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Design for Social Impact: A Research-Driven Approach to Addressing Challenges Faced by Amputees in Egypt

Abstract

Socio-economically challenged amputees in Egypt face systemic challenges that extend beyond physical limitations and difficulties, highlighting a pressing need for inclusive design solutions. This study examines how human-centered design can be effectively employed to address these issues by tailoring the research process to the local cultural and socioeconomic context. A mixed-methods approach was implemented, incorporating the following: a field research that provided a broad understanding of the available services and their accessibility; a case study of a service provider and individual patients that offer detailed insights into gaps in the rehabilitation system available. Semi-structured interviews, observations, and participatory techniques played a central role in capturing authentic experiences and perspectives, fostering trust and empathy with participants. Analytical tools like mind mapping and giga mapping were used to organize findings and identify interconnected challenges. The research process demonstrates the critical importance of human-centered design in identifying the core challenge and crafting relevant, accessible, and impactful solutions that directly address the target audiences' needs and effectively improve their quality of life.

Keywords:*human-centered design, design for social impact, amputees, rehabilitation, socioeconomic challenges*

Introduction

Learning to walk again after lower-limb amputation is a physically and emotionally demanding journey. While advanced prosthetic technologies exist, they remain out of reach for many in developing countries. High-tech solutions, though promising, often fail to adapt to rural lifestyles, leading patients to abandon their devices and revert to makeshift aids like wooden sticks. The situation is exacerbated by poor access to rehabilitation services, limited awareness, and socio-cultural stigma.

Living in Egypt, I have witnessed the disparities firsthand—from individuals able to access overseas rehabilitation to those living with unaccommodated residual limbs. Despite this range, most amputees, particularly from low-income backgrounds, lack access to essential services and support. The result is not only physical immobility but psychological marginalization and a perceived dependency on others.

This research aims to address these inequalities by applying a human-centered design lens to understand and respond to the needs of socio-economically challenged lower-limb amputees.

Literature Review

Post-amputation recovery is shaped by a complex interplay of physical, psychological, and socioeconomic factors.

Physical Challenges. Recovery often involves difficulties with stump healing, chronic pain, and the fitting and maintenance of prosthetics. Poorly fitted devices can cause spinal misalignment, discomfort, and discouragement from continued use (Footcare MD, 2017; E. Kurichi et al., 2010).

Psychological Challenges. The psychological toll of amputation is substantial. Depression, anxiety, identity crises, and social isolation are common, particularly among trauma survivors and younger patients (Desmond et al., 2002; Hawamdeh et al., 2008). Without proper support systems, emotional recovery can be delayed or inhibited.

Socioeconomic Barriers. The financial burden of prosthetic care, coupled with limited access to rehabilitation services—especially in rural areas—often results in prolonged immobility and dependency (Tyc, 1992). Rehabilitation success depends not only on physical treatment but also on access to early interventions, pain management, proper prosthetic fit, and psychological and social support

In low-income communities, these barriers are further intensified. Many prosthetic devices are imported, costly, and poorly suited to local environments, making them inaccessible or ineffective for many users (Bhaskaranand et al., 2003). Public healthcare infrastructure often lacks investment, and prosthetic services are frequently provided by undertrained personnel, increasing the risk of misfitting and patient harm (Morsy, 2018). Cultural stigma surrounding disability further isolates amputees, creating additional

psychological burdens and discouraging the use of assistive devices in public life.

Together, these intersecting challenges demonstrate the urgent need for locally appropriate, inclusive rehabilitation strategies—particularly for socioeconomically disadvantaged populations.

Study Objectives

This study aims to explore how a human-centered design approach can help uncover the complex challenges faced by lower-limb amputees from socioeconomically disadvantaged communities in Egypt. Grounded in principles of empathy, trust, and contextual awareness, the research seeks to surface insights that reflect the lived realities of individuals navigating post-amputation life within under-resourced systems.

The objective is not only to understand the physical, psychological, and social barriers that hinder effective rehabilitation, but also to identify opportunities for inclusive, low-cost, and locally relevant design interventions. By doing so, the study aspires to contribute to more equitable and responsive support systems that can improve the quality of life for marginalized amputees.

Methodology

This study employed a qualitative, human-centered design methodology, grounded in the principles of empathy, contextual sensitivity, and participatory engagement. Rather than approaching the research as a detached observer, the process was guided by immersion, relationship-building, and an intentional effort to listen deeply to the needs, concerns, and hopes of those directly affected

by amputation. This enabled the generation of insights that were not only analytical but also emotionally and socially grounded.

The empirical research design was structured into three iterative phases, each building upon the last to deepen understanding and highlight areas of critical need:

Field Research: Conducted across a variety of public, private, and informal prosthetic service providers to map the national landscape and examine issues of accessibility, quality, affordability, and user experience.

Service Provider Case Study (Al-Hayyah Facility): Focused on a rehabilitation center known for its patient-centered ethos, this phase involved long-term observational engagement and informal, semi-structured interviews with staff, patients, and caregivers over a period of one year and a half.

Individual Patient Case Study: A focused exploration of the experience of a 23-year-old female amputee from a rural area. This phase aimed to understand how systemic challenges manifest in day-to-day life and influence personal and social well-being.

A multi-method qualitative approach to data collection was adopted to capture complex realities from multiple perspectives:

Participant Observation: As the researcher, I was embedded within Al-Hayyah's Cairo branch for over eighteen months as an assistant, attending bi-weekly sessions and assisting during consultations and fittings. This assistant role allowed for natural rapport-building with both staff and patients, and allowed for a

comprehensive understanding of the organization's operations, routines, and interpersonal dynamics between all stakeholders.

Additionally, this role allowed me to develop a deeper, firsthand understanding of the prosthesis fitting and rehabilitation process within a low-resource context. I observed how patients navigated the physical, emotional, and logistical demands of rehabilitation and prosthesis fitting, often under immense financial and social strain. Rather than following the standardized and linear model often outlined in literature, the process revealed itself to be far more complex and adaptive—shaped by material limitations, informal practices, necessary improvisations and evolving patient-caregiver dynamics. These insights, grounded in participatory observation, offered a detailed and layered view of amputee care delivery reality on ground.

Semi-Structured Interviews: Conducted with patients, caregivers, prosthetists, physiotherapists, and center managers. These were approached conversationally, often occurring informally during waiting periods or clinical sessions, which made participants more comfortable and open. However, building trust—particularly with patients—proved challenging. Many had been previously misled or exploited, receiving low-quality prostheses after paying significant sums. Others had been dismissed by medical professionals, and some faced additional barriers due to illiteracy, which made it difficult to verify information or advocate for themselves.

For the first two months, I focused primarily on observation—listening, learning the language patients used, and understanding how they wished to be treated and engaged. This period of quiet

immersion was essential in creating space for genuine connection. Over time, familiarity and consistency helped ease initial hesitation. The first informal conversation with a patient in the waiting area marked a turning point; gradually, others began to open up. In some cases, patients invited me to help explain medical instructions in simpler terms or take notes on their behalf. These interactions became critical to building trust and collecting insights that would have otherwise remained inaccessible.

Contextual Engagement and Shadowing: The research extended into patients' lived environments, including home visits, to observe how clinical advice translated—or failed to translate—into daily practice. Shadowing was a key method used during the third phase of the study, particularly in the individual case study of a 23-year-old female amputee living in a rural village. I traveled to her home and accompanied her throughout her daily routine to better understand the challenges she faced beyond the clinic setting.

This immersive approach offered a clearer picture of how she navigated work, social interactions, and mobility while managing a painful stump and attempting to apply the rehabilitation exercises recommended by physiotherapists. Some elements of the prescribed routine were followed, while others proved difficult due to physical discomfort, environmental constraints, or lack of ongoing support. Observing these moments firsthand provided a deeper, more grounded understanding of how systemic barriers manifest in everyday life—insight that could not have been captured through clinic-based conversations alone.

Ethnographic Sensitivity: All data collection was shaped by respect for the emotional and cultural boundaries of participants. Due to shyness, discomfort, or cultural norms—especially among female participants—no recordings or photographs were taken. Notes were taken discreetly and respectfully.

To interpret and organize the collected data, the following analytical tools were used:

Mind Mapping: To cluster insights and observe relationships between themes emerging from interviews and observations.

SWOT Analysis: To assess strengths, weaknesses, opportunities, and threats within Egypt’s prosthetics and rehabilitation ecosystem.

Giga Mapping: A systems-oriented method used to trace multilayered connections between institutional gaps, societal norms, and patient outcomes. This visualization helped identify where failures accumulate and where design interventions might be most impactful.

Findings

The research revealed that lower-limb amputees in socioeconomically disadvantaged communities face systemic barriers that severely compromise their post-amputation quality of life. Services are largely centralized in urban areas, making access difficult and costly for rural patients. High-quality prosthetics remain financially inaccessible, while cheaper alternatives are often ill-fitted and uncomfortable, leading to pain and abandonment. A lack of

guidance on stump care and mobility training, coupled with unqualified personnel, further limits patients' ability to adapt.

Even in more empathetic care settings, such as Al-Hayyah Rehabilitation Center, key gaps persist. Patients often receive information verbally with no follow-up support, caregivers sometimes mediate or override decisions, and gender dynamics can inhibit trust and comfort during fittings. These issues are particularly pronounced among women and those with prior negative care experiences.

The case of Ms. S., a young woman from a rural area, underscored the long-term consequences of these gaps. Her earlier experience with an ill-fitted prosthesis had caused spinal complications, and the absence of pre-prosthetic care left her unaware of basic stump management. Cultural discomfort further hindered her engagement in rehabilitation. Her story reflected how physical harm, emotional strain, and social stigma are deeply intertwined—and how they often begin well before a prosthesis is fitted.

To better illustrate the interconnected nature of these challenges, a Giga Map (Figure 1) was developed based on the empirical research phase. The map organizes findings across three layers: (1) country-level systemic gaps, (2) amputee-specific service gaps, and (3) resulting quality of life difficulties. These layers are further categorized by issues such as poor public infrastructure, lack of specialized training, inadequate insurance, and underdeveloped local product design.

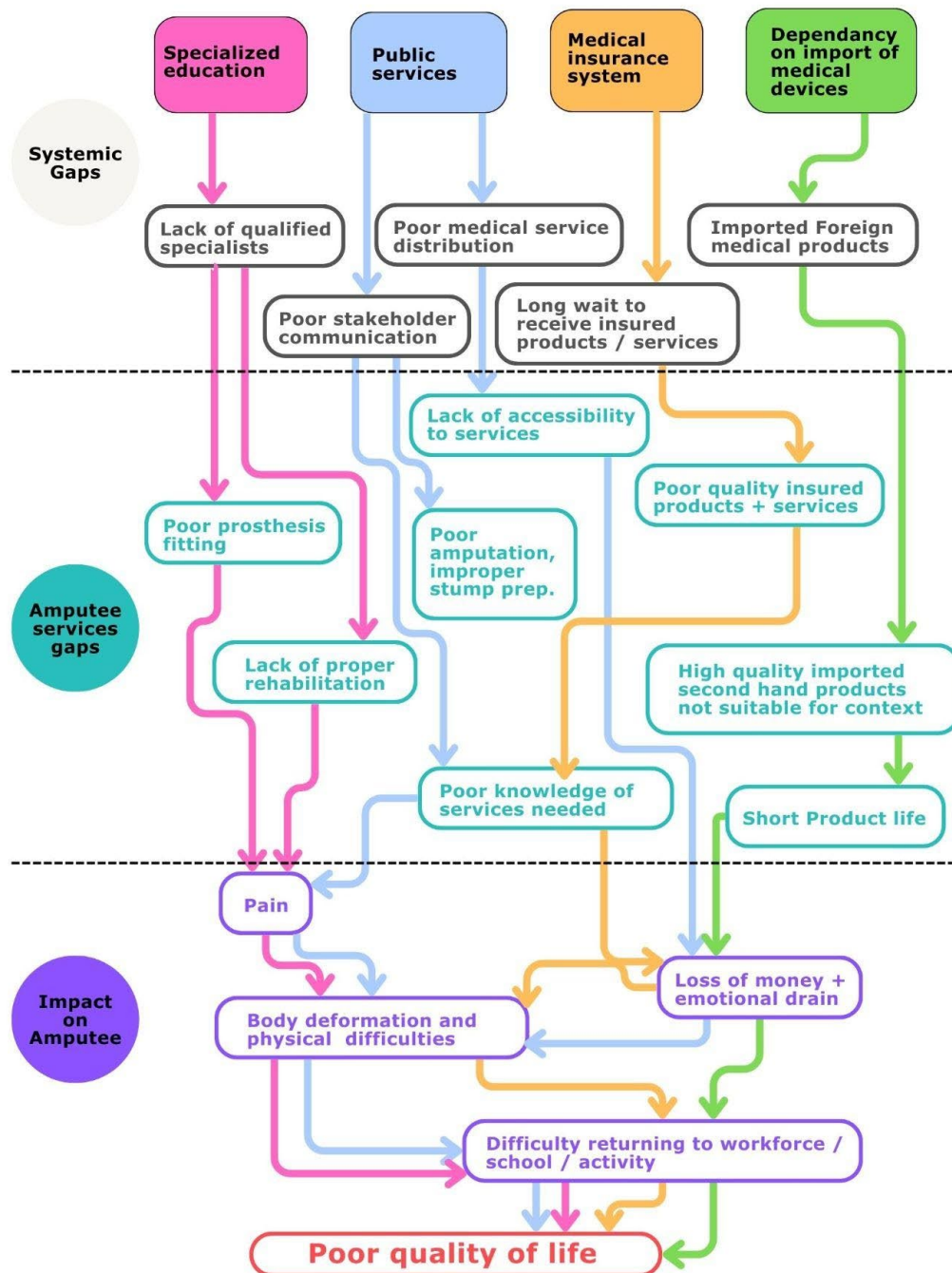


Figure 1: Findings Giga-map

The map reveals how one issue often leads to another in a cascading, domino-like effect. For example, a lack of specialized education contributes to a shortage of qualified rehabilitation professionals, which in turn results in poor prosthetic fitting and limited patient guidance. This leads to physical pain and gait deviation, which eventually contributes to body disfigurement, emotional distress, and social exclusion. Ultimately, these overlapping challenges culminate in diminished independence and poor quality of life.

By visualizing these complex relationships, the Giga Map highlights the need for integrated, cross-sectoral and human-centered approaches to rehabilitation process innovation—ones that go beyond basic clinical care and are context-specific to address patients' needs and concerns.

Discussion

The human-centered research process revealed rehabilitation as a critical and underserved stage in the amputee journey—one that directly affects long-term adaptation, independence, and overall quality of life. While the larger systemic challenges—such as poor communication between healthcare professionals, lack of specialist training, and limited access to services—require long-term infrastructural reform, it became clear that targeted improvements in rehabilitation could create immediate and meaningful impact.

This insight was grounded in both field observations and case analysis, where recurring issues of misaligned prosthetics, pain, and poor gait were linked directly to the absence of structured, coordinated rehabilitation efforts. As a response, a seven-step

rehabilitation model (Table 1) was proposed, aimed at bridging these service gaps through coordinated care, user-specific treatment plans, and continuous support via a dedicated case manager.

STEP	FOCUS AREA	KEY PARTICIPANTS	KEY ACTIVITIES & TAKEAWAYS
1. PRE-SURGERY MEETING	Surgical planning and psychological prep	Surgeon, Physiotherapist, Prosthetist, Psychologist, Dietitian, Nurse	Amputation planning, prosthetic options, pre-surgery exercises, caregiver guidance
2. POST-SURGERY RECOVERY	Wound care and emotional support	Nurse, Psychologist, Physiotherapist	Stump care, pain and phantom limb management, grief support
3. PREPARATORY PHASE	Early physiotherapy and independence	Physiotherapist	Mobility with preparatory prosthesis, stump reduction, daily activity training
4. BASIC GAIT TRAINING	Gait skills and readiness assessment	Physiotherapist	Gait training, pain monitoring, socket fit assessment, intro to home gait tools
5. FINAL PROSTHESIS PREPARATION	Socket casting and gait analysis	Prosthetist, Physiotherapist	Permanent socket fitting, gait correction, evaluation of home training progress
6. PERMANENT PROSTHESIS TRAINING	Functional adaptation and maintenance	Physiotherapist, Prosthetist	Advanced gait training, prosthesis care, real-world mobility tasks
7. FOLLOW-UP & REINTEGRATION	Long-term adjustment and social reintegration	Full team incl. Psychologist, Vocational Therapist	Socket adjustments, gait check, psychological support, vocational planning

Table 1: 7-step rehabilitation model

The proposed rehabilitation process is structured as a seven-phase journey designed to align clinical expertise with the realities of life in low-resource contexts. Adapted from ideal models and informed by the existing practices at the Al-Hayyah facility, this structure emphasizes continuity, patient education, and long-term support. Each meeting is designed as a full-day intensive workshop to accommodate patients traveling from rural areas, with structured

“homework” and take-home materials to reinforce progress between sessions.

Beginning with a rarely offered pre-surgery session (depending on Amputation circumstances) and continuing through long-term follow-up, each phase brings together an interdisciplinary team to address physical, emotional, and logistical challenges. This process is intended to be flexible and scalable—suitable for both new and experienced amputees—and relies on consistent patient involvement, clear communication, and a case-managed approach for coordination. While implementation may vary based on facility capacity and geography, the model offers a structured foundation for improving long-term rehabilitation outcomes.

Among the most pressing issues identified in the research was the long-term physical impact of incorrect gait patterns following amputation. Poor alignment and limb compensation, often resulting from ill-fitted prostheses and lack of supervised gait training, were shown to contribute to serious complications such as pelvic tilt, spinal misalignment, and chronic pain. In one documented case, these issues had advanced to the point of affecting the patient’s ability to bear children—highlighting the profound implications of inadequate post-amputation support.

Gait training, though essential, remains inaccessible to many patients due to cost, distance, and limited availability of physiotherapists. To address this gap, a low-cost wearable tool—the Dynamic Gait Brace—was developed to support patients in maintaining proper step width during unsupervised home training (Figure 2). Designed as an extension of the therapist’s role, the brace restricts unconscious deviations by guiding the user’s legs into

correct alignment, mimicking the adjustments typically made during in-person sessions.

The prototype consists of an adjustable elastic hip belt connected to vertical and horizontal straps, which help maintain correct spacing between the legs. Materials were chosen for affordability and ease of production, making the tool accessible to the study's target group. It was tested in two versions, both emphasizing modularity and comfort across different age and body types. While not a replacement for supervised care, the brace is intended to improve training outcomes between clinical visits, reduce harmful gait patterns, and support long-term physical well-being.



Figure 2: The Dynamic Gait Brace

Five Years Later: A Shifting Landscape of Need and Capacity (2025)

As of 2025, five years after the initial design and testing phase, the socio-economic reality for many amputees in Egypt has grown more complex. Worsening economic conditions have placed overwhelming pressure on patients from low-income backgrounds. Rehabilitation—despite its proven importance and medical endorsement—has become a luxury many cannot afford. Patients are often faced with impossible choices: investing in a prosthesis or feeding their families. Even when rehabilitation is advised and necessary, it is now frequently postponed or foregone entirely due to lack of time, financial means, and emotional bandwidth. Immediate survival needs outweigh long-term health considerations.

In parallel, the rise of internet access has introduced a new duality in the rehabilitation journey. On one hand, patients now have unprecedented access to information about their condition, enabling a greater sense of agency and understanding. On the other hand, without guidance from trained professionals, this unfiltered access can lead to misinformation, unrealistic expectations, or improper self-treatment methods, ultimately increasing the risk of harm or disengagement from formal rehabilitation services.

This combination of economic hardship and unstructured knowledge access complicates the rehabilitation landscape further, underscoring the need for sustainable, low-cost, and context-sensitive solutions that don't rely solely on ideal systems or patient-driven initiative. The findings of this study remain relevant and timely, pointing to rehabilitation as a crucial but fragile field of

intervention—one that must adapt not only to medical need, but also to shifting social and economic realities.

Conclusion

This study demonstrates the necessity and power of human-centered design in developing social impact solutions. By embedding the research within the lived realities of Egypt’s socio-economically challenged amputees, it was possible to surface deeply rooted issues and propose relevant, achievable interventions. Rehabilitation, though often overlooked, proved to be a pivotal phase in patient recovery and independence. The insights gathered here offer a roadmap for designing better, more inclusive healthcare systems—starting not from what is ideal, but from what is real.

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