National Rehabilitation Center
Republic of Korea

INRS International Neurorehabilitation Symposium
REHABWEEK 2025

Design of an Ankle Rehabilitation Robot at Home for Stroke Survivors with Hemiplegia

Byung-Woo Ko, Jihyeon Jo, and Myungjoon Lim†

(e-mail: rstpmj@gmail.com†)

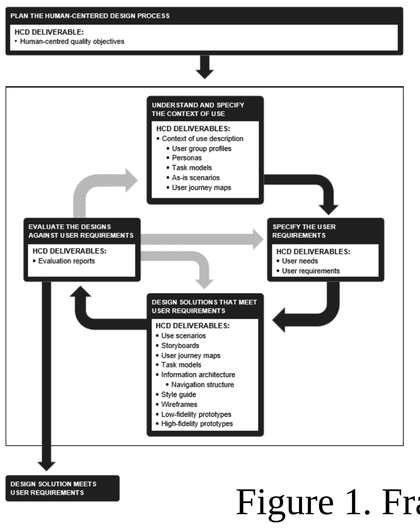
Department of Rehabilitative and Assistive Technology, National Rehabilitation Center, Seoul, South Korea

1. INTRODUCTION (Rehab Robots at Home)

- **Stroke** results in significant neurological deficits, impacting the functionality of limbs and reducing the overall quality of life.
- Conditions such as **foot drop** can hinder mobility and independence, often requiring extensive rehabilitation efforts.
- Recent legislative changes in Korea, including **the Integrated Care Support Act** and **home rehabilitation programs**, emphasize the significance of effective home-based solutions.
- This study introduces the **Ankle Rehabilitation Robots at Home (ARRaH) Product-Service Systems (PSS)**, designed to strengthen lower limbs and enhance the quality of life for stroke survivors experiencing hemiplegia.

2.METHOD (HCD + PSS)

- **Human-Centered Design (HCD)** modified from **ISO9241-210**
- **Product-Service Systems (PSS)** modified from **IEC TS 63134:2020**



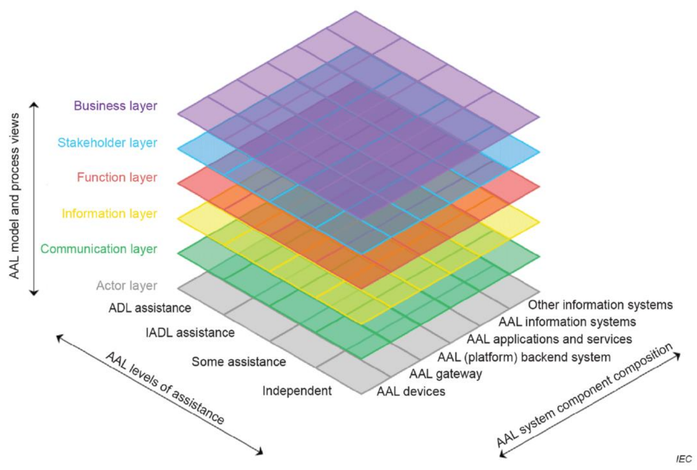
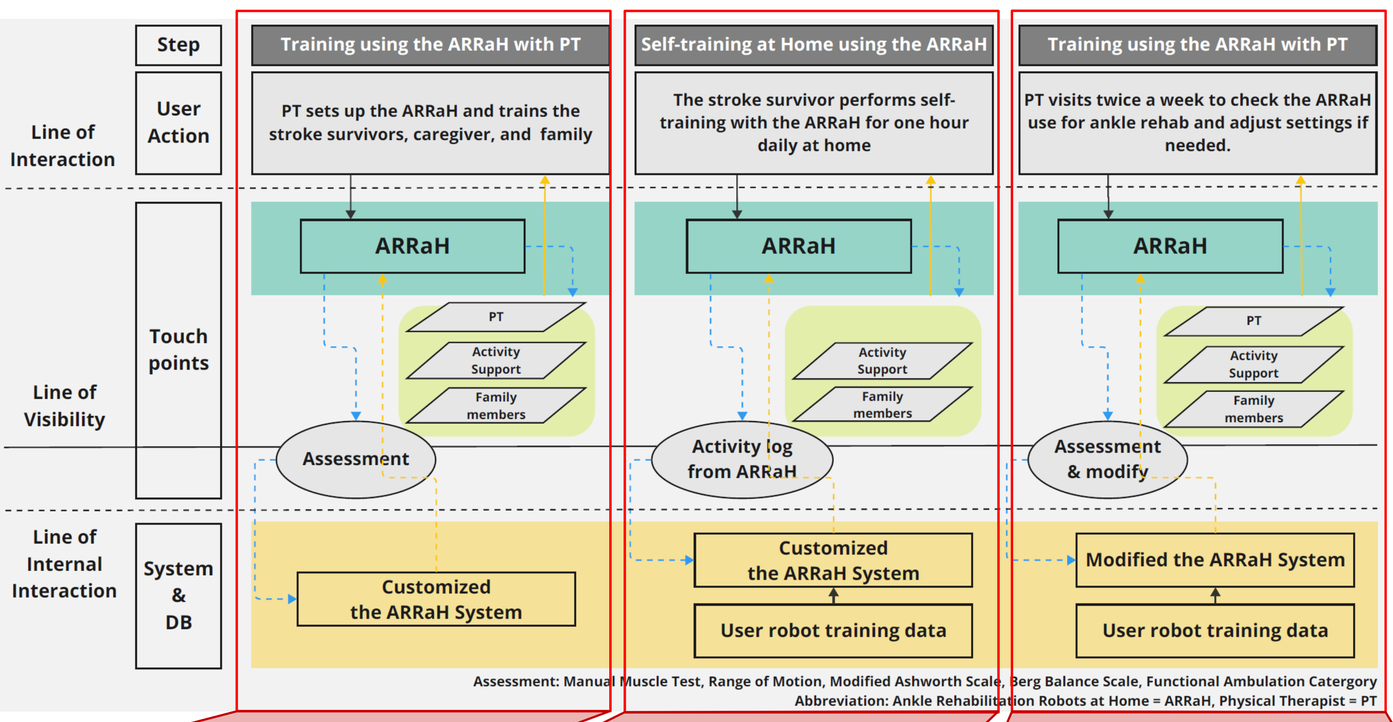


Figure 1. Framework for HCD and PSS

3. RESULT (ARRaH PSS)

- **Smart PSS Design:** In the context of home-based rehabilitation in Korea, ARRaH plays a supportive role for physical therapists in ankle rehabilitation. The 10 scenarios, including both initial and follow-up visits, were Proposed.



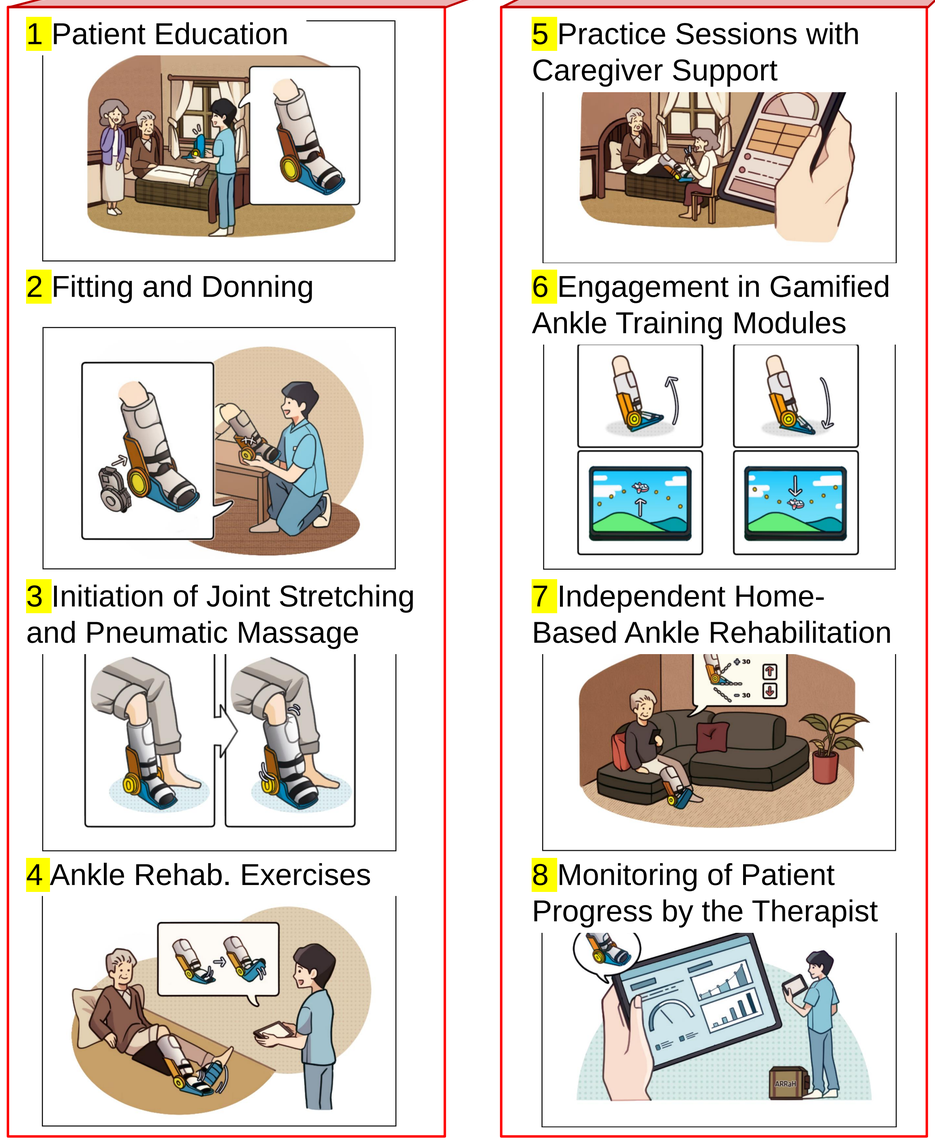


Figure 2. Smart PSS for the ARRah system.

- **Product and Application Design:** ARRaH features a **pneumatic inner boot** for muscle relaxation and a **motorized exoskeleton frame** providing passive, active-assist, and resistive modes. The ARRah App serves as the user interface, offering personalized rehabilitation and allowing users to share exercise data with therapists for improved monitoring.

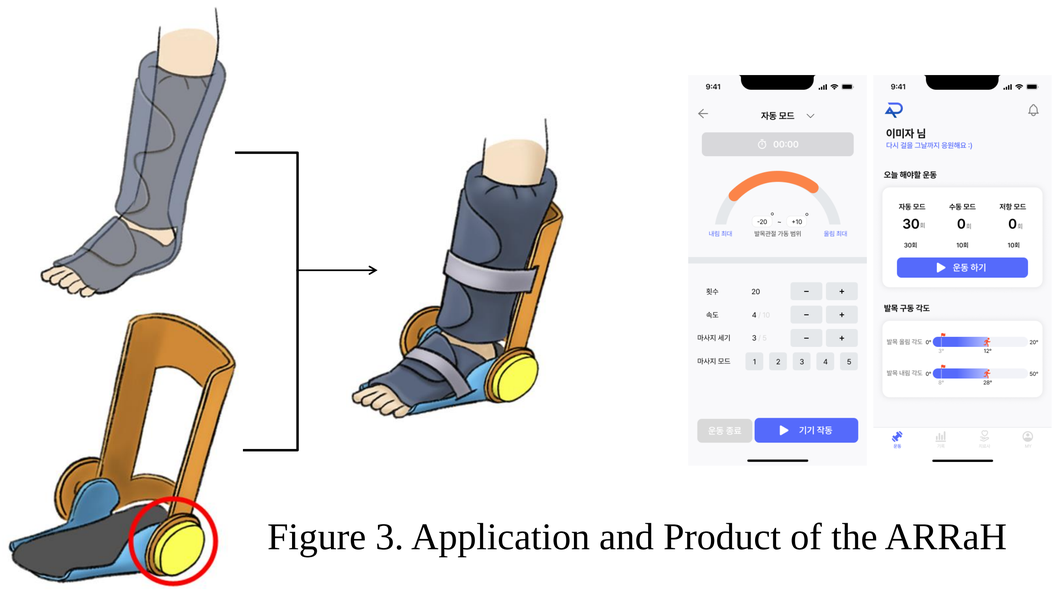


Figure 3. Application and Product of the ARRaH

- **Stakeholder Map and Business Model**: a rental home rehabilitation model backed by National Health Insurance and local authorities. Personalization driven by data improves service effectiveness and accessibility.

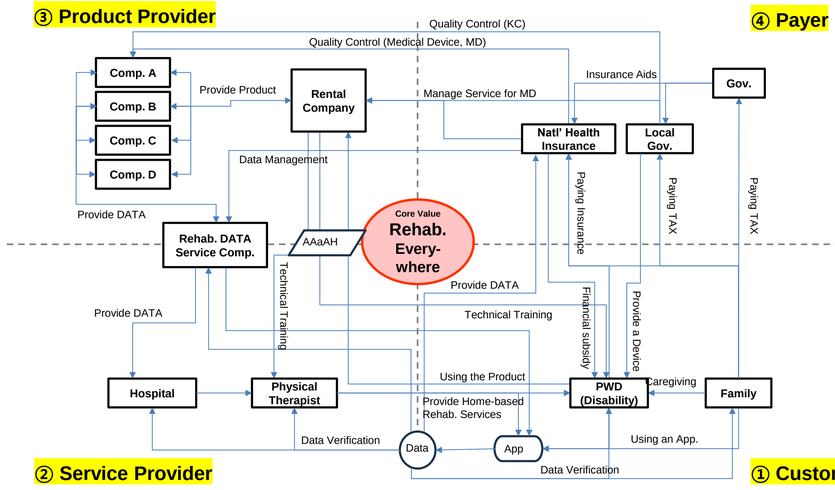


Figure 4. Business Model and Stakeholder Map for the ARRaH

4. DISCUSSION AND CONCLUSION

- This research employed Human-Centered Design (HCD) and Product-Service System (PSS) methodologies to create **ARRaH**, an ankle rehabilitation solution tailored **for stroke survivors in a home environment.**
- The solution was conceptualized as a **Smart PSS, integrating the product, application, and stakeholder map, which culminated in a sustainable business model.**
- In the next phase, we intend to conduct **clinical evaluations of both the product and service components of ARRaH**, while also enhancing the PSS for effective implementation in **home visit rehabilitation scenarios**.

▪ This study was supported by a grant (#NRCTRIN-24006 and 25006) of the Translational Research Center for Rehabilitation Robots, National Rehabilitation Center, Ministry of Health & Welfare, Korea.