

Evocative Design Evaluation (EDE): A Conceptual Framework for Emotion-Driven Product Development in Rehabilitation Contexts

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ABSTRACT

The development of rehabilitation products has traditionally prioritized functional performance, ergonomics, and clinical effectiveness, while the emotional experiences of users throughout the rehabilitation journey remain comparatively underexplored. This study proposes the development of Conceptual Evocative Design Evaluation (EDE) framework as an emotion-driven design evaluation approach that integrates users' affective responses into rehabilitation product development. Grounded in human-centered design and design evaluation principles, the framework aims to support designers in identifying, interpreting, and translating emotional experiences into meaningful design decisions that enhance user engagement, acceptance, and long-term rehabilitation outcomes. A qualitative research design was adopted using a sequential exploratory approach. Data were collected through semi-structured interviews with stakeholders involved in rehabilitation product design and development, complemented by Verbal Protocol Analysis (VPA) to capture participants' cognitive and emotional reasoning during design evaluation activities. The collected data were analyzed using thematic analysis to identify recurring patterns and relationships that informed the development of the proposed framework. Methodological triangulation and iterative interpretation were employed to strengthen the credibility and trustworthiness of the findings. The study identified nine major themes that describe the emotional dimensions influencing rehabilitation product evaluation and demonstrate how users' affective experiences can be systematically translated into actionable design considerations. These findings informed the development of the Conceptual Evocative Design Evaluation framework, which establishes a structured relationship between emotional responses, design interpretation, and design intervention throughout the product development process.

Keywords— Evocative Design Evaluation, Rehabilitation Product Design, Emotion-Driven Design, Human-Centered Design, Conceptual Framework Development

INTRODUCTION

Recent developments in rehabilitation engineering have increasingly recognized that successful rehabilitation extends beyond restoring physical function to fostering positive user experiences that encourage sustained participation and behavioral engagement. As rehabilitation products are frequently used over prolonged periods in clinical and home environments, the interaction between users and products becomes highly experiential, influencing confidence, motivation, self-efficacy, and overall quality of life. Consequently, researchers have advocated for rehabilitation technologies that combine functional performance with human-centered and emotionally responsive design principles to improve user acceptance and long-term adherence (Buker, 2024; Peng et al., 2025). These developments reflect a broader transition from technology-centered innovation towards

person-centered rehabilitation, where emotional well-being is increasingly recognized as an integral component of successful healthcare interventions.

Parallel to these developments, human-centered design (HCD) has emerged as one of the most influential methodologies for healthcare innovation. HCD promotes continuous stakeholder involvement throughout problem identification, ideation, prototyping, and evaluation to ensure that products respond to users' functional, cognitive, emotional, and contextual needs. A comprehensive review by Göttgens et al. (2021) demonstrated that participatory and iterative design processes consistently improve the relevance and usability of healthcare innovations while highlighting the need for more rigorous evaluation methods capable of capturing users' lived experiences beyond conventional usability assessment. This observation is particularly significant within rehabilitation product development, where patient experiences evolve continuously throughout recovery and adaptation.

Emotion-driven design has likewise gained considerable attention as an emerging paradigm for developing products that establish meaningful relationships between users and artefacts. Rather than considering emotions as secondary outcomes of product interaction, recent research positions emotional responses as measurable design requirements capable of influencing behavioral intention, trust, product attachment, and sustained engagement. Yang et al. (2021) demonstrated that integrating emotional requirements into systematic product development significantly enhances user acceptance and interaction with smart healthcare products, while Buker (2024) further reported that emotionally appealing assistive products positively contribute to users' perceived self-efficacy and may even compensate for limitations in conventional usability attributes. Collectively, these studies suggest that emotional evaluation should be integrated as a complementary dimension alongside functional and ergonomic performance throughout product development.

Despite these advances, existing evaluation frameworks for rehabilitation products remain predominantly oriented towards measurable indicators such as usability, ergonomic performance, biomechanical efficiency, and clinical effectiveness. Comparatively fewer studies provide structured methodologies for systematically interpreting users' emotional experiences during product interaction and translating these insights into design decision-making. While participatory design methods successfully identify user needs, they often lack explicit mechanisms for evaluating the emotional meanings that emerge throughout rehabilitation experiences. This methodological gap presents an opportunity to develop evaluation approaches capable of linking emotional interpretation with iterative design intervention, thereby enriching evidence-based rehabilitation product development and supporting more holistic healthcare innovation.

In response to this research gap, the present study introduces the Evocative Design Evaluation (EDE) conceptual framework as a qualitative evaluation parameter that systematically captures users' emotional responses and translates them into actionable design knowledge during rehabilitation product development. The framework builds upon established principles of human-centered design, emotional design, and qualitative design inquiry while extending existing evaluation practices through the integration of Verbal Protocol Analysis (VPA) and thematic interpretation. By positioning emotional experiences as a legitimate source of design evidence, the proposed framework contributes to both rehabilitation design research and public health innovation, offering designers and healthcare practitioners a structured approach for developing rehabilitation products that are not only clinically effective but also emotionally meaningful, motivating, and responsive to users' lived experiences.

LITERATURE REVIEW

Rehabilitation product design has evolved from a predominantly engineering-focused discipline towards a human-centered approach that integrates functional performance with users' physical, cognitive, and psychosocial needs. Contemporary rehabilitation products including assistive technologies, therapeutic devices, and home-based rehabilitation systems are expected not only to improve clinical outcomes but also to promote user engagement, independence, and quality of life. This shift aligns with person-centered healthcare, which recognizes that successful rehabilitation depends on users' sustained participation and meaningful interaction with therapeutic products rather than technical performance alone (Göttgens et al., 2021; Peng et al., 2025). Recent studies further demonstrate that rehabilitation technologies designed through participatory and human-

centered approaches achieve greater usability, acceptance, and long-term adherence by addressing the contextual needs and lived experiences of users (Buker, 2024).

Human-Centered Design (HCD) has therefore become a fundamental methodology in healthcare innovation, encouraging the active involvement of patients, clinicians, caregivers, and designers throughout the product development process. Guided by iterative design and continuous stakeholder engagement, HCD enables designers to identify latent user needs beyond observable functional requirements. Nevertheless, existing HCD practices within rehabilitation largely emphasize usability, ergonomics, safety, and clinical effectiveness, while emotional experiences are often treated as secondary outcomes rather than explicit design evaluation criteria (Göttgens et al., 2021). As rehabilitation frequently involves prolonged product interaction, emotional factors such as confidence, motivation, trust, dignity, and perceived empowerment become increasingly influential in determining user acceptance and treatment adherence.

The growing field of emotion-driven design extends conventional product evaluation by recognizing emotions as integral to users' overall product experience. Drawing upon the foundational work of Norman (2004), Desmet and Hekkert (2007), contemporary research demonstrates that emotional responses significantly influence user satisfaction, behavioral intention, product attachment, and sustained engagement. Recent studies further argue that emotional requirements should be systematically incorporated into healthcare and assistive technology development, as positive emotional experiences enhance users' self-efficacy, confidence, and willingness to continue rehabilitation programmes (Yang et al., 2021; Buker, 2024). However, despite increasing recognition of emotional design, existing rehabilitation product evaluation methods remain predominantly centered on functional usability, ergonomic assessment, and clinical performance, offering limited guidance for translating emotional experiences into actionable design knowledge.

Qualitative design research increasingly advocates evaluation approaches that integrate users' cognitive and emotional experiences into iterative product development. Among these approaches, Verbal Protocol Analysis (VPA) provides a systematic means of capturing participants' reasoning, reflections, and emotional interpretations during design evaluation, enabling researchers to reveal insights that conventional usability testing may overlook. Combined with thematic analysis, VPA facilitates the interpretation of users' lived experiences into meaningful design evidence capable of informing design refinement and innovation.

Despite substantial progress in rehabilitation engineering, human-centered design, and emotional design research, a methodological gap remains in systematically integrating emotional evaluation into rehabilitation product development. Existing studies rarely provide structured frameworks that translate users' emotional responses into design interventions throughout the development process. Addressing this gap, the present study proposes the Evocative Design Evaluation (EDE) conceptual framework, which integrates emotion-driven evaluation, Human-Centered Design principles, and Verbal Protocol Analysis to support evidence-based, user-responsive rehabilitation product development. By positioning emotional experience as a critical source of design evidence, the framework contributes a holistic evaluation approach that complements conventional usability assessment and advances more meaningful, patient-centered rehabilitation innovation.

METHODOLOGY

Research Design

This study adopted a qualitative exploratory research design to investigate how emotional experiences can be systematically integrated into rehabilitation product development through the proposed Evocative Design Evaluation (EDE) conceptual framework. A qualitative approach was considered appropriate because the study sought to understand participants' experiences, interpretations, and decision-making processes regarding rehabilitation product design rather than measuring predefined variables. Consistent with Human-Centered Design (HCD), the research focused on capturing multiple stakeholder perspectives to understand the complex relationships between users, rehabilitation protocols, and product development.

The research employed two complementary qualitative methods: (i) in-depth semi-structured interviews to explore stakeholders' experiences and expectations regarding rehabilitation product development, and (ii) Verbal

Protocol Analysis (VPA) to investigate participants' cognitive and emotional reasoning while evaluating rehabilitation devices within a simulated post-stroke rehabilitation context. The integration of these methods enabled methodological triangulation by combining reflective narratives with real-time cognitive processes, thereby providing a richer understanding of emotion-driven design evaluation.

Research Participants

Purposive sampling was employed to recruit participants possessing direct knowledge and practical experience relevant to rehabilitation product development. The interview phase involved sixteen participants representing four stakeholder groups: four industrial or product designers experienced in healthcare design, four rehabilitation healthcare professionals involved in post-stroke treatment, four caregivers of post-stroke patients, and four product developers or engineers responsible for medical device development. These participants provided diverse perspectives across clinical practice, design, engineering, and caregiving, enabling a comprehensive understanding of rehabilitation product requirements.

A second phase involving Verbal Protocol Analysis consisted of twenty-one participants who evaluated selected rehabilitation devices while observing and reflecting on structured post-stroke rehabilitation activities. Participants verbalized their thoughts throughout the evaluation process, allowing researchers to capture cognitive reasoning, emotional responses, and design interpretations as they naturally occurred during interaction with the rehabilitation artefact.

Method	Participants	Number	Experience	Selection Criteria
Semi-structured Interview	Rehabilitation designers	4	>5 years	Experience in rehabilitation product design
	Physiotherapists	4	Clinical rehabilitation	Licensed clinicians with stroke rehabilitation experience
	Product engineers	4	Medical product development	Medical product development experience
	Caregivers	4	Experience assisting stroke patients	Primary caregiver of post-stroke patient
Verbal Protocol Analysis	Product developers	7	Rehabilitation design	Rehabilitation product development
	Designers	7	Industrial/Product Design	Industrial/Product Design expertise
	Engineers	7	Medical device development	Medical device engineering experience

Figure 1. Demographic Profile and Professional Characteristics of Participants Involved in the Semi-Structured Interviews and Verbal Protocol Analysis

Data Collection Procedure

Data collection was organized into two sequential phases.

Phase One: Semi-Structured Interviews

The first phase consisted of in-depth semi-structured interviews designed to explore stakeholders' experiences and perceptions regarding rehabilitation product development. Each interview lasted between 45 and 90 minutes and was conducted either face-to-face or through secure online communication platforms, depending on participant availability.

The interview protocol consisted of twelve open-ended questions organized around six principal domains:

i) rehabilitation product functionality and usability	ii) ergonomic suitability and physical interaction	iii) practicality within rehabilitation settings	iv) user engagement and motivation	v) emotional and psychological responses during rehabilitation	vi) integration of rehabilitation devices within structured therapy protocols
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Figure 2. Six Principal Domains Used for In-Depth Semi-Structured Interviews Session

To deepen participants' reflections, probing questions explored perceived challenges in existing rehabilitation products, emotional barriers to sustained product use, stakeholder collaboration during product development, and recommendations for improving rehabilitation experiences through design. All interviews were audio-recorded with participants' consent and transcribed verbatim before analysis.

Phase Two: Verbal Protocol Analysis

The second phase employed Verbal Protocol Analysis (VPA) to investigate participants' cognitive and emotional evaluation processes during rehabilitation product interaction. Participants were presented with rehabilitation devices used within post-stroke therapy sessions and were encouraged to continuously verbalize their thoughts while observing, interacting with, or evaluating the products. The evaluation protocol was designed to simulate realistic rehabilitation scenarios by considering the sequence of rehabilitation activities commonly prescribed during post-stroke recovery. Participants were encouraged to describe their observations, perceived usability, emotional reactions, anticipated user experiences, therapeutic suitability, and potential design improvements throughout the evaluation process. The VPA sessions were audio- and video-recorded to preserve verbal narratives alongside behavioral interactions with the rehabilitation devices. These recordings enabled detailed interpretation of participants' design reasoning and emotional responses throughout the evaluation process.

Data Analysis

Interview transcripts and VPA recordings were analyzed using Reflexive Thematic Analysis (RTA) following the six-phase framework proposed by Braun and Clarke (2021, 2022). Reflexive thematic analysis was selected because it provides a rigorous and flexible methodology for identifying patterns of meaning while supporting conceptual framework development.

The analysis proceeded through six iterative stages:

Stage 1:	familiarization with interview transcripts and VPA recordings through repeated reading and observation		
	Stage 2:	systematic generation of initial codes representing meaningful units of data	
		Stage 3:	organization of related codes into preliminary themes

			Stage 4:	critical review and refinement of themes to ensure coherence, distinctiveness, and relevance across stakeholder groups	
				Stage 5:	definition and naming of themes by developing clear conceptual descriptions
				Stage 6:	synthesis of themes into an integrated conceptual framework representing emotion-driven rehabilitation product evaluation.

Figure 3. Six Iterative Stages Used Via Reflexive Thematic Analysis (RTA) for VPA Procedure

Coding was conducted inductively, allowing themes to emerge from participants' experiences while remaining informed by Human-Centered Design and emotional design principles. Throughout the analytical process, continuous comparison across stakeholder groups enabled identification of convergent and divergent perspectives that informed framework development. The proposed EDE conceptual framework should be regarded as a conceptual design and evaluation framework synthesized from qualitative evidence and established Human-Centered Design and emotional design theories. It is intended to guide rehabilitation product development and provide a foundation for future empirical validation rather than to serve as a definitive predictive or performance measurement model.

Trustworthiness of the Study

To enhance the credibility, dependability, confirmability, and transferability of the findings, several qualitative quality assurance strategies were implemented. Credibility was strengthened through methodological triangulation by integrating semi-structured interviews with Verbal Protocol Analysis, enabling comparison between reflective experiences and real-time evaluation processes. Data source triangulation was achieved through the inclusion of multiple stakeholder groups representing clinical practice, design, engineering, and caregiving perspectives. Dependability was supported by maintaining a comprehensive audit trail documenting participant recruitment, interview procedures, coding decisions, analytical development, and framework construction. Reflexive memo writing throughout the analytical process facilitated transparency regarding researchers' interpretations and evolving conceptual understanding. Confirmability was reinforced through peer debriefing among members of the research team during theme refinement and framework development. Where appropriate, preliminary interpretations were discussed with selected participants to ensure that conceptual interpretations accurately reflected their intended meanings. Transferability was enhanced through detailed descriptions of participant characteristics, rehabilitation contexts, data collection procedures, and analytical processes, enabling future researchers to evaluate the applicability of the proposed framework within other rehabilitation environments.

Development of the Evocative Design Evaluation Conceptual Framework

The Evocative Design Evaluation (EDE) conceptual framework was developed through an iterative synthesis of empirical findings and existing Human-Centered Design principles. Rather than functioning solely as an evaluation instrument, the framework was conceptualized as a systematic design guideline supporting interdisciplinary collaboration throughout rehabilitation product development. Insights generated from interviews and Verbal Protocol Analysis were progressively integrated to identify relationships between users' emotional experiences, rehabilitation activities, stakeholder interactions, and design decision-making. These relationships informed the construction of a framework illustrating how emotional evidence can guide iterative product refinement across different stages of rehabilitation product development. The conceptual framework positions patients, caregivers, rehabilitation professionals, designers, and engineers as interconnected stakeholders within an inclusive product development ecosystem. It further illustrates how emotional evaluation can complement functional, ergonomic, and clinical considerations throughout rehabilitation product design, ultimately supporting more patient-responsive and evidence-informed innovation.

DISCUSSION AND LIMITATION

One limitation of this study is that the proposed Evocative Design Evaluation (EDE) Framework was developed primarily from qualitative findings derived through in-depth semi-structured interviews and Verbal Protocol Analysis. Consequently, the framework should be interpreted as a conceptual and evidence-informed design guideline rather than an empirically validated evaluation model. While the qualitative approach provides rich insights into stakeholders' lived experiences, design expectations, and emotional responses, the framework has not yet been systematically evaluated for its effectiveness in improving rehabilitation product usability, user satisfaction, therapeutic adherence, or long-term rehabilitation outcomes. Future research should therefore undertake empirical validation practically through prototype implementation, comparative case studies, longitudinal investigations, and multi-center clinical evaluations to assess the framework's reliability, applicability, and impact across diverse rehabilitation contexts.

Although the proposed conceptual framework was developed from perspectives obtained within post-stroke rehabilitation, many of its design principles including Human-Centered Design, emotional engagement, usability, trust, empowerment, and holistic stakeholder collaboration are conceptually transferable to broader rehabilitation product development contexts. Nevertheless, the findings should not be interpreted as universally applicable without further validation across different rehabilitation populations, healthcare systems, cultural settings, and assistive technologies. Future studies should therefore examine the framework in diverse rehabilitation domains, including musculoskeletal rehabilitation, neurological rehabilitation beyond stroke, pediatric rehabilitation, geriatric rehabilitation, and home-based digital rehabilitation systems.

Future Framework Validation

Although the present study establishes the conceptual development of the Evocative Design Evaluation framework, further validation is recommended to strengthen its practical applicability. Future studies should undertake expert validation using structured consensus techniques such as the Delphi method involving multidisciplinary panels comprising rehabilitation physicians, occupational therapists, physiotherapists, industrial designers, biomedical engineers, and healthcare researchers. Subsequent validation may also include multiple case studies across different rehabilitation settings and rehabilitation devices to evaluate the framework's transferability and practical effectiveness. Comparative investigations examining rehabilitation products developed with and without the EDE conceptual framework would further demonstrate its potential contribution to enhancing user engagement, emotional experience, therapeutic adherence, and patient-centered rehabilitation outcomes.

Ethical Considerations

This study was conducted in accordance with established ethical principles for research involving human participants, with particular emphasis on voluntary participation, confidentiality, privacy, and data protection. Prior to data collection, all participants received a detailed explanation of the study objectives, procedures, potential risks, and their rights as research participants, and provided written informed consent before participating in the interviews and Verbal Protocol Analysis (VPA). Permission to conduct the study was also obtained from the collaborating rehabilitation care center and the relevant medical team members responsible for facilitating participant recruitment and rehabilitation activities. To safeguard participant privacy and institutional confidentiality, all personal identifiers, institutional names, unpublished clinical information, and sensitive rehabilitation records were anonymized during data analysis and reporting. No identifiable photographs, videos, or images of participants are presented in this paper. Any figures, illustrations, workflow diagrams, or representative images included are solely for conceptual and illustrative purposes to depict the rehabilitation context and do not disclose the identity of individual participants, healthcare professionals, or institutions. All research data were securely stored and accessed only by the research team, ensuring compliance with recognized ethical standards for qualitative research and the responsible conduct of research involving vulnerable populations.

RESULTS AND FINDINGS

Overview of the Findings

The qualitative findings were derived from two complementary data sources: (i) sixteen (16) in-depth semi-structured interviews involving designers, rehabilitation healthcare professionals, caregivers, and product developers; and (ii) Verbal Protocol Analysis (VPA) sessions involving twenty-one (21) participants evaluating rehabilitation devices within a post-stroke rehabilitation context. Data from both phases were analyzed using Reflexive Thematic Analysis, enabling the integration of stakeholder perspectives and real-time evaluation processes. The analysis generated nine interrelated themes that collectively informed the development of the proposed Evocative Design Evaluation (EDE) conceptual framework. Together, these themes illustrate how emotional experiences influence the evaluation, acceptance, and iterative development of rehabilitation products.

Theme	Description	Primary Stakeholders	Respondent Consensus
Theme 1	Usability	All stakeholder groups	Very High
Theme 2	Engagement and Interactivity	Patients, caregivers, designers	High
Theme 3	Reflective Experience	Designers, clinicians	Moderate
Theme 4	Practicality	Clinicians, engineers	High
Theme 5	Evocative Experience	Patients, caregivers	Very High
Theme 6	Motivation and Well-Being	Patients, therapists	Very High
Theme 7	Empowerment	Patients, clinicians	High
Theme 8	Trust and Comfort	All stakeholder groups	Very High
Theme 9	Holistic Rehabilitation Integration	All stakeholder groups	Very High

Table 1. Summary of Themes Generated from the Analysis Multidisciplinary Pillars of Holistic Rehabilitation Integration

Stakeholder Perspectives in Rehabilitation: A Theme-Based Analysis

This document provides a comprehensive breakdown of the nine core themes identified in rehabilitation and their specific relevance to various stakeholder groups. By categorizing these themes by stakeholder, this briefing highlights the unique focus areas and priorities for those involved in the rehabilitation ecosystem.

Universal Focus Areas (All Stakeholder Groups)

Certain themes are foundational to the rehabilitation process and are prioritized by every stakeholder group, including patients, caregivers, designers, clinicians, engineers, and therapists. These universal themes ensure a baseline of quality and integration.

Theme	Description of Stakeholder Focus
Theme 1: Usability	A universal requirement focusing on the ease of use and functional accessibility of rehabilitation tools and processes.

Theme 8:	Trust and Comfort	The essential psychological and physical security required for all parties to engage effectively in the rehabilitation journey.
Theme 9:	Holistic Rehabilitation Integration	The seamless coordination of rehabilitation efforts into a unified, comprehensive approach that serves all participants.
Universal Themes	Usability, Trust and Comfort, Holistic Rehabilitation Integration.	

Table 2. Summary of Universal Themes and Focus Areas

Stakeholder-Specific Focus Areas

The following sections detail the specific themes that resonate with individual stakeholder groups, beyond the universal themes listed above.

1. Patients Patients are centered on themes that address their internal drive, emotional state, and active participation in their recovery.	Engagement and Interactivity	Focuses on the dynamic nature of rehabilitation tools.
	Evocative Experience	Prioritizes the emotional and sensory impact of the rehabilitation process.
	Motivation and Well Being	Addresses the psychological drive necessary to sustain long-term recovery efforts.
	Empowerment	Focuses on gaining agency and control over their personal health outcomes
2. Caregivers Caregivers share a focus with patients on the experiential and interactive aspects of the rehabilitation environment.	Engagement and Interactivity	The importance of active participation and stimulating rehabilitation environments.
	Evocative Experience	The role of emotional resonance and meaningful experiences in care.
3. Designers Designers prioritize the creation of systems and	Engagement and Interactivity	Designing for high levels of user participation and responsiveness.

experiences that are both interactive and conducive to professional analysis.	Reflective Experience	Creating opportunities for contemplation and analysis within the rehabilitation framework.
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4. Clinicians Clinicians focus on themes related to professional oversight, practical application, and patient agency.	Reflective Experience	Utilizing data and experiences to analyze progress and adjust treatment.
	Practicality	The focus on functional, efficient, and realistic implementation of rehabilitation protocols.
	Empowerment	Supporting the patient's ability to take charge of their recovery.

5. Engineers The engineering perspective is primarily concerned with the technical feasibility and functional execution of rehabilitation solutions.	Practicality	Ensuring that rehabilitation tools and systems are reliable, functional, and effectively implemented.
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6. Therapists Therapists focus specifically on the psychological catalysts required for successful physical or cognitive rehabilitation.	Motivation and Well Being	The critical focus on encouraging and maintaining the patient's commitment to the rehabilitation regimen.
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Table 3. Summary of Specific Focus Areas based from Stakeholders Feedback and Perspectives

Summary of Theme Distribution

The following table serves as a cross-reference for the nine rehabilitation themes across all unique stakeholder groups.

Theme	Patients	Caregivers	Designers	Clinicians	Engineers	Therapists
1. Usability	X	X	X	X	X	X
2. Engagement and Interactivity	X	X	X			

3. Reflective Experience			X	X		X
4. Practicality			X	X	X	
5. Evocative Experience	X	X				X
6. Motivation and Well Being	X		X			X
7. Empowerment	X			X		
8. Trust and Comfort	X	X	X	X	X	X
9. Holistic Rehab Integration	X	X	X	X	X	X

Table 4. Cross-Reference for the Nine Rehabilitation Themes Across Stakeholder Groups

EVOCATIVE EMOTION-DRIVEN ELEMENTS

Usability

Participants consistently discussed the importance of intuitive operation, ease of learning, and compatibility with users' physical and cognitive capabilities throughout the rehabilitation process. Usability extended beyond basic functionality and encompassed the product's ability to support therapeutic activities with minimal complexity and reduced physical or mental effort. Usability emerged as a fundamental design parameter influencing the effectiveness, acceptance, and long-term use of rehabilitation products by extending beyond operational simplicity to encompass intuitive interaction, ergonomic suitability, cognitive accessibility, task efficiency, and compatibility with users' physical capabilities, therapeutic routines, and evolving recovery needs. Participants consistently emphasized that rehabilitation devices should minimize physical and cognitive burden while supporting meaningful therapeutic engagement throughout post-stroke rehabilitation.

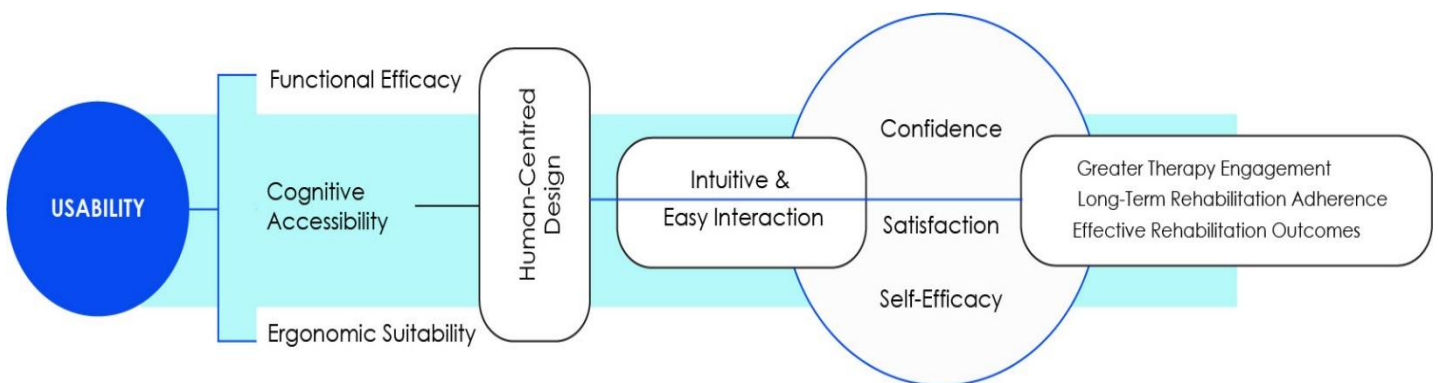


Figure 4. Conceptual Model of “Usability” Supporting Effective Rehabilitation Product Design

These findings reinforce the principles of Human-Centered Design (HCD), which advocate designing products around users' lived experiences, contextual needs, and active stakeholder involvement including patients, caregivers, rehabilitation professionals, designers, and engineers to ensure rehabilitation technologies align with real-world clinical and home environments (ISO 9241-210, 2019; Göttgens et al., 2021). From an emotional design perspective, usability extends beyond functional performance by shaping users' confidence, satisfaction, self-efficacy, and willingness to continue rehabilitation, as intuitive and predictable interactions reduce frustration and anxiety while fostering positive therapeutic experiences (Norman, 2004; Yang et al., 2021; Peng et al., 2025). Accordingly, the proposed Evocative Design Evaluation (EDE) framework positions usability as an iterative and emotion-driven evaluation parameter that integrates functional efficiency with emotional

reassurance, enabling continuous design refinement through stakeholder feedback and experiential insights to produce rehabilitation products that are clinically effective, emotionally supportive, and capable of enhancing sustained rehabilitation adherence and patient-centered outcomes.

Engagement and Interactivity

Participants emphasized that rehabilitation devices should actively sustain users' interest throughout repeated therapy sessions. Interactive elements, responsive feedback, and adaptive task progression were perceived as important characteristics for maintaining long-term participation in rehabilitation programmes. Engagement and interactivity emerged as critical design parameters that sustain users' motivation and active participation throughout prolonged rehabilitation by transforming rehabilitation devices from passive therapeutic tools into responsive, personalized, and meaningful systems. Participants consistently emphasized the importance of interactive features such as immediate performance feedback, adaptive task progression, intuitive interfaces, and responsive user-product communication to maintain attention, reduce monotony, and encourage continuous participation in repetitive post-stroke therapy.

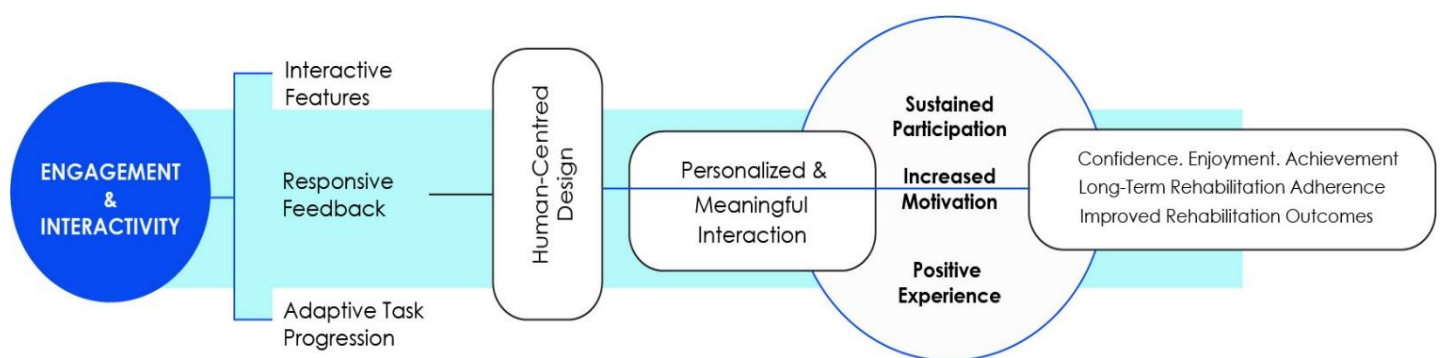


Figure 5. Conceptual Model of “Engagement and Interactivity” Supporting Patient-Centered Rehabilitation

These findings align with Human-Centered Design (HCD), which advocates designing rehabilitation technologies around users' capabilities, preferences, contextual needs, and evolving recovery journeys through continuous collaboration with patients, caregivers, therapists, designers, and engineers, thereby ensuring that interaction mechanisms remain accessible, relevant, and supportive of real rehabilitation practices (ISO 9241-210, 2019; Göttgens et al., 2021). From an emotional design perspective, meaningful interactions foster confidence, enjoyment, accomplishment, and emotional attachment, reducing frustration while strengthening users' intrinsic motivation and long-term commitment to rehabilitation (Norman, 2004; Yang et al., 2021; Peng et al., 2025). Accordingly, the proposed conceptual Evocative Design Evaluation (EDE) framework positions engagement and interactivity as iterative, emotion-driven evaluation parameters that integrate personalized interaction with positive emotional experiences, enabling rehabilitation products to enhance therapy adherence, interdisciplinary communication, and patient-centered rehabilitation outcomes.

Reflective Experience

Participants described rehabilitation devices as tools that encourage users to monitor progress, recognize personal achievements, and reflect upon their recovery journey. Reflection emerged through participants' discussions of visual feedback, perceived improvement, and meaningful interaction with therapy activities. Reflective experience emerged as a vital design dimension that enables rehabilitation products to support users in recognizing progress, interpreting personal achievements, and finding meaning throughout their recovery journey. Participants emphasized that rehabilitation devices should facilitate self-monitoring through features such as progress visualization, personalized feedback, milestone recognition, and adaptive goal setting, allowing users to appreciate incremental improvements and remain engaged during prolonged post-stroke rehabilitation.

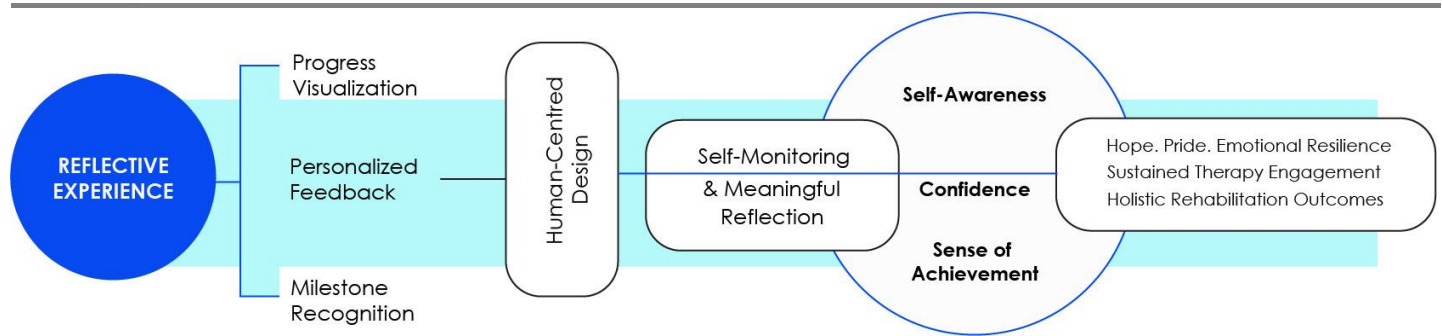


Figure 6. Human-Centered Reflective Experience Supporting Patient Engagement and Recovery

Consistent with Human-Centered Design (HCD), these findings highlight the importance of designing rehabilitation technologies that accommodate users' evolving cognitive, emotional, and experiential needs while fostering meaningful communication among patients, therapists, and caregivers through shared understanding of rehabilitation progress (ISO 9241-210, 2019; Göttgens et al., 2021). From an emotional design perspective, reflective experiences cultivate hope, pride, resilience, and confidence by reinforcing users' sense of accomplishment and personal growth, thereby strengthening their commitment to rehabilitation (Norman, 2004; Yang et al., 2021). Ultimately, this contributes to a more holistic, patient-centered approach to rehabilitation product design in which functional recovery and emotional well-being are considered complementary outcomes of successful therapeutic intervention.

Practicality

Practicality referred to the extent to which rehabilitation products could be integrated into everyday clinical practice and home-based rehabilitation. Participants discussed portability, ease of setup, maintenance requirements, storage, and compatibility with existing rehabilitation protocols. Practicality emerged as a key design parameter that determines whether rehabilitation products can be effectively integrated into routine clinical practice and home-based rehabilitation without imposing unnecessary physical, cognitive, or operational demands on users and caregivers. Participants highlighted the importance of portability, intuitive setup, durability, ease of maintenance, and compatibility with existing rehabilitation protocols as essential characteristics for supporting continuous therapy across diverse rehabilitation environments. These findings align with Human-Centered Design (HCD), which emphasizes understanding users' real-world contexts, rehabilitation workflows, environmental constraints, and stakeholder roles to ensure that products are adaptable, accessible, and responsive to everyday rehabilitation needs (ISO 9241-210, 2019; Göttgens et al., 2021). From an emotional design perspective, practical rehabilitation products enhance users' confidence and reassurance by reducing operational complexity, uncertainty, and dependence on specialist assistance, thereby enabling greater focus on therapeutic activities and promoting sustained engagement (Norman, 2004; Peng et al., 2025).

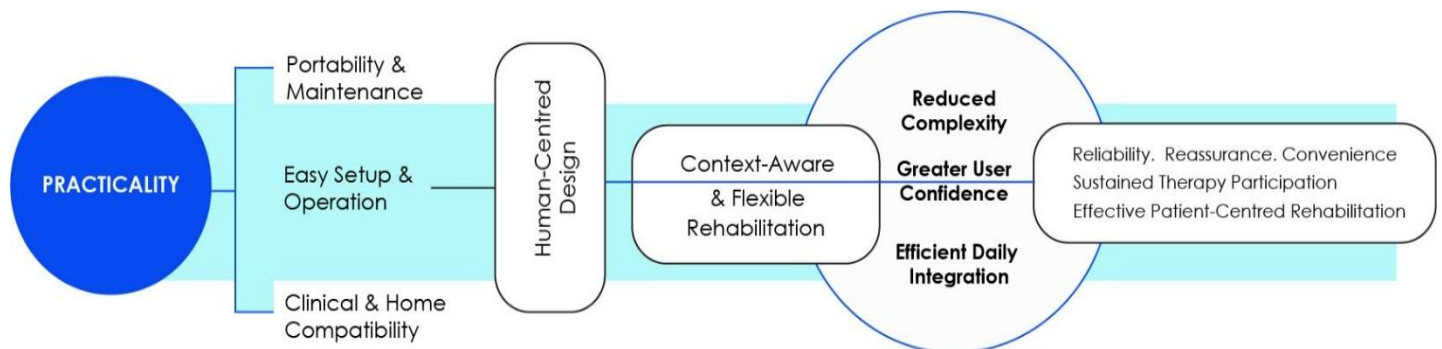


Figure 7. Conceptual Model of “Practicality” Supporting Rehabilitation Product Design and Therapy Integration

Practicality is achieved by developing products that respond directly to the realities of users' environments, capabilities, and rehabilitation contexts. HCD encourages designers to gain a comprehensive understanding of how rehabilitation activities are performed, where they occur, who is involved, and what barriers users encounter throughout the recovery journey (ISO 9241-210, 2019). Such an approach enables designers to consider

contextual factors including patients' physical limitations, caregivers' responsibilities, therapists' clinical workflows, available rehabilitation space, and resource constraints during product development. Consequently, practical rehabilitation products are designed not only to fulfil therapeutic functions but also to minimize operational complexity, reduce dependency on specialist assistance, and support flexible use across multiple rehabilitation settings. These considerations are particularly relevant in Malaysia, where access to specialized rehabilitation services may vary between urban and rural healthcare facilities, increasing the importance of adaptable and user-friendly rehabilitation solutions. Contemporary healthcare design research similarly highlights that practical, context-sensitive technologies are more likely to achieve long-term adoption because they align with users' everyday experiences and support continuous participation in rehabilitation activities (Göttgens et al., 2021; Peng et al., 2025).

Evaluating practicality requires designers to examine how rehabilitation products fit within users' daily lives, clinical workflows, caregiver responsibilities, and therapeutic objectives while simultaneously considering users' emotional responses to product interaction. Features such as intuitive assembly, lightweight construction, portability, straightforward maintenance, adaptability to different rehabilitation stages, and compatibility with therapist-guided protocols contribute not only to improved functionality but also to enhanced confidence, convenience, and peace of mind among users. By embedding practicality within Human-Centered Design and emotional design principles, rehabilitation product development can generate solutions that are clinically appropriate, contextually responsive, emotionally reassuring, and sustainable for long-term use. This holistic perspective ultimately supports greater rehabilitation adherence, improves collaboration among stakeholders, and contributes to more effective patient-centered rehabilitation outcomes.

Evocative Experience

Participants highlighted the importance of emotional responses elicited during product interaction, including feelings of reassurance, enjoyment, confidence, and meaningful connection with rehabilitation activities. Emotional engagement appeared to influence willingness to continue therapy and overall perceptions of the rehabilitation experience. Evocative experience emerged as the central dimension of the proposed Evocative Design Evaluation (EDE) framework, reflecting the capacity of rehabilitation products to foster meaningful emotional responses that shape users' perceptions, motivation, and commitment throughout the recovery process. Participants consistently associated positive therapeutic experiences with feelings of reassurance, confidence, enjoyment, dignity, and emotional connection, suggesting that these responses significantly influence continued engagement with rehabilitation activities.

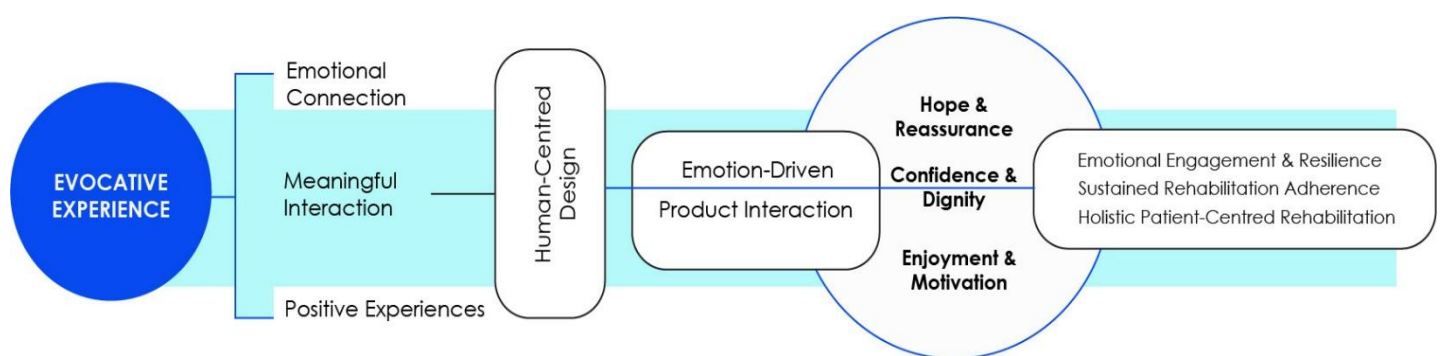


Figure 8. Conceptual Model of “Evocative Experience” Supporting Emotion-Driven Rehabilitation Product Design

These findings reinforce Human-Centered Design (HCD), which advocates understanding users' lived experiences, emotional needs, and rehabilitation contexts through active stakeholder involvement to create products that are personally meaningful as well as clinically effective (ISO 9241-210, 2019; Göttgens et al., 2021). Consistent with emotional design theory, positive emotional experiences strengthen users' attachment to rehabilitation technologies and encourage sustained participation by making therapy more rewarding and personally relevant (Norman, 2004; Desmet & Hekkert, 2007).

Motivation and Well Being

Motivation emerged as an important factor influencing sustained rehabilitation participation. Participants discussed how encouraging feedback, visible progress, achievable goals, and positive therapeutic experiences contributed to continued engagement with rehabilitation activities. Motivation and well-being emerged as interconnected dimensions that significantly influence users' commitment to rehabilitation and their overall recovery experience. Participants indicated that rehabilitation products should not only facilitate therapeutic exercises but also encourage users to remain motivated, emotionally resilient, and optimistic throughout prolonged rehabilitation programmes. By actively involving patients, caregivers, rehabilitation professionals, and designers throughout the development process, HCD ensures that rehabilitation products address both functional needs and psychological challenges commonly experienced during post-stroke recovery, such as frustration, anxiety, uncertainty, and declining confidence (ISO 9241-210, 2019; Göttgens et al., 2021). This user-centered approach encourages the development of rehabilitation solutions that support positive behavioral change while promoting users' physical and emotional well-being.

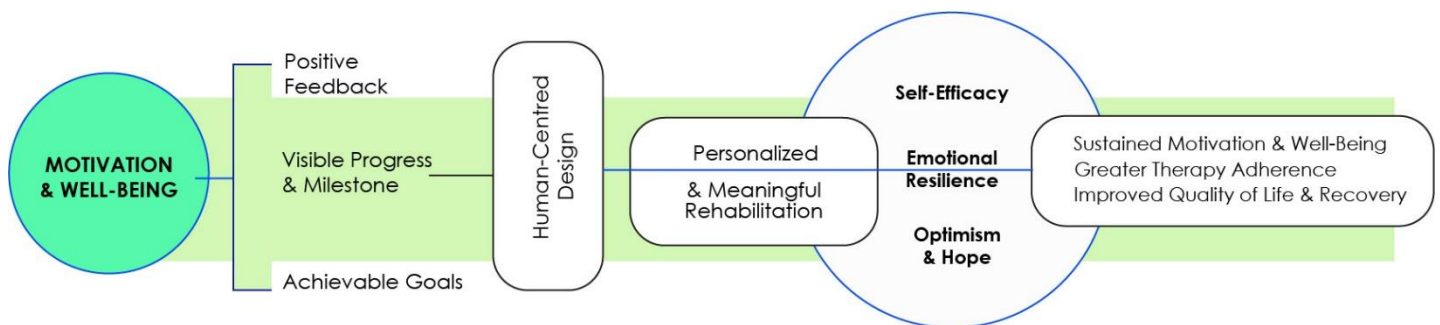


Figure 9. Conceptual Model of “Motivation and Well-Being” Supporting Patient-Centered Rehabilitation

From the perspective of emotional design, motivation is intrinsically linked to users' emotional experiences during product interaction. Rehabilitation devices that provide positive feedback, recognize incremental progress, support achievable therapeutic goals, and create rewarding user experiences foster feelings of competence, hope, self-efficacy, and accomplishment. According to Norman's (2004) emotional design framework, emotionally satisfying interactions enhance users' willingness to continue engaging with products, while Desmet and Hekkert (2007) argue that positive product experiences contribute to enduring emotional attachment and behavioral persistence. Motivation and well-being function as essential evaluative parameters that enable designers to assess how rehabilitation products influence users' emotional resilience and long-term therapeutic engagement. Incorporating these dimensions into rehabilitation product development encourages the creation of interventions that extend beyond clinical functionality to support holistic recovery, improve treatment adherence, and enhance the overall quality of life of individuals undergoing rehabilitation.

Empowerment

Participants described rehabilitation products as enabling greater independence and confidence when appropriately aligned with users' abilities and rehabilitation goals. Empowerment was associated with increased autonomy, decision-making, and active participation throughout recovery. Empowerment emerged as a significant outcome of effective rehabilitation product design, reflecting users' ability to actively participate in their own recovery, make informed decisions, and regain confidence in performing daily activities. Participants emphasized that rehabilitation devices should enable users to feel capable rather than dependent, supporting greater autonomy throughout the rehabilitation journey. Within the Human-Centered Design (HCD) approach, empowerment is achieved by involving patients, caregivers, rehabilitation professionals, and designers throughout the product development process to ensure that rehabilitation solutions are responsive to users' functional abilities, personal goals, and evolving recovery needs (ISO 9241-210, 2019). Such collaborative design practices encourage products that adapt to users' capabilities, provide meaningful therapeutic support, and facilitate active participation rather than passive treatment, thereby strengthening users' sense of ownership and control over their rehabilitation process.

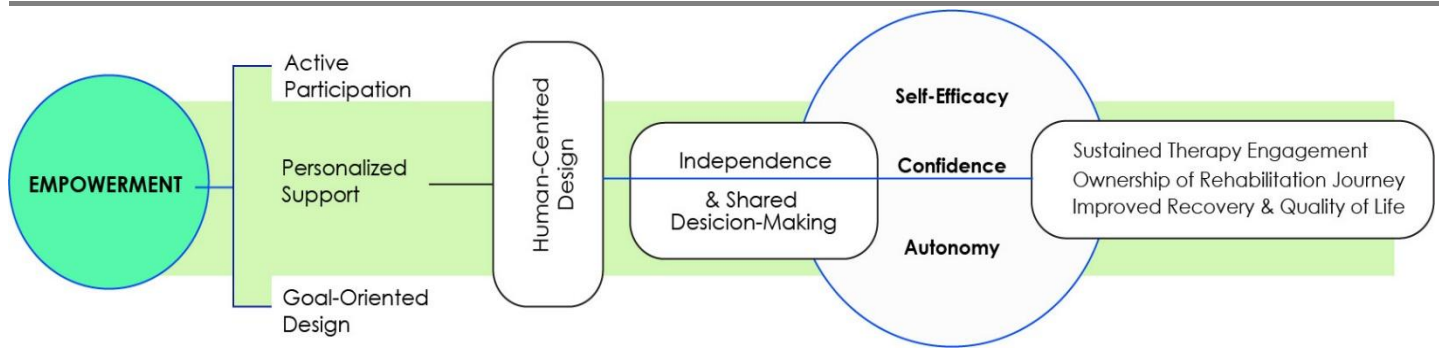


Figure 10. Conceptual Model of “Empowerment” Supporting Patient-Centered Rehabilitation

Empowerment is closely associated with positive emotional experiences that reinforce self-efficacy, confidence, independence, and resilience during rehabilitation. Norman's (2004) behavioral and reflective dimensions of emotional design suggest that products capable of enabling successful interaction and recognizing personal achievement contribute to stronger emotional attachment and sustained engagement. Likewise, Desmet and Hekkert (2007) argue that meaningful product experiences positively influence users' perceptions of competence and personal value. Empowerment is positioned as a critical evaluative parameter that extends beyond physical functionality to examine how rehabilitation products enhance users' confidence to participate actively in therapy and everyday life. Integrating empowerment into rehabilitation product development therefore supports the creation of patient-centered solutions that encourage self-management, improve therapeutic adherence, strengthen collaborative rehabilitation practices, and ultimately contribute to more sustainable functional recovery.

Trust and Comfort

Trust was associated with users' confidence in the safety, reliability, and consistency of rehabilitation devices, while comfort referred to both physical ergonomics and psychological reassurance during therapy. Participants suggested that trust and comfort influenced their willingness to use rehabilitation devices consistently over extended periods. Trust and comfort emerged as essential determinants of users' acceptance and continued use of rehabilitation products, particularly within post-stroke rehabilitation where prolonged interaction with therapeutic devices is required. Participants associated trust with the perceived reliability, safety, consistency, and clinical credibility of rehabilitation products, while comfort encompassed both physical ergonomics and psychological reassurance throughout therapy sessions. From a Human-Centered Design (HCD) perspective, trust and comfort are established by designing rehabilitation products around users' physical capabilities, cognitive limitations, therapeutic goals, and contextual needs through continuous engagement with patients, caregivers, rehabilitation professionals, and designers (ISO 9241-210, 2019). This collaborative design process enables the identification of ergonomic requirements, safety concerns, and contextual barriers early in product development, resulting in rehabilitation solutions that are easier to use, physically comfortable, and better aligned with real rehabilitation practices. Consequently, users are more likely to develop confidence in the product and integrate it consistently into their rehabilitation routines.

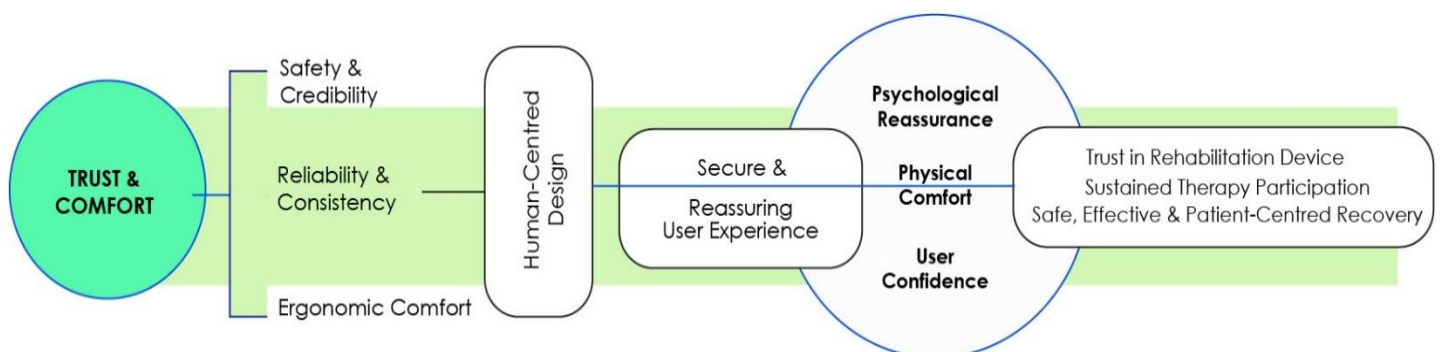


Figure 11. Conceptual Model of Trust and Comfort Supporting Patient-Centered Rehabilitation

Within this study, of emotional design, trust and comfort contribute significantly to users' emotional well-being by reducing uncertainty, anxiety, and fear often associated with rehabilitation following neurological impairment. Norman's (2004) emotional design framework suggests that products capable of delivering predictable, reliable, and reassuring interactions generate positive emotional responses that strengthen users' confidence and willingness to engage with therapeutic activities. Similarly, Desmet and Hekkert (2007) emphasize that positive product experiences arise when functional performance is accompanied by emotional reassurance and meaningful interaction. Within the proposed Evocative Design Evaluation (EDE) framework, trust and comfort function as complementary emotional design parameters that influence users' perceptions of safety, therapeutic confidence, and long-term adherence. Incorporating these dimensions into rehabilitation product development encourages designers to evaluate not only the technical performance of rehabilitation devices but also how they foster psychological security, physical ease, and emotional reassurance, ultimately supporting more effective, patient-centered, and sustainable rehabilitation outcomes.

Holistic Rehabilitation Integration

The final theme reflected participants' recognition that rehabilitation products should support the broader rehabilitation ecosystem rather than function as isolated devices. Participants discussed the importance of integrating product design with rehabilitation protocols, therapist guidance, caregiver involvement, and patients' daily routines. Holistic rehabilitation integration emerged as the overarching theme that unifies the functional, emotional, and contextual dimensions of rehabilitation product development. Participants emphasized that rehabilitation devices should not be designed as standalone therapeutic tools but as integral components of the broader rehabilitation ecosystem involving patients, caregivers, rehabilitation professionals, designers, engineers, and structured therapy protocols. From a Human-Centered Design (HCD) perspective, effective rehabilitation products must respond to users' evolving physical, cognitive, emotional, and environmental needs throughout the entire rehabilitation journey rather than addressing isolated functional problems (ISO 9241-210, 2019). This systems-oriented approach encourages continuous stakeholder collaboration and iterative design refinement to ensure that rehabilitation products are compatible with clinical workflows, home-based rehabilitation, caregiver support, and personalized therapy goals. Such integration strengthens communication among stakeholders while enabling rehabilitation products to adapt to the dynamic nature of post-stroke recovery. By incorporating these interconnected dimensions into rehabilitation product development, designers can create rehabilitation solutions that not only improve clinical effectiveness but also strengthen patient engagement, interdisciplinary collaboration, continuity of care, and long-term rehabilitation adherence. This holistic perspective advances rehabilitation product development beyond conventional device design towards a comprehensive, patient-centered innovation framework capable of supporting sustainable recovery and improved quality of life.

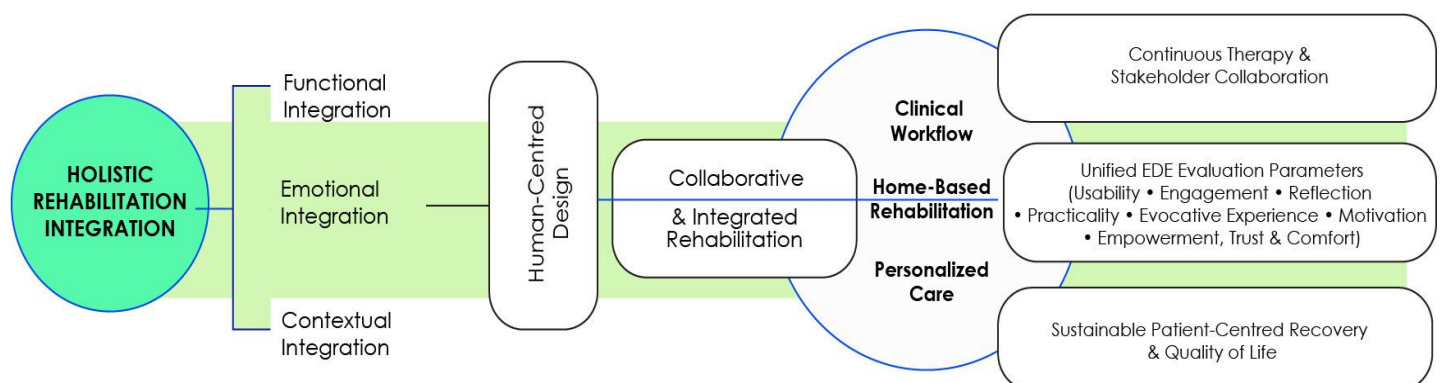


Figure 12. Holistic Rehabilitation Integration as the Integrative Design Parameter within the Proposed Evocative Design Evaluation (EDE) Framework

DISCUSSION

Development of the Evocative Design Evaluation Framework

The conceptual EDE Framework was developed through a systematic and scientifically rigorous research process that integrated evidence from an extensive literature review, empirical data collection, expert validation, and iterative synthesis. The framework construction followed a structured methodology to ensure that the identified evaluation domains were theoretically grounded, empirically supported, and practically relevant to rehabilitation product development. By combining multidisciplinary perspectives from design, engineering, healthcare, and end-user experiences, the framework establishes a comprehensive evaluation model that captures both functional performance and emotional dimensions of rehabilitation. The integration of findings across all nine themes informed the conceptual development of the Evocative Design Evaluation (EDE) Framework. The conceptual framework synthesizes users' emotional experiences, stakeholder perspectives, and rehabilitation processes into a structured approach for rehabilitation product development. Rather than viewing usability, ergonomics, and emotional responses as independent considerations, the framework positions them as interconnected dimensions that collectively guide design decision-making throughout iterative product development.

The proposed Evocative Design Evaluation (EDE) conceptual framework represents a comprehensive, human-centered approach to rehabilitation product development by systematically integrating emotional experiences into the design evaluation process. Unlike conventional rehabilitation product development, which predominantly emphasizes functionality, ergonomics, safety, and clinical performance, the EDE framework positions users' emotional experiences as an essential source of design evidence throughout the product lifecycle. Developed from the synthesis of multidisciplinary stakeholder perspectives and grounded in Human-Centered Design (HCD), emotional design, and qualitative design evaluation, the framework provides a structured methodology for understanding how patients, caregivers, rehabilitation professionals, designers, and engineers collectively influence the development of rehabilitation products. By recognizing emotional responses as complementary to functional performance rather than secondary outcomes, the framework broadens the scope of rehabilitation evaluation to include psychological well-being, motivation, confidence, trust, empowerment, and meaningful engagement, ultimately supporting more holistic and patient-responsive rehabilitation solutions.

Systematic Human-Centered Rehabilitation Product Development Parameter

Figure 12 presents the proposed conceptual EDE Framework, illustrating the relationships among stakeholders, rehabilitation protocols, emotional evaluation, and iterative design refinement. The framework serves as a systematic guide for integrating patients' lived experiences into rehabilitation product development while supporting interdisciplinary collaboration among designers, healthcare professionals, engineers, caregivers, and end users. The significance of the conceptual EDE framework lies in its ability to reposition design evaluation as a continuous knowledge-generation process rather than a single validation activity conducted after product development. Throughout the rehabilitation journey, users continuously experience changes in physical capability, emotional resilience, therapeutic motivation, and environmental context. Consequently, rehabilitation products should evolve through iterative evaluation that captures these changing experiences and translates them into actionable design decisions. The conceptual EDE framework addresses this need by integrating nine interrelated evaluation domains: usability, engagement and interactivity, reflective experience, practicality, evocative experience, motivation and well-being, empowerment, trust and comfort, and holistic rehabilitation integration into a systematic design process. Collectively, these domains provide designers with a comprehensive understanding of how rehabilitation products perform not only from a technical perspective but also from the viewpoint of users' lived experiences, thereby strengthening design decision-making throughout successive stages of product development. The framework may transform rehabilitation product development from a device-centered approach to a human-centered, emotion-driven, ecosystem-oriented innovation for better recovery and well-being holistically.



Figure 12. Proposed Conceptual Evocative Design Evaluation (EDE) Framework for Emotion-Driven

CONCLUSION

A key contribution of the conceptual framework is the establishment of a comprehensive design guideline that is tailored to patients' individual preferences, rehabilitation goals, and contextual needs. Human-Centered Design advocates active stakeholder participation throughout product development; however, existing rehabilitation design practices frequently lack structured mechanisms for translating qualitative user experiences into design requirements. The conceptual EDE framework addresses this limitation by creating an evaluative platform

through which emotional, cognitive, behavioral, and contextual insights are systematically interpreted alongside functional and clinical considerations. This enables designers to identify evolving patient preferences related to comfort, motivation, confidence, independence, and therapeutic engagement while simultaneously considering caregivers' practical concerns and clinicians' rehabilitation objectives. Rather than promoting a one-size-fits-all solution, the framework supports adaptive and inclusive rehabilitation product development by recognizing that users' needs vary across different stages of recovery, levels of functional ability, and rehabilitation environments. Such an approach facilitates the development of rehabilitation products that are more responsive to individual rehabilitation pathways while promoting greater acceptance and long-term use.

Another significant contribution of the EDE framework conceptually, is the integration of emotion-driven parameters directly within rehabilitation therapy protocols, enabling emotional experiences to become measurable indicators during design evaluation. Rehabilitation is inherently iterative, requiring patients to repeatedly perform therapeutic activities over extended periods, often accompanied by fluctuating motivation, confidence, and emotional well-being. Conventional evaluation approaches primarily monitor clinical progress and functional performance, whereas the EDE framework extends evaluation by incorporating emotional indicators such as reassurance, engagement, reflective achievement, empowerment, trust, and psychological comfort throughout therapy sessions. Through qualitative methods such as semi-structured interviews and Verbal Protocol Analysis, emotional responses can be observed and interpreted in relation to specific rehabilitation activities, allowing designers and rehabilitation professionals to understand not only whether a device functions effectively but also how it influences patients' willingness to participate in therapy. Integrating these emotion-driven parameters into therapy protocols therefore provides a richer evidence base for iterative product refinement while strengthening communication among designers, therapists, caregivers, and patients during rehabilitation planning and evaluation.

Furthermore, the EDE framework may advance accessibility by embedding Human-Centered Design principles and well-being considerations throughout both the design and rehabilitation environments. Accessibility within this framework extends beyond physical usability to include cognitive accessibility, emotional accessibility, therapeutic inclusiveness, and contextual adaptability. Rehabilitation products should accommodate diverse physical capabilities, cognitive conditions, emotional states, and environmental settings while supporting users' dignity, autonomy, and participation throughout rehabilitation. By incorporating well-being as a central evaluation parameter, the framework encourages rehabilitation products that reduce cognitive burden, minimize anxiety, strengthen emotional resilience, and foster positive therapeutic experiences. This holistic perspective aligns with contemporary healthcare priorities that advocate person-centered care, inclusive design, and quality-of-life outcomes alongside clinical effectiveness.

The conceptual EDE framework also may promote interdisciplinary collaboration by establishing a common evaluative language across design, engineering, rehabilitation medicine, occupational therapy, physiotherapy, and caregiving. Rather than evaluating rehabilitation products independently within individual disciplines, the framework encourages collaborative interpretation of users' experiences and iterative refinement throughout product development. This collaborative ecosystem facilitates shared decision-making, enables the integration of diverse professional expertise, and supports the development of rehabilitation products that are simultaneously clinically appropriate, technically feasible, ergonomically effective, emotionally meaningful, and contextually relevant. Such interdisciplinary alignment is particularly important in post-stroke rehabilitation, where successful recovery depends upon coordinated interaction among multiple stakeholders over prolonged periods.

RECOMMENDATIONS AND FUTURE RESEARCH

Overall, the proposed **Evocative Design Evaluation (EDE)** framework offers a novel conceptual model that bridges conventional rehabilitation product evaluation with emotion-driven design by integrating Human-Centered Design principles, emotional design parameters, and rehabilitation processes into a unified evaluative approach. The framework provides a systematic means of translating users' lived experiences into evidence-informed design decisions that extend beyond functional performance to enhance patient engagement, therapeutic adherence, psychological well-being, and sustainable recovery. While the present study establishes the theoretical foundation of the EDE framework through qualitative inquiry, future research should focus on its

empirical validation in real-world rehabilitation settings involving rehabilitation product users, designers, therapists, caregivers, and other healthcare professionals. Specifically, studies should evaluate whether rehabilitation products developed using the EDE framework produce measurable improvements in usability, user acceptance, emotional satisfaction, therapy adherence, and rehabilitation outcomes compared with conventional design approaches. Longitudinal investigations, prototype evaluations, and multi-site implementation studies across diverse rehabilitation contexts including different disabilities, age groups, healthcare environments, and cultural settings would further establish the framework's reliability, transferability, and generalizability. Such validation will strengthen the framework's practical applicability and contribute to the advancement of evidence-based, patient-centered rehabilitation product innovation within healthcare and public health.

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