence matrix **T**.

This is a key step in the DEMATEL method, as it captures both the direct and indirect effects within the system. By using the identity matrix **I**, the total influence matrix **T** is calculated through the summation of the infinite series of direct effects:

$$T=X(I-X)^{-1} \quad (4)$$

Based on matrix **T**, calculate the row sums D_i and column sums R_j respectively. The value D_i+R_i represents centrality, indicating the overall importance of that attribute within the system; while the value D_i-R_i represents causality, used to determine whether the attribute is a net cause (positive value) or a net effect (negative value).

Step 4: Construct a Comprehensive Priority Index.

A unique contribution of this research is the design and implementation, concurrently with Ecole de Technologie Superieure (ETS) Montreal, a two layered prioritization system. For Kano classification can only determine features that are "attractive" but technologically isolated or prohibitively expensive without user knowledge if used in isolation, while DEMATEL may overemphasize merely technology-driven factors users cannot perceive.Therefore, we propose the Comprehensive Priority Index (CPI) to integrate these dimensions:

$$CPI_i=W_{Kano,i}\times(D_i+R_i) \quad (5)$$

Among them, $W_{Kano,i}$ represents the satisfaction weight derived from the Better-Worse coefficient, while (D_i+R_i) represents the centrality of the system. This algorithm avoids developing in the blind making sure that a feature with higher priority is not only highly desirable by users but also playing an important role within the logic of functions ecosystem where a it belongs.

III. RESULTS

A. Classification Results of Rehabilitation Needs

Kano table survey-based and standardized design attribute data processing, this study diagnosed 23 home-used postpartum pelvic floor rehabilitation devices via the category fuzzy analytical method. We learned the classification matrix and scatter plot of user requirement attributes by counting responsiveness frequency in terms of Must-be (M), One-dimensional, Attractive (A), Indifferent (I) and Reverse order attribute quality flagged qualities based on better-worse velocity analysis.

1) Overview of Attribute Categories

The statistical results of the above data indicate that postpartum women's demand for rehabilitation equipment has obvious nonlinear characteristics. Of the 23 attributes, around a third (30.4%) are must haves relating to safety and basic physical comfort or one dimensioners on performance of core functions accounting for just over half in total whilst the others cover psychological activities and interactive experiences up to now PKK number is what this into four categories with no variance out side these mini groups The distribution demonstrates how traditional linear models fail to capture the complex psychology of users in stacking individual functions, and thus unable to significantly adapt postpartum women with specific rehabilitation requirements(Table 2).

TABLE II. OVERVIEW OF 23 DESIGN ATTRIBUTE CATEGORIES

Attribute number	Property name	Kano attribute classification	Better (satisfaction coefficient)	Worse (dissatisfaction coefficient)	Attribute Interpretation
P1	Prober material biocompatibility	M（essential）	0.28	-0.89	If the material is substandard, it should be rejected outright; if it meets the standards, it is justified.
P2	Design of Temperature Probe	O（1 yuan）	0.65	-0.62	Temperature makes us feel more comfortable, while the absence of it brings coldness—a linear relationship.
P3	probe curvature	O（1 yuan）	0.58	-0.55	The core index affecting the comfort of wearing.
P4	Portable storage design	A（glamour）	0.72	-0.25	Unexpected privacy considerations enhance goodwill.
P5	Run in silent mode	M（essential）	0.30	-0.82	Noise is a major privacy issue that must be addressed.
P6	Convenience of fuselage cleaning	M（essential）	0.35	-0.78	Health is the fundamental baseline of medical devices.
P7	Anti-slip and non-slip design	I（zero difference）	0.25	-0.30	Users may not notice it by default, as it is less noticeable.
P8	Wireless charging method	A（glamour）	0.60	-0.20	Compared with wired, wireless adds convenience and surprises.
M9	output current stability	M（essential）	0.15	-0.95	The safety baseline must be absolutely stable.
M10	overload power-off protection	M（essential）	0.10	-0.92	The hidden security function, low perception but great impact.
M11	real-time error correction	O（1 yuan）	0.75	-0.70	Core medical pain points directly determine treatment confidence.

2) Must-be Needs: The Baseline of Security and Trust

Better-Worse coefficient analysis shows that several key attributes exhibit extremely high absolute values of dissatisfaction coefficients (that is, Worse coefficients close to -1), clearly indicating must-have requirements. Among them, "current output stability" and "probe material skin-friendliness" are typical examples.

Data analysis indicates that the better coefficient for this type of attribute is extremely low, meaning the device performs perfectly in this aspect (for example, severe current stability), and users' satisfaction does not significantly increase because this is considered the "factory default setting" expected of medical devices. However, once these functions perform poorly (such as causing a tingling sensation or triggering allergic reactions due to materials), user satisfaction drops off a cliff. In the interviews, this pragmatic influence of comfort was reflected in user concerns about "foreign body sensation" and a desire for "safety," which corresponds well with these results. This is product's "safe fortress" with its irreplaceable status in all home medical scenes, that if anything goes wrong and chipped away of it will generate a serious sense of insecurity for users therefore leading them to abandon the mug.

3) One-Dimensional Demand: Similar to visually linear drive

Typical single-dimensional characteristics: "Correct wrong moves in real time" or "Gradually increased contraction intensity". The Good and Bad coefficients for those attributes are also quite large (in fact they almost same), which tells us that functionality has a strong linear positive attitude to satisfaction. Specifically, "real-time errors correction" itself responds to the fundamental problem of serious anxiety from a continuous discussion on comments received such as " Is it wrong? Are you pushing incorrectly"; which is thought in an earlier study by Rubio that too identified; refuting with users' significant feedback. With the algorithm, he knew when users were compensating with their abdominal muscles or poorly exerting, and if that was a problem it could prompt correcting in real time confidence through rehabilitation skyrockets.Conversely, if the device lacks this intelligent error-correcting mechanism, users may fall into the fear of "blind training," worry about counterproductive effects, and thus experience strong dissatisfaction.

This result confirms that in the core stages of treatment, users not only need devices to be "active," but also require the devices to ensure the "correctness" and "progressiveness" of rehabilitation training through precise feedback control. This forms the core competitive advantage of the product in terms of functionality—that is, "the better it performs, the more satisfied the users are; the worse it performs, the more dissatisfied the users become."

4) Attractive Needs (Appealing): The Psychological Engine of Compliance

The most inspiring findings in the study regarding the identification of attractive attributes mainly include "gamified training interface" and "community check-in feature ".

The Worse coefficient of the class attribute is close to zero, indicating that the device lacks gamification features and users do not feel dissatisfied because this is beyond their expectations for traditional medical devices. However, its

Better factor is significant, suggesting that once engaging game interactions are introduced (such as controlling a game character through pelvic floor muscle contractions), users' feelings of pleasure and surprise will be greatly enhanced. In the context of prolonged postpartum rehabilitation cycles that are tedious and prone to causing anxiety, emotional needs, though not directly treating diseases through physical means, serve as the "engine" for maintaining users' long-term willingness to use (compliance). They are the key breakthrough for addressing postpartum depressive emotions and achieving differentiated product experiences[23][24].

5) Better-Worse Sensitivity Analysis

We have also created a Better-Worse scatter plotting to give the significance score for each attribute. Results indicate that quality of the experience can meaningfully contribute to satisfaction (high Better value) but, ultimately other more fundamental attributes define what it takes for a product or service to cross over into meaningful adoption (large absolute Worse).This provides a quantitative basis for exploring causal relationships between attributes using the DEMATEL method in the next stage: we need to further clarify whether the entertainment need of "gamification" can only truly enhance compliance if the essential requirement of "physical comfort" has been met(Figure 2).

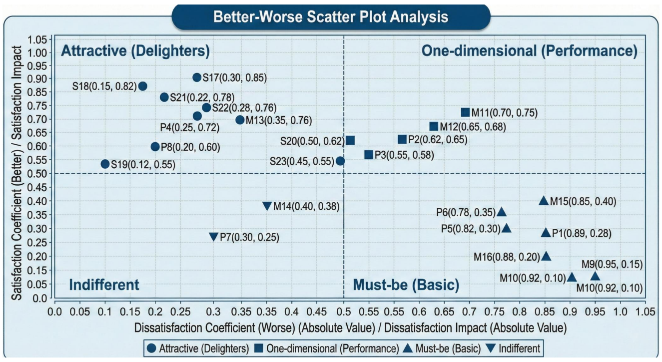

Fig. 2. Analysis of Better-Worse Scatter Plot

B. Causal Relationship Network of Requirements

After clarifying the attributes of user requirements through the Kano model, this study further employs the DEMATEL method to construct an Influence Relationship Network Map (INRM) in order to reveal the core causal association mechanisms among the various attributes. By calculating centrality (D+R) and cause degree (D-R), we categorized the 23 attributes into "cause group" and "result group."

1) Influential Network Relation Map (INRM) Analysis

Figure 3 shows the distribution of key design attributes in the buffer coordinate system. The X-axis represents centrality, indicating the importance of the attribute within the system; the Y-axis represents causality, where positive values mean the attribute is a "cause" driving other factors, and negative values mean the attribute is an "effect" influenced by other factors.

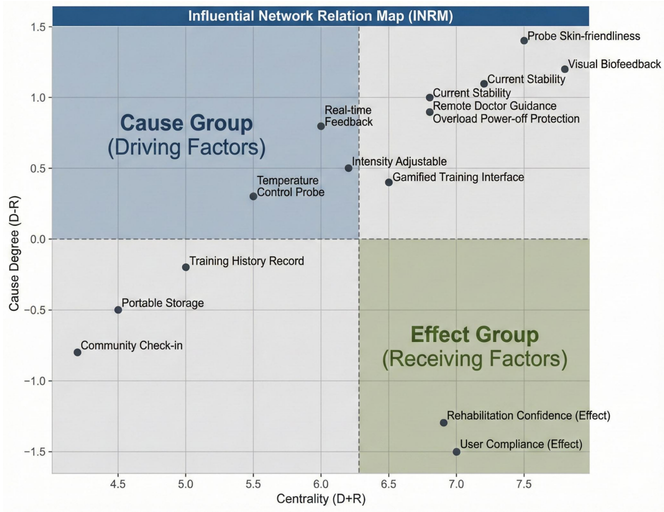

Fig. 3. Demand Impact Network Relationship Map (INRM)

2) Driving Factor Analysis: The Foundational Role of Technology and Engineering

As shown in Table 3, "biofeedback technology" and "sensor skin-friendliness" exhibit exceptionally high positive causality values (reaching 1.2 and 1.5 respectively), appearing in the upper region of the INRM map. This indicates that they are the driving forces behind the entire rehabilitation experience system.

TABLE III. DEMATEL CAUSAL PARAMETER KEY ATTRIBUTE ANALYSIS (PARTIAL DATA)

Property name (property)	Centrality (D+R)	Degree of Cause (D−R)	Properties are clear
Raw Material: Skin-Friendly	7.50	1.50	Core reason
visualized biofeedback	7.80	1.20	Core reason
output current stability	7.20	1.10	Core reason
telemedicine guidance	6.80	1.00	latent drive
Gamified Training Interface	6.50	0.40	auxiliary drive
Community Check-in	4.20	-0.80	result factor
User compliance	7.00	-1.50	Core Results

In general, the accuracy of biofeedback technology is the cornerstone for building user trust. Causal networks indicate that only after addressing the two prerequisites of "skin-friendliness" and "feedback accuracy" can other auxiliary functions be effective.

3) Analysis of Result Factors and Cognitive Bias

Significantly negative causality scores for "user compliance" and "rehabilitation confidence" (-1.50 and -1.30) are regarded as result clusters. This means that enterprises cannot directly design for "compliance"; rather, it is a systemic outcome jointly produced by comfortable visual appeal, precise feedback, and engaging interactive interfaces.

Indeed, although "remote doctor guidance" is classified as an indifferent attribute (I) in the Kano model, it demonstrates a high causality score of 1.0 in DEMATEL. This reveals a cognitive bias between user perception and system logic: while user cues hint at medical intervention, in the monitoring logic it actually serves as a crucial implicit driving factor for ensuring the correctness of training.

C. *Comprehensive Priority Ranking*

To avoid the limitations of a single method, this study refers to the Comprehensive Performance Index (CPI) formula and combines Kano's satisfaction weights with the system centrality of DEMATEL to produce a final ranking of all attributes.

1) Top 10 List of Key Requirements

Table 4 lists the top 10 key requirements identified through algorithmic screening. These attributes form the design core of the next-generation pelvic floor muscle rehabilitation device.

TABLE IV. DEMATEL CAUSAL PARAMETER KEY ATTRIBUTE ANALYSIS (PARTIAL DATA)

Ranking	Design Properties	Kano classification	system center linear measure (D+R)	Policy recommendations
1	visualized biofeedback	O （1 yuan）	7.8	core differentiation function
2	Raw Material: Skin-Friendly	M （essential）	7.5	access to infrastructure
3	output current stability	M （essential）	7.2	Safety baseline
4	Gamified Training Interface	A （glamour）	6.5	Key to improving compliance
5	overload power-off protection	M （essential）	6.8	Risk Management
6	Adjustable shrinkage strength	O （1 yuan）	6.2	Personalized Experience
7	Design of Temperature Probe	O （1 yuan）	5.5	Enhanced comfort
8	Training data history	O （1 yuan）	5.0	long term incentive
9	Portable storage design	A （glamour）	4.5	scene
10	real-time error correction	O （1 yuan）	6.0	Custom Upgrade

2) Validation of Sorting Logic

"Visual Biofeedback" ranks at the top of the sequence because it excels in two dimensions: In the Kano model, it belongs to the "attractive quality" (O), which can linearly enhance the coefficient; in the DEMATEL model, it has the highest centrality (7.8) among all factors, directly linking "alleviation of user anxiety" and "building confidence in rehabilitation." This confirms that this feature is the key factor addressing the core pain point of "not knowing whether the exercise is performed correctly."

Following closely are the must-have attributes related to safety and comfort (such as material and current stability). While these may not bring surprises, they trigger high priority due to their extremely high system centrality. "Gamified Training," as the highest-ranked attractive attribute, takes the fourth position, demonstrating that after basic issues are addressed, enhancing adherence through fun and engaging design is the top path for product differentiation. This sorting result provides solid mathematical and logical support for formulating the phased product iteration strategy in Chapter 4[25].

IV. DISCUSSION

A. *The Coupling Mechanism of "Sense of Security – Compliance" ("Security – Compliance" Coupling Mechanism)*

The reversed findings of this study reveal a unique "sense of security–compliance" association mechanism in the design of postpartum pelvic floor rehabilitation devices, breaking the simple logic that "the stronger the function, the longer the use." This study demonstrates that physical comfort is the fundamental correlational indicator of psychological compliance[26][27][28].

1) Causal Influence of Physical Attributes on Psychological Behavior

As shown in Figure 4, we compared the DEMATEL causal degrees of key attributes. The data show that "probe skin-friendliness" and "current stability," as representatives of the physical safety aspect, have the highest positive causal degrees (reaching 1.5 and 1.1, respectively), making them the absolute "drivers" in the system.

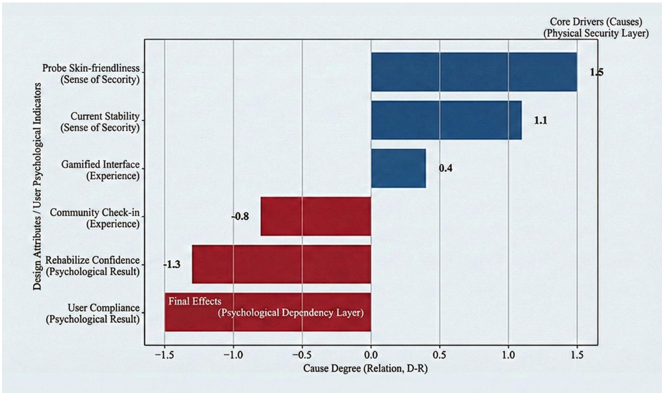

Fig. 4. Comparative Analysis of Causality Degree between Physical Security Attributes and Psychological Compliance Results

Conversely, "rehabilitation confidence" and user compliance" are the lowest in the chart with much negative values (-1.5 and -1.3). The large "stake" that exists in this potential difference demonstrates the nonnatural aspect of compliance as a state rather than one which can be described adequately by such concepts.

Thus, with invasive medical devices the actual first point of contact is a barrier to trust for users. Because if inserting the probe makes you feel like they are putting something foreign into your body, or it gives a cold sensation, or sends an electric tingle down to trigger our instant psychological defenses and here is where we lose face in this "reactive outcome" of being defensive. It becomes an immediate contradiction to any sense of physical security, and it instantly destroys the potentially positive mental pathway that leads a user down their road towards gamified experiences or community interaction. As Figure 4 demonstrates, the gamified interface" offers little to no drive (0.4) compared to securing a fundamental need — in this case, safety.

Although this study confirms that "physical safety" is the logical starting point for compliance, in the context of home-based autonomous training, the concept of safety must expand from the more severe aspects of "passive device safety" (such as leakage protection M10 and non-toxic materials P1) to include "biomechanical activation." Due to the absence of a clinician's hands-on palpation, users are highly susceptible to abnormal increases in pelvic floor pressure caused by incorrect exertion patterns (such as the Valsalva maneuver or abdominal muscle compensation), which can lead to serious secondary injury risks. Specifically, one cannot rely solely on a single surface electromyography (sEMG) signal, but should instead combine vertical internal pressure sensors with abdominal tension monitoring:

- The real-time gradient between vaginal pressure and intra-abdominal pressure allows the algorithm to accurately detect "false contractions" — cases where the user is exerting force, but it is a sequential pushing rather than an upward lifting force.
- Intelligent cut-off mechanism: If a negative biomechanical pattern is detected (such as a sudden increase in abdominal pressure without activation of the pelvic floor muscles), the device should immediately trigger a "training cut-off" mechanism similar to an "overload power-off protection (M10)," forcibly pausing the session and issuing an alert.

This "error-prevention mechanism" based on sensor fusion technology essentially turns clinical experts' "damage control experience" into an algorithm. It not only addresses the user's deep-seated fear of "practicing incorrectly," but also elevates the "real-time error correction (M11)" — an expected feature in this study — into a cornerstone for building core trust, further strengthening the causal chain of "physical safety—dependence."

2) Medical-Grade Trust and Consumer-Grade Experience

We compared the results of this study with others existing once and realized that, it was very different from research on fitness trackers or exercise equipment. With regular wearables like a Fitbit or Apple Watch, the studies show that users are okay with monitoring for data accuracy and social reasons more so than constant wearing.

However, when it comes to postpartum pelvic floor rehabilitation, the words "privacy" and "intrusiveness"° incredibly increase user comfort. Sirgut wants wearers to experience as minimal discomfort from the wearable, but since the rehabilitation process involves such high profile body parts, users have very little tolerance for pain due to the device. One of these biggest reasons for treasuring Remote Doctor Guidance identified through this analysis: Users look beyond just a piece of electronics; they want an expert companion with a "sense-level trust, like you would in medical-grade"Therefore, "a sense of security" carries much more weight in the causal network than in ordinary consumer electronics, and is a core link tied to users' desire and ongoing engagement [29][30][31][32].

In summary, the key to improving compliance is not to "persuade" users to persist, but rather to eliminate their subconscious physiological fears through maximally comfortable physical design (such as silicone materials and constant temperature control), thereby naturally encouraging continuous use.

B. Establish a dual closed-loop supervision mechanism between families and clinics

Although the home environment offers great flexibility for postpartum rehabilitation, the effective attrition and potential risk of injury resulting from "the absence of clinical supervision" remain central concerns for both doctors and patients. Based on the high-causality attributes identified in this study — "real-time error correction (M11)" and "remote physician guidance (S21)" — we believe that, in order to bridge this gap in trust through hardware development, it is essential to establish a dual-supervision mechanism with seamless integration between client and cloud. This will ensure medical-grade standards are maintained even outside of clinical settings:

- Primary Supervision: A "real-time error correction feedback loop" based on edge computing (Local Feedback Loop). Addressing the challenge that doctors cannot be present in home settings, the device itself must serve as the "first responder." By leveraging the highly valued "visual biofeedback (S17)" and "real-time error correction (M11)" functions identified in this study, the device should be equipped with high-precision EMG assessment algorithms. These algorithms can internally detect dozens of erroneous muscular activation patterns (such as abdominal muscle compensation or even incorrect Valsalva maneuvers). This immediate, automated intervention mechanism replaces the ideal therapist guidance in a clinical setting, ensuring that every home training session delivers its core effectiveness.
- secondary supervision: Based on supervised "asynchronous professional intervention" via the cloud. The DEMATEL analysis in this study shows that while "remote physician guidance" is recognized by users as a highly relevant and critical factor (Kano attribute: I), it is also a strong driving factor in the system (causality degree 1.0), indicating the existence of an implicit "fallback need." Therefore, product design should include a cloud-based data interface that regularly synchronizes household training data (such as muscle strength curves, explosive force trends, etc.) to clinical physicians. Doctors are available online in real time, but can intervene via an alert mechanism triggered by abnormal data trends. This mechanism preserves the privacy and convenience of home rehabilitation while maintaining an "invisible" level of professional medical oversight, thereby addressing users' intense anxiety over "blind training."

- Conclusion: Only when "edge-side intelligent algorithms" and "cloud-based medical expertise" work together can home devices truly make the leap from "consumer-grade electronic toys" to "medical-grade rehabilitation terminals," achieving a fundamental shift from a "function-centered" approach to a "treatment-centered" one.

C. *Strategic Roadmap for Product Iteration*

Based on the ranking results of the Composite Priority Index (CPI) and causal network analysis, this study proposes a phased product iteration strategy. This strategy is to help the enterprise under resource constraints on "trust–fulfillment–emotion" logical order, rather than simply increase the number of functions. Figure 5 clearly plots the course of this strategic journey.

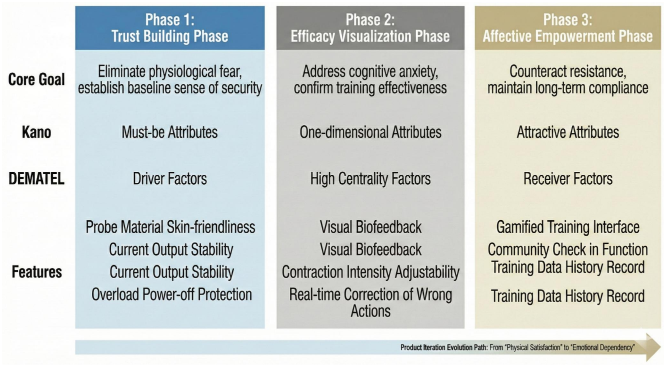

Fig. 5. Three-level Reconstruction Evolution Roadmap of Household Pelvic Floor Rehabilitation Equipment Based on Kano-DEMATEL

First Phase: Trust-Building Period

- Strategic Positioning: The product is the information of this phase. User experience should begin with DEMATEL data verification and the most causal factors of Must-be attributes.
- Core Task: We want to remove contributing physiological fears and psychosomatic anxiety that surrounds these invasive devices.
- Implementation Path: Focus the R&D resources on that foundational building block at the hardware level. For example, using medical-grade liquid silicone rubber (LSR) technology to make sure the choice of material is safe for use on skin; Developing a "soft start" algorithm that ensures constant current output. Which at this point makes any complex software features secondary, because a physical shortcoming will cause user attrition straight up.

Second Stage: Effect Visualization Phase

- Strategic Positioning: This is the product "growth stage". With physical trust in place, user attention turns towards cognitive anxiety alleviation.
- Core Task: Utilize technological solutions to transform invisible perceptual activities into tangible feedback, thereby validating the effectiveness of training.
- Implementation Path: Introduce highly centralized, single-dimensional attributes. The main purpose of the app was to create a visual biofeedback system with zero latency showing EMG waveforms on the mobile device in real time, enabling users to 'see' their effort. Simultaneously, provide users at different rehabilitation stages with customizable levels of contraction intensity to enable a linearly amplified feedback.

Third Stage: Emotional Empowerment Period

- Strategic Positioning: This is a wonderful moat for your product. Then the competition is in psychological and emotional terms when features become basic functions, disease management.
- Core Task: Use attractive properties to overcome monotomy during mid-late rehabilitation and ensure long-term user reliance.
- Implementation Path: Emotionalized functions are, in the end, drivers of outcomes. Take bland Kegel exercises to the interactive level & gamify it (i.e., playing game character using contraction), build a peer motivation feature, Check-in community. By now, users are no longer pushing through their persistence just with willpower but actually enjoying the game and socializing.

D. *Operationalizing the Iteration Strategy: Validation Framework and Metrics*

First-phase validation: Security prototype testing focused on "trust building." In the early stages of product development (EVT/DVT phase), the emphasis is not on the richness of features, but on stress-testing the "essential attributes."

- Implementation method: Blind test.
- Key indicators: Focus on "adverse reaction trigger rate" and "inconsistency in current monitoring score (VAS Pain Scale)."
- Passing criteria: Only when the "rejection rate due to physical impossibility" drops to 0%, and the coefficient of variation (CV) of current output

Second-phase validation: For the A/B test targeting "effect visualization," it is necessary to verify whether it truly reduces cognitive anxiety.

- Implementation method: Group A uses the traditional interface with a numerical countdown, while Group B uses the "visualized interface (S17+M11)" which includes real-time EMG waveforms and error correction prompts.
- Key metric: General self-efficacy
- Hypothesis validation: Verify whether visual feedback significantly enhances users ' sense of control over the restart process, thereby confirming the linear gain effect of the "unidimensional attribute."

Third-phase validation: Longitudinal Survival Analysis Focused on "Compliance."To determine whether gamification and community features (motivational attributes) can sustain long-term dependence on the laboratory, it is necessary to go beyond short-term settings.

- Implementation Method: Conduct a 3-6 month at-home clinical observational study (RCT).

- Key Metrics: Use the Kaplan-Meier survival analysis method to measure users' "active retention rate," and record the "average weekly frequency."
- Core Objective: Only when the introduction of emotional empowerment features leads to a noticeably flatter user decline curve compared to the mask phase, can the strategy's effectiveness in overcoming the long-term monotony of recovery be demonstrated, thereby completing the commercial cycle.

E. Management Insights for Health Technology Enterprises

The insights from this study are not only theoretical—they can also provide direct guidance for the strategic decision-making of home medical device enterprises. Based on the analysis results of the Kano-DEMATEL model, we have summarized highly critical management insights aimed at correcting the widespread issue of resource misallocation in the current industry. Figure 6 provides a comparative illustration between traditional resource misallocation patterns and the data-driven human resource strategies advocated in this study

Insight One: Reversing Resource Allocation Priorities:

As shown in the left side of Figure 6, many companies influenced by internet thinking tend to adopt an "inverted pyramid" model for resource allocation. They pour a large amount of resources into developing specific "emotional/community layers" in the first generation of products (such as complex social features and point systems), attempting to quickly launch the product through conceptual hype while neglecting the foundational "physical/safety layers."

However, DEMATEL analysis in this study clearly indicates that social features such as "community check-ins" are typical outcome factors (effect, DR < 0), whose occurrence depends on the fulfillment of prerequisite conditions. If the underlying factors like perceived comfort or current stability (high cause degree factors) are not properly addressed, users cannot even establish basic trust. No matter how sophisticated the neighbor community functions are, they are just castles in the air and cannot translate into actual compliance.

Management Recommendation: Companies should adopt the "upright pyramid" strategy as shown in the right side of Figure 6. Managers are discouraged from chasing after those sexy features in the initial stages of this here product and instead challenged to implement strategic discipline that they can rigorously measure. Research and development should be funded with the primary motivation of addressing base layers: perception, materials engineering, safety algorithms. Obligations, feedback and community interactions at higher levels can only follow after the hardware experience becomes sufficiently polished and trust is sown.

Insight Two: The "Veto Power" of Compliance Baselines over Innovation:

Kano Model analysis shows that must-be attributes, such as overload protection and material safety, cannot further increase user satisfaction but have 'one-vote veto power'. This veto power describes the transmission mechanism of failure arises from safety attributes (eg., an accidental electric shock) can propagate a high-causality chain, ultimately destroying all psychological defenses for the users and driving compliance metric to zero instantaneously in DEMATEL. The above literature not only reported the problems related to medical device compliance, but also illustrated that enterprises should consolidate invulnerable compliance fire wall for medicial devices while they making an effort on a beautiful innovation in AI algorithm and cloud based big data analysis [33][34]. When viewed systemically, any danger to that (such as reducing the already present stability requirements for more surfacey features i.e. faster BT connections) is one of those catastrophically short-sighted moves Compliance and safety have to be the bedrock of innovation.

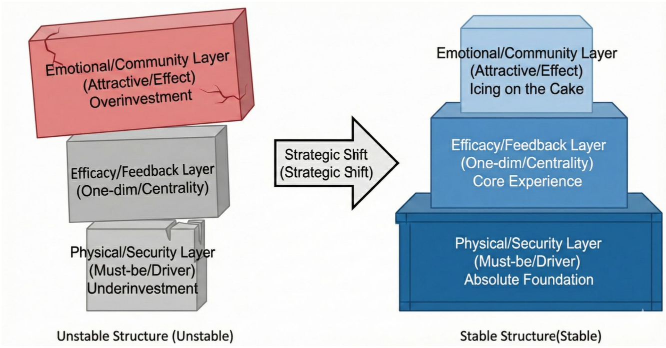

Fig. 6. Comparative Analysis of Resource Allocation Strategies: From the Misconception of "Heavy Head and Light Feet" to the Strategy of "Cornerstone Support"

V. Conclusion

A. Theoretical and Practical Contributions

Proper DEMATEL method and Kano model parameters were determined to construct the same in this study for deconstruction of user needs complexities surrounding a home-use PPRF device, signifying an initial move towards theoretical understanding from practical point of view. This is shown narratively in Figure 7, which clearly qualitatively represents the essence of these two levels and their complex interrelations.

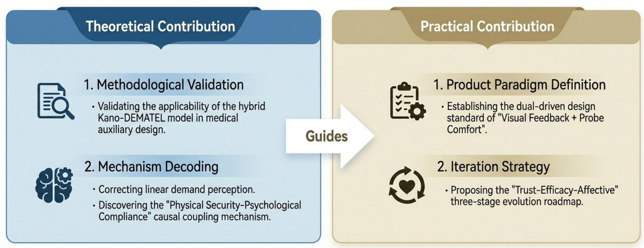

Fig. 7. An Overview of Theoretical Contribution and Practical Value

1) Theoretical Summary: Deconstructing Nonlinear Demands and the Success of Causal Mechanisms

Theoretical Significance: On the theoretical aspect, we have corroborated that Kano-DEMATEL hybrid model is applicable to medical assistive device design and can prevent shortcomings in traditional single linear models (such as the Likert scale).

- Linear Cognition: In other words, the data shows that postpartum rehab needs do not just increase at a standard linear rate. Penetrating attributes (such as skin parity) have an ambiguous 'negative pull', the lack of which can cause a large reduction in UX, something that is rarely mentioned in conventional studies.

- Revealing Coupling Mechanisms: This study is the first to reveal and certify that physical safety leads people to psychological compliance. We completed the DEMATEL causal map and revealed physical level comfort as a key leading indicator of psychological compliance. From a systems theory point of view, this result appears to explain why software-driven incentives (i.e., check-in points) will never solve the compliance issue which has been plaguing the industry for far too long.

2) Practical Value: Dual-Drive Standards and Iterative Model

At a more practical level, this study translates the abstract nature of pertinent theoretical knowledge into concrete terms such as product definitions and strategic guidance.:

- Defining Product Standards: The research clearly identifies this next-gen pelvic floor muscle rehab device must be "dual-drive", to overcome both symptom anxiety with a form of biofeedback and basic physiological balance, via microphone in comfort. This standard will set a clear bar for the industy and prevent blind reserves in function.

- Guiding Iterative Strategy: Iterative Strategy Using Three Stages Based on the Comprehensive Priority Index (CPI): From Trust Building, Through Achieving Feasibility, to Emotional Empowerment It allows companies to prioritize where the real heavy lifting is required when it comes research and development in resource-constricted environment so that customer centric value can be maximized.

B. Current Situation and Future Prospects

Although this study provides systematic insights and has identified monitoring criteria, there are still the following limitations, which also indicate directions for future research:

1) Current Situation

Firstly, there are limitations regarding the geographical distribution of the sample. The participants in this study are mainly concentrated in specific first-tier cities. Considering the influence of regional culture and economic level on postpartum rehabilitation concepts, privacy awareness, and willingness to pay, the generalizability of the research conclusions still needs to be validated with a wider geographical distribution. Secondly, the data sources mainly rely on user reviews. Although cross-validation was performed through text mining, there may still be bias present in retrospective self-reports.

2) Future Prospects

Based on the above, future research can proceed along the following two dimensions:

- Introduction of measurement indicators: It is recommended to incorporate physiological signal data (such as changes in electromyography, pelvic floor muscle strength measurement values) and conduct correlation analysis with survey questionnaires, in order to construct a more precise "subjective-objective placement–psychological experience" mapping model.

- Exploration of immersive experiences: By integrating virtual reality (VR) or augmented reality (AR) technologies, explore immersive home rehabilitation experiences. For example, study the specific effects of VR visual feedback on pain perception during DO pelvic floor muscle training or on extending training duration, thereby seeking new technological breakthroughs for product innovation in the "emotional empowerment" stage.

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