Human Factors in Aging and Special Needs, Vol. 133, 2024, 61–69
https://doi.org/10.54941/ahfe1004894

Self-Service Health Screening Devices Based on Community Health Management Services

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ABSTRACT

The development of primary public health services in China is facing great challenges. A shortage of family doctor resources, inadequate health awareness of residents, and low health screening coverage of residents are still the current dilemmas that primary health services face. Gradually, community health services that include a type of self-service health screening device are starting to emerge. In this context, a community is defined as a collection of individuals living in a particular geographical area with public facilities for their daily life use. In light of today's aging trends, self-service devices may be adopted by senior residents, who are the primary users of community services. Enabling seniors to manage their health more proactively can effectively prevent primary health care services from stagnating. This study aimed to explore how design can help older adults better adopt self-help sign detection devices in the community in the context of technological development. A value sensitivity research approach was used in this thesis. First, through a desktop survey and conceptual literature review, the current health care dilemma and development trends were understood, and values appreciated by each stakeholder for self-help physical sign testing in a community setting were defined. The combination of multiple interview methods was used by users to analyze information on existing self-services used to integrate the value claims of health screening devices in Shanghai to gain a more realistic view and explore potential design opportunities. Finally, the value claims were further transformed into a solution that was designed. This includes suggestions for the design of devices that can be used in the near future, for human–machine interaction processes, for overall service processes, and for future functional expansion. The industrial design was also produced through sketches and 3D model iterations. The findings and outcomes can be used as a reference for the development and design of current or near-future self-service sign detection devices.

Keywords: Self-service, Community, Health screening, Elderly users, Value-sensitive design, Service design

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INTRODUCTION

Community Health Management Within the Tiered Diagnosis and Treatment System

Healthcare is a critical component of public welfare and directly affects the health and familial wellbeing of the populace. Amidst the balancing act of equitably distributing medical resources and safeguarding the health rights of citizens, China has enacted multiple reforms, such as the tiered diagnosis and treatment system, aimed at enhancing resource efficiency. This system is designed to allocate medical resources logically and establish a continuum of health management. Despite challenges in the grassroots medical system, in 2019, outpatient services at China's township health clinics and community health service centers accounted for merely 23.3% of the nation's total outpatient visits, with an average of only approximately 2.22 general practitioners per 10,000 people, as stated in the Statistical Bulletin on the Development of Health and Wellness in China (Anonymous, 2020; Ma et al., 2020). Furthermore, the coverage rate for health check-ups lags behind that of developed nations, at a mere 37%, as analyzed in the China Physical Examination Industry Research and Business Investment Decision Analysis Report (Anonymous, 2020). Confronted with the challenge of an aging population, which is especially pronounced in China, as of the end of 2019, the country was home to approximately 254 million individuals aged 60 and above, constituting 18.1% of the total population. This figure is projected to exceed 28% by 2040 (Pang, Hu, & Yang, 2021). With chronic noncommunicable diseases emerging as a primary health concern, the health management of the elderly population has surfaced as a pivotal issue. To address these challenges, China has rolled out the "Internet + Medical Health" digital health initiative, bolstering comprehensive health services through partnerships and technological innovations, such as optical sensing, to encourage the advancement of home health testing and personal health monitoring (The State Council of the People's Republic of China, 2021). These steps highlight the need and significance of shifting from a predominantly treatment-oriented approach to a more effective health management model.

The Current State of Community Health Management

China's community health services are currently facing critical challenges: a shortage of medical staff, limited service offerings, and inadequate support for preventive healthcare. This scenario has led to suboptimal preventive health check-ups, partly due to insufficient community facilities and services. Such deficiencies hinder the effectiveness of community-based family doctor systems, particularly in the context of China's rapidly aging population. Addressing these issues requires leveraging advancements in internet healthcare to develop user-friendly medical devices for nonprofessional settings. Prioritizing elderly people's needs in these community health initiatives is crucial, as is enhancing vital sign monitoring and health awareness at the community level.

LITERATURE REVIEW

Value-Sensitive Design Theory

Value-sensitive design (VSD) serves as the principal framework for this research. A deeper comprehension of VSDs was pursued before embarking on practical research, gathering more information on value orientations and stakeholder positioning to support further studies. Introduced by Batya Friedman in the 1990s, VSD is a design philosophy that integrates human values into the design of new technologies (Friedman & Hendry, 2019). VSD epitomizes a human-centered design ethos that proactively incorporates human values throughout the technological design process. It has provided designers with theoretical and methodological guidance, outlining human values in a principled and systematic manner. Central to this approach is the mobilization of researchers' ethical and technical creativity, which is deemed one of the most expansive methods for examining human value trade-offs within technology (Value Sensitive Design Lab, n.d.).

Selection and Transformation of Values

The Meaning of Values

In both nonacademic and academic settings, "value" generally signifies principles or standards held to be important in personal or social life, particularly in ethical and moral dimensions (Oxford English Dictionary). Friedman, the progenitor of VSD, delineates value as matters of significance to an individual's life, focusing on ethical dimensions (Friedman et al., 2019). Values are categorized into moral, conventional, and personal domains: the moral domain encompasses normative judgments such as justice and rights; the conventional domain is concerned with behavioral consistency; and the personal domain involves judgments of self-governance (Turiel, 1983).

Stance on Value Selection

VSD compels designers to sift through a multitude of values to construct a research panorama. The process of selecting values is inherently subjective, given that any list of values could be incomplete, a critique often leveled at VSD (Davis & Nathan, 2015). VSD adopts an interactive posture, recognizing that humans shape technology and that technology reciprocally shapes human experiences and society (Miller, Friedman, & Jancke, 2007). Furthermore, design processes need to address value conflicts and disagreements, and VSDs provide a framework for managing such conflicts (Friedman, Kahn, & Borning, 2013).

Critiques of Value Selection

Critics point out the subjective nature of VSDs, where different stakeholders may harbor diverse expectations for the same value, resulting in solution conflicts. VSD conventionally assumes a positive valuation of technology; however, practical applications should take into account the real effects of technology on stakeholders.

Transformation of Values

Employing VSDs to probe the latent effects of novel technologies can aid in discerning how technological characteristics can either support or impede value. Translating values into design stipulations implies fusing values with tangible settings, evolving into measurable design criteria. Van de Poel suggested a methodology for transforming values into assessment standards and then into specific attributes (Kroes & Van de Poel, 2015). This necessitates mediating value conflicts without engendering new ones, ensuring that the defined attributes are efficient, reusable, and accurate.

METHODOLOGY

Concept-Experience-Technology Ternary Research

Initially, conceptual research laid the groundwork. This stage entailed two principal tasks: first, identifying stakeholders who are influenced by the implementation of technology, which included both direct and indirect participants. Second, insights into the potential values held by these stakeholders might hold in relation to their interactions with nascent technological advancements, guided by the perspectives of value-sensitive design (Ding & Du, 2020) (Jin & Shang, 2020). A thorough literature review highlighted the dichotomy faced by community health services: a scarcity of resources versus the challenges of an aging population and the urgency to foster personal health management skills in anticipation of sufficient medical resource availability (Li, 2019) (Yang, Xie, & Shao, 2020).

Transitioning into the empirical research phase, built upon the conceptual foundation, we immersed ourselves in understanding stakeholders' behaviors, values, and demands through methodical observations and structured interviews. This phase focused on how stakeholders interpret personal values within interactive contexts and navigate through the juxtaposition of conflicting values in the design decision-making process.

Building upon the value research previously outlined, this section explores the requisite attributes for self-service detection design. This exploration entails analyzing existing device service issues, design challenges associated with value characteristics in the usage environment, and specific features of relevant technologies. Merging findings from the technological research phase, we transformed these essential values into critical design practice elements. By integrating insights across conceptual, empirical, and technological dimensions, this study scrutinized the functional forms of existing products. This thorough analysis has established a robust foundation for designing self-service health screening devices, with careful consideration given to the practical needs and ease of use for users. Our objective is to develop a product that not only fulfills the basic health management requirements of the community but is also equipped to keep pace with rapidly evolving technology.

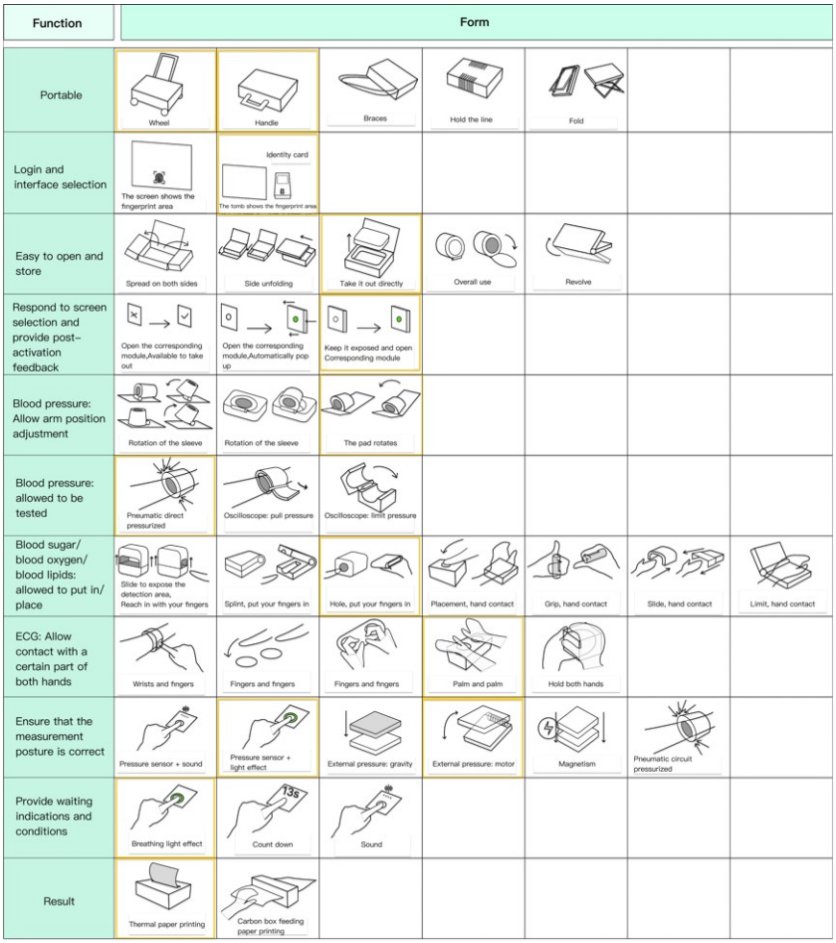

Figure 1: Product function-form diagram.

Design of Self-Service Testing Equipment

Value Proposition in PSS Design

In the context of product service system (PSS) design, our study identifies critical user needs through observations at self-service health stations in Shanghai and interviews with key stakeholders. The findings emphasize the importance of accessibility, cost-efficiency, perceived usefulness, usability, and comfort aligned with a community-centric approach in health products.

Future Multi-Level Distributed Community Sign Detection Service System

The proposed model introduces a tiered system of health monitoring devices, providing a range of services from basic health checks near residences to specialized screenings for chronic diseases at community centers. Basic health metrics such as blood pressure and glucose levels demand devices that are easily accessible, simple to use, and maintained by community volunteers. In contrast, screenings for complex chronic conditions are centralized at community service points with professional support.

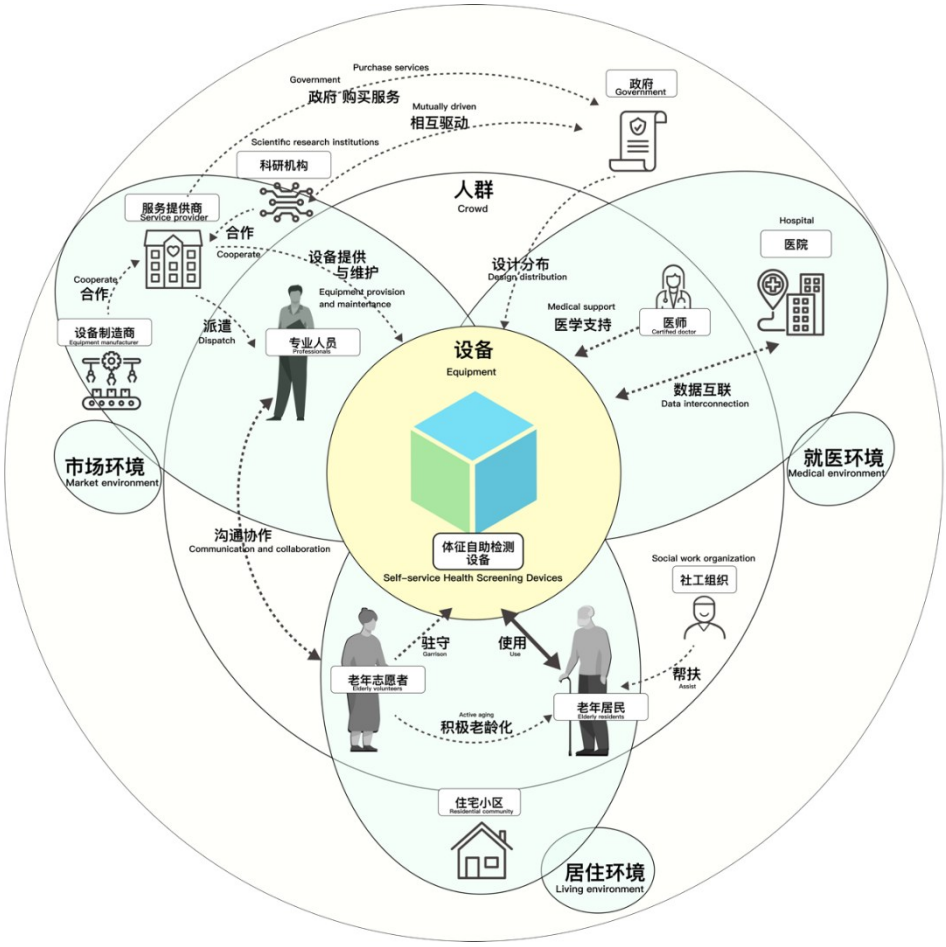

Figure 2: Current equipment system location map

Design Practice for Self-Service Vital Signs Monitoring

The design process begins with the integration of various detection technologies into user-friendly devices. It aims to simplify operations and enhance usability, particularly for older users. The key design features include:

- Integrated detection technologies for a simplified and efficient health monitoring process.
- A shift from traditional medical product design to a more inclusive and community-friendly approach.
- Enhanced accessibility and usability, catering to older adults and ensuring inclusivity for all community members.

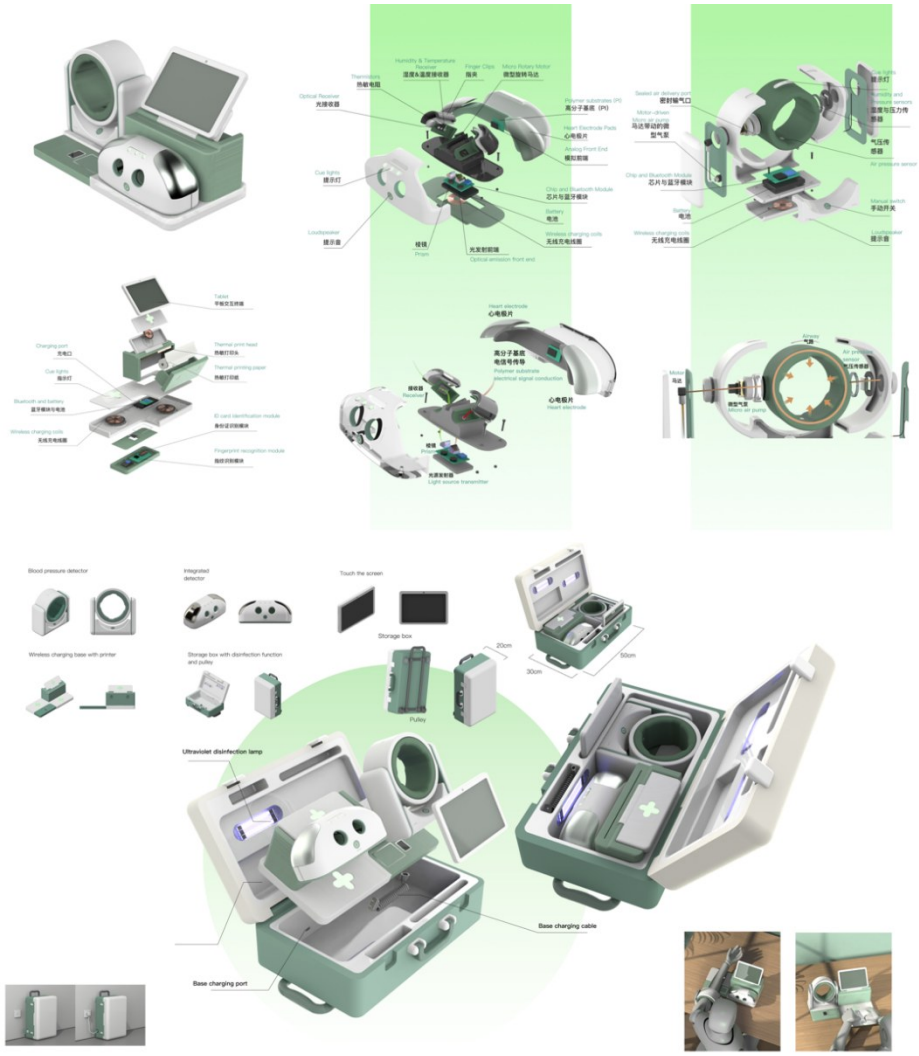

Figure 3: Concept rendering of the final scheme.

DISCUSSION

Self-service vital sign monitoring devices have emerged as crucial tools for bridging the gap in community health management, particularly given the nuanced needs of an aging population. These devices offer enhanced accessibility and professionalism, and the integration of gerontechnology has transformative potential, especially for elderly people. This study's experimental phase has revealed stakeholders' value demands and envisioned the future with tiered service models in line with advancements in extracorporeal testing technology and societal aging trends. However, challenges abound in transitioning from concept to community-wide implementation, notably limited user feedback due to the pandemic's impact on healthcare delivery and insufficient sample sizes in empirical research. These challenges underscore the need for a flexible, iterative design process responsive to the

growing needs of an aging population increasingly susceptible to chronic noncommunicable diseases.

CONCLUSION AND FUTURE WORK

This study, grounded in value-sensitive design, investigated the evolving service models of self-service vital sign monitoring devices through literature reviews and interviews. This study suggested a user-friendly design for basic monitoring, which is crucial for active aging and chronic disease management. The research acknowledges certain limitations, including limited practical application during the pandemic and a narrow focus on elderly participants.

Future directions involve using mixed methods to understand user needs and device usage comprehensively and integrating advanced data analytics and AI for enhanced performance and personalized health recommendations. Future studies aim to incorporate these devices effortlessly into older adults' lives, fostering active aging and improving their autonomy and quality of life. As healthcare moves toward a digital model, such devices, combined with gerontechnology, will be key to ongoing health management, aligning with the WHO's health goals. Economic, privacy, and ethical aspects will be crucial in developing a digitally inclusive healthcare system for the aging population.

ACKNOWLEDGMENT

The authors would like to acknowledge and thank everyone involved in making these projects successful—in particular, the Residents of Hehai Community and the students and staff of the product design department at the College of Design and Innovation, TongJi University.

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