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An Inclusive Study of Postpartum Emotional Guidance Mobile Application Based on IPA Analysis Method

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Abstract. Postpartum mental health is a common concern in modern society, but many women struggle to access adequate support. This study aims to propose an inclusive design framework for a mobile application for postpartum emotional support. The user's needs and expectations were extracted from the app reviews using the Non-negative Matrix Factorization (NMF, Non-negative Matrix Factorization) technique, which is widely used in the field of data mining and pattern recognition, and were combined with a tool for evaluating and optimizing the characteristics of a product or service: the Importance-Performance Analysis (IPA, Importance-Performance Analysis) model to explore the association between perceptions and expectations of postpartum women. As a result of the analysis, six key quality elements were identified and four areas of design and development were suggested. The core innovation of this study is the introduction of an IPA analysis method based on the NMF algorithm, which enhances the design and development of the application to ensure that a wider range of user needs are met. This not only facilitates the inclusive design of mobile applications, but also enhances the decision-making ability of new mothers in online mental health services.

Keywords. Postpartum mental health, NMF model, IPA analysis method, inclusive design, design framework

1. Introduction

Postpartum mood shifts post-birth, encompassing dysphoria, anxiety, and depression[1]. Symptoms like ongoing sadness, waning interest, fatigue, and insomnia, affecting maternal bonding and child development[2][3]. Women encounter obstacles accessing postpartum care due to societal stigmas and cultural myths about depression. This hinders help-seeking. Economic and geographic barriers limit psychological support, notably in China, where quality counseling is costly, disadvantaging vulnerable groups. Gaps in knowledge among patients and healthcare providers can result in overlooked diagnoses. Comprehensive approaches are needed to address these multifaceted challenges and ensure adequate care for postnatal women.

Internet-based postnatal mental health interventions offer innovative support for postpartum women, surmounting barriers like accessibility[4]. These platforms provide

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timely psychological aid, combatting stigma through anonymity and catering to individual needs with diverse communication tools. They raise mental health awareness among postnatal women[5].Literature highlights e-health's mental health potential. Zubala et al. examine digital art therapy's trajectory, emphasizing its merits and challenges[6]. Lackie et al.'s focus groups explore postpartum depression needs and barriers, stressing early user needs understanding in e-health interventions.Globally, researchers rigorously evaluate postpartum e-mental health tools[7]. Miura's review suggests app efficacy in improving postpartum depression outcomes[8]. Qin's study examines CareMom app efficacy in reducing early postpartum depressive symptoms, albeit with limitations[9].Mobile apps offer newfound postpartum support, but aligning them with user needs remains crucial. Questionnaire-based methods, influenced by cultural nuances, might pose challenges as app user demographics diversify. Crafting universally appealing and effective designs becomes paramount.

This is the first phase of a multi-phase study to develop an effective app for postpartum emotional relief, and the goal of this preliminary phase is that the IPA analysis method based on the NMF algorithm provides a more systematic and objective approach to app design. By more accurately identifying user needs and translating those needs into specific design requirements, relevant mobile app design can be made more inclusive and accessible.

2. Research approach

An inclusive design approach is essential for mobile apps targeting postpartum mood relief. The inclusive design cube, proposed by John Clarkson and Simeon Keates from the University of Cambridge (see Figure 1)[10].

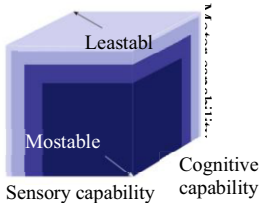

Figure 1. Inclusive design cube.

This model describes users with different abilities. From the inside out, the groups are: Usable Designers, Extensible, Maximum Beneficiaries, and All. Inclusive design aims to extend the beneficiaries, not to apply across the board. It requires designers to understand user diversity and seek innovative solutions. This study uses the NMF algorithm to distill user reviews of apps, combined with IPA analysis, to explore the key factors influencing postpartum mood relief apps to ensure inclusive design.

3. Method

3.1. Research process

This study evaluates the top 8 maternal and child emotional healing apps. User feedback is analyzed to identify primary needs. The methodology involves data collection, NMF model analysis for user needs, IPA analysis via questionnaires, and data-driven design recommendations.

3.2. User requirement mining based on NMF model

In this study, the top 100 most helpful user reviews of the 8 most downloaded mother and baby and emotional healing apps in the mobile app stores for the Chinese market were selected for data crawling and collection, and the python 3.9.7 tool was used to extract 5 topics and related keywords by setting the number of topics to 5 through the NMF model and converting them into visualization files: the NMF visualization model graphs(see Figure 2).

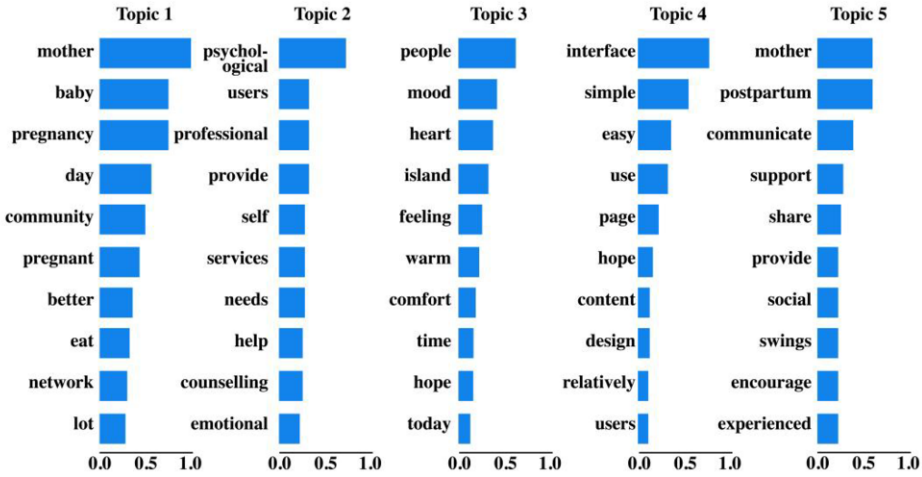

Figure 2. updated Topics in NMF model

Through app analysis and literature, user needs are identified: 1. Open sharing platform. 2. Data privacy. 3. Expert advice. 4. Personalized settings. 5. User-friendly interface. These insights guide the expansion of app features (see Table 1).

Table 1. Expansion of functional elements

Users demand	functional elements	Index
Local resource support	Local resource support	A1
	resource library	A2

	Expert consultation appointment	3	A
	Self-help healing guide	4	A
Customized service	Healing progress tracking	5	A
	Mood reminder	6	A
	Rich way to record emotions	7	A
	Mood music library	8	A
	Customized chemotherapy healing program	9	A
	Emotional health test	10	A
Interface and interaction	Clean interface	11	A
	Tactile feedback	12	A
	Emotional real-time operation guide	13	A
	Multilanguage support	14	A
	Mood color analysis	15	A
	Speech function	16	A
Privacy security	Data security	17	A
	Privacy Settings	18	A
	Mood hole	19	A
Exchange and share	Story hole	20	A
	Communication community	21	A
	Mood circle	22	A

3.3. app demand analysis based on IPA questionnaire

In this study, a Likert scale assessed satisfaction and importance of inclusivity in a postpartum emotional relief app. Ranging from "very dissatisfied" to "very satisfied" (scored 1-5), it gauged the demand for inclusion. The IPA model's core calculation involves importance (I) and satisfaction (P). Data from user surveys inform these dimensions, computed using the formula:

$$\mathrm{IPA} = [(\mathrm{I} - \mathrm{P})/\mathrm{I} \times 100 \tag{1}$$

According to the IPA value, it can be categorized into five levels: i.e. ⩽ 5.00 (very satisfied), 5.01~7.00 (more satisfied), 7.01~10.00 (generally satisfied), 10.01~15.00 (less satisfied), and ⩾15.01 (dissatisfied).

The questionnaires were researched through online social networking platforms for postpartum female groups, and 122 valid questionnaires were recovered after excluding invalid questionnaires.

4. Result analysis

4.1. Reliability and validity test

Cronbach reliability test was conducted on 22 variables in the questionnaire. If the reliability coefficient was above 0.8, the questionnaire scale was highly reliable (see Table 2).

Table 2. Reliability statistics

Scale	Alpha	Number of terms
Satisfaction	0.875	22
IImportance degree	0.862	22

In general, the smaller the significance level of the Bartlett sphericity test (P<0.05), the more likely there is a meaningful relationship between the original variables. If the KMO value is greater than 0.7, the significance of the Bartlett sphericity test statistical value is 0.000<0.01, which indicates that the validity of the data is good (see Table 3).

Table 3. Reliability statistics

		Satisfaction	Significance
KMO sample appropriateness measure.		0.726	0.796
Bartlett sphericity test	Chi-Square Approx	1668.354	1011.193
	Degree of freedom	231	231
	significance	0.000	0.000

4.2. Sample statistical analysis

Among the 122 valid samples of the survey, 35.25% of the women had postpartum anxiety, 54.92% had postpartum depression symptoms, 89.34% had received psychological counseling or treatment, and 56.56% had used mobile apps to relieve the bad mood after childbirth, detailed information (see Figure 3).

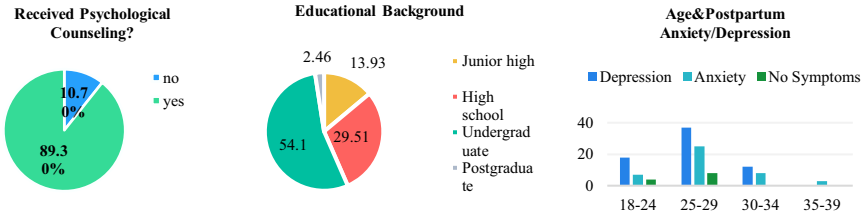

Figure 3. Sociological characteristics of the sample population.

4.3. Importance - IPA analysis of satisfaction

Based on the IPA index (Table 4), importance ranks: Privacy > Professional support > Communication > Interface > Customized service. Satisfaction ranks: Communication > Customized > Professional > Privacy, with privacy settings being least satisfying yet most valued. Mobile app development often overlooks privacy, impacting user satisfaction. Users value communication for emotional support and self-awareness.

Table 4. Importance and satisfaction evaluation of postpartum women on the inclusive demand elements of mobile apps for postpartum emotional relief

Users demand	Functional element		Significance		Satisfaction	
		Index	Mean	standard	AVG	SD
Local support	Local resource suppor	A1	4.020	1.012	3.140	0.973
	resource library	A2	4.190	0.725	3.340	1.049
	Expert consultation appointment	A3	4.320	0.860	2.900	1.064
	Self-help healing guide	A4	4.190	0.714	3.350	0.816
Customized service	Healing progress tracking	A5	4.130	0.709	2.710	0.947
	Mood reminder	A6	4.380	0.662	3.440	0.868
	Rich way to record emotions	A7	3.780	0.791	3.680	0.953
	Mood music library	A8	3.740	0.601	3.510	0.879
	Customized Healing Program	A9	4.600	0.571	3.010	0.966
	Emotional health test	A10	4.440	0.632	3.080	0.913
Interface and Interaction	Clean interface	A11	4.460	0.634	2.980	0.879
	Tactile feedback	A12	4.130	0.829	3.380	0.801
	Emotional real-time operation guide	A13	4.310	0.577	3.740	0.865
	Multilanguage support	A14	4.130	0.819	3.400	0.911

	Mood color analysis	A15	3.760	0.698	3.190	1.040
	Speech function	A16	3.740	0.716	3.660	0.783
Privacy security	Data security	A17	4.310	0.632	3.030	0.921
	Privacy Settings	A18	4.410	0.716	2.790	0.888
	Mood hole	A19	4.400	0.738	3.400	0.771
Exchange and share	Story hole	A20	4.340	0.615	3.400	0.947
	Communication community	A21	4.200	0.693	3.450	0.977
	Mood circle	A22	3.830	0.603	2.810	1.102

4.4. IPA generates performance value and expected value analysis

The IPA analysis framework takes "degree of performance" or "satisfaction" as the vertical axis, "importance" as the horizontal axis, and satisfaction as the vertical axis. the first quadrant is "keep up the good work", the second quadrant is "possible overkill", the third quadrant is "low priority", and the fourth quadrant is "concentrate here".

SPSS was used to analyze 22 inclusive demand factors, and the mean values of app inclusive importance and satisfaction were 4.60 and 3.75, respectively. It is used as the dividing line of the 4 quadrants of the IPA diagram to generate the IPA diagram (Figure 4).

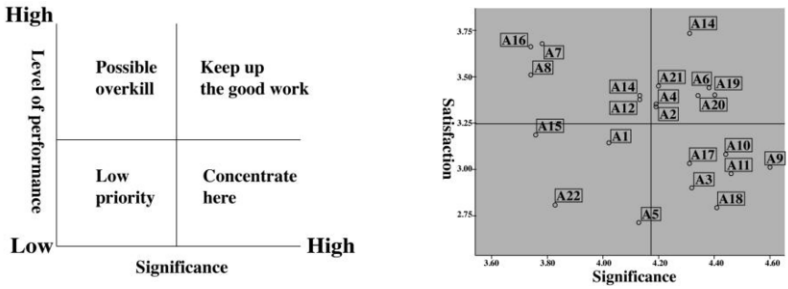

Figure 4. IPA analysis architecture.

In the continued section, seven factors—psychology, parenting resources, self-help healing, mood reminders, emotional guidance, mood sharing, and community communication — are highlighted. These are highly prioritized from postpartum women's perspective and should be retained in future app versions.

The over-supply area encompasses five factors: diverse emotion recording, mood music, touch feedback, multilingual support, and voice functions. These areas display minimal gaps between importance and satisfaction, suggesting room for improvement in app development.

The low-priority area comprises four factors: local resource support, healing progress tracking, mood color analysis, and mood circles. These aspects receive less emphasis from postpartum women, providing avenues for potential innovation in app development.

Lastly, the key improvement area includes six factors: expert consultations, customized healing plans, emotional health checks, streamlined interface, data security, and privacy settings. These are crucial for postpartum women but might lack functionality or offer subpar experiences, signifying areas for focused app enhancements.

5. Results and discussion

Based on the user-inclusive requirements derived from the results of the IPA analysis, categorize the functional elements required for the design and development of the postpartum mood relief mobile application and make specific design recommendations (see Table 5).

Table 5. Postpartum Emotional Relief Classification of Functional Elements Required for Mobile App Design and Development

Category	Feature	Method
Core Features	Psychological Support	Content based on expert-reviewed psychological knowledge.
	Self-guided Healing	Authoritative advice with regular self-healing prompts.
	Mood Sharing	Safe, anonymous platform for mood and story sharing.
Optimization & Expansion	Diverse Recording	Voice recording, emotional diaries, etc.
Innovation	Music Library	Mood-based music recommendations.
	Local Resources	Map of nearby mental health resources.
	Progress Tracking	Goal-setting with visual progress tracking.
	Color Analysis	Mood representation through color choices.
	Mood Circles	Clear categories with communication tools.
Improvement Focus	Interface	Simple, intuitive with interactive features.
	Privacy	Encrypted data with anonymous usage options.
	Health Check	Varied mental health self-assessments.
	Custom Healing	User data-driven content recommendations.

5.1. Core functional area design recommendations

The core functionality constitutes the essence of the app's composition, and neglecting these pivotal aspects significantly impacts user satisfaction. Therefore, prioritizing core functions in design is crucial. Psychosocial support and autonomous healing guidance, categorized under professional assistance, directly influence user trust and engagement.

Emphasizing professionalism by integrating expert certification logos in content output enhances user confidence. Clarity in fonts and layouts ensures easy comprehension of expert advice. Segregating content types with tags aids user navigation. Incorporating a user rating feature enables assessment of content quality and professionalism.

For self-guided healing guidance, employ multimedia elements like charts and animations for vivid, comprehensible content. Customizable reminder settings empower users in autonomous healing based on personal preferences.

As privacy is paramount, Mood Hole must offer a secure platform for private conversations or community engagement with controlled sharing options. Aesthetic symbols or stickers can augment emotional expression. Categorizing story sharing enables filtered viewing, fostering safe and fluid mood sharing while promoting mutual support among users.

5.2. Optimization and Expansion of Functional Area Design Recommendations

Enhancing and broadening these features will notably enhance user experiences, offering diverse and personalized choices. Including varied emotion recording methods (text, voice, stickers) will enrich expression. A mood music library recommending suitable tracks based on emotional states aids emotional regulation. Expanding language support and voice functions broadens the app's user base, facilitating more accessible communication. These enhancements boost emotional involvement, satisfaction, and overall app appeal and utility.

5.3. Concerns and recommendations for improving the design of functional areas

Optimizing the Concerns and Improvements functions significantly impacts user satisfaction. Enhanced functionalities not only boost user engagement and app promotion but also elevate usage rates and market recognition. Design adjustments prioritize a calming interface: employing soft colors like light blue or green, gentle animations, and simple typography to minimize distractions and reduce user stress. Clear button layouts and intuitive graphic elements aid readability. Privacy measures include transparent policies and prominently displayed privacy options using visual cues on registration and settings pages. User-friendly emotional scales aid emotional understanding. Visual aids like charts depict mental health status effectively.

5.4. Design Recommendations for the Innovation and Experimentation Area

The push for innovation and experimentation is pivotal in bolstering an APP's core competitiveness. Leveraging local resources, the proposed design entails a map interface featuring nearby mental health facilities and related venues. This interface streamlines access to comprehensive details, including operational hours, fees, and service specifics, offering tailored filters for content searches, ensuring relevance and utility. Recommendations for the Healing Progress Tracker include a straightforward goal-setting tool for defining recovery objectives. Intuitive progress indicators, such as bars or charts, vividly illustrate users' advancement. Mood color analysis calls for a diverse palette reflecting users' emotions, with corresponding insights fostering self-awareness. Designing mood circles involves a user-friendly interface categorizing circles by emotional states. The app should integrate diverse communication tools, encouraging mutual support and interaction among users.

5.5. limitations

This study, utilizing the IPA analysis based on the NMF algorithm for investigating inclusive design needs in postpartum emotional relief mobile apps, encounters limitations. The absence of dedicated apps in Chinese stores led to selecting the top 8 mother-baby apps, potentially excluding features from other apps. The survey's limited size and online distribution could bias towards active or concerned participants, missing those restricted by web technology. To address this, employing diverse survey platforms and incentivizing participation is recommended. Although NMF and IPA models are widely used, they might not capture all user needs, leading to incomplete insights.

Moreover, design recommendations based on user perceptions may overlook technological, economic, and social factors, impacting feasibility. However, this study is part of a broader project aimed at refining this framework through an app's development.

Despite limitations, the IPA-NMF method remains effective, merging data mining and interpretative analysis for a comprehensive grasp of user needs. In-depth user feedback analysis guides product refinement, enhancing user experience and quality.

6. Results and discussion

The IPA analysis, utilizing the NMF algorithm, provides an impartial approach for inclusive design in postpartum emotional relief apps. This study explores authentic user needs, guiding app design and development. Key findings highlight user priorities: privacy/security, professional support, communication/sharing, interface interaction, and customized services. Underrated, privacy/security significantly impacts user satisfaction, necessitating focused attention in future development. Communication/sharing and professional support are crucial for user experience and should be core app features. Prioritizing user satisfaction and tailored outputs will enhance overall contentment. While the IPA-NMF method innovates demand analysis, further research is needed for better user experience and coverage.

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