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서비스 적정성 평가를 이용한 배설 및 식사 돌봄로봇 이용자의 만족도 평가

Assessing the Satisfaction of Care-Robot Users through the Measurement of Service Adequacy

So Seul Park[1] and Yong Soon Shin[1,*]

[1]*College of Nursing, Hanyang University, Seoul, Republic of Korea*

Abstract

This study applied the Measurement of Service Adequacy (MSA) method to evaluate service performance and user acceptance of two types of care robots — an excretion care robot and a meal-assistance robot. As demand for long-term care continues to rise in ageing societies, care robots have emerged as a promising means of reducing the physical and psychological burden on caregivers; however, evidence quantifying real-world user satisfaction remains scarce. A total of 60 caregivers (30 per device) participated in a one-month field trial using the CareBidet excretion care robot (CURACO, Korea) or the Obi meal-assistance robot (DESiN LLC, USA). Satisfaction was measured with a modified K-QUEST 2.0 questionnaire combined with the SUXES protocol, capturing the Desired (D), Acceptable (A), and Perceived (P) levels for each attribute. MSA was calculated as P − A. The excretion care robot yielded positive MSA values on nearly every attribute, most notably durability (+2.6), effectiveness (+2.4), convenience (+2.2), and safety (+2.0). The meal-assistance robot obtained more modest positive scores, led by ease of use (+0.8) and physical dimensions (+0.7). Cost was the only attribute with a negative MSA for both robots (excretion −0.1; meal −0.6), and environmental compatibility was borderline (0.0) for the meal-assistance robot. Findings indicate that both devices meet the minimum acceptable level of service in their principal clinical functions, but economic accessibility and adaptation to the physical caregiving environment must be prioritised in future development and reimbursement policy.

Keywords: *care robot, care burden, MSA, SUXES, SERVQUAL*

I. Introduction

The rapid ageing of the population in the Republic of Korea and other high-income countries has produced a steep increase in demand for long-term care while simultaneously shrinking the working-age pool from which formal caregivers are recruited. To address this structural mismatch, service robots have progressively moved from research prototypes into clinical, residential and community settings, including hospital guidance robots [2], infection-control robots [3], and dedicated care robots supporting activities of daily living [5], such as excretion care robots [6] and robotic feeding devices [7].

Despite active product development, evidence on the real-world acceptability of care robots among older users and their caregivers is limited. Older adults frequently encounter difficulty adopting new digital and mechanical technologies [10], and the small, laboratory-based satisfaction surveys currently in use rarely reflect the expectations, contextual constraints, or economic realities encountered in the caregiving environment. A more structured framework is therefore required — one that quantifies not merely whether users are “satisfied” in the abstract, but whether the delivered service meets or exceeds the minimum level they are prepared to accept.

The Measurement of Service Adequacy (MSA), derived from the SERVQUAL and SUXES traditions, compares users’ Perceived experience (P) with their Adequate (A, i.e., minimally acceptable) expectation. A positive MSA

value indicates that the service exceeds the minimum acceptable level; a negative value signals a shortfall that requires corrective action. The present study applied MSA to two representative care robots — the CareBidet excretion care robot and the Obi meal-assistance robot — with the aim of generating actionable evidence to guide product improvement and reimbursement policy.

II. Methods

1. Participants

Participants were 60 caregivers (30 per device) recruited from homes, nursing facilities, and long-term care hospitals in the Seoul metropolitan and Gyeonggi regions who directly provide excretion or meal care to older adults or persons with reduced mobility. All participants in the excretion care robot cohort were certified caregivers; the meal-assistance cohort additionally included family caregivers.

2. Devices

The excretion care robot was the CareBidet (CURACO, Republic of Korea), which automatically detects urine and faeces, aspirates waste, delivers warm-water cleansing, and dries the perineal region. The meal-assistance robot was the Obi (DESiN LLC, USA), a table-top robotic arm that presents pre-loaded food to the user under button-based control.

3. Instruments and MSA calculation

Satisfaction was measured with a modified 13-item questionnaire combining eight items from K-QUEST 2.0 (effectiveness, durability, safety, ease of use, convenience, comfort, dimensions, and cost) with five items from a technology acceptance model (usability, design, environmental compatibility, communication with the user, and overall satisfaction). Following the SUXES protocol, participants rated each item at three levels: the Desired level (D), the Adequate — that is, minimally acceptable — level (A), and, after one month of use, the Perceived level (P). MSA was then calculated as P − A and the Measurement of Service Superiority (MSS) as P − D. Positive MSA indicates that the device exceeds the user's minimum acceptable level; negative MSA indicates a shortfall.

Fig. 3. Logic of Measurement of Service Adequacy (MSA) and Measurement of Service Superiority (MSS)

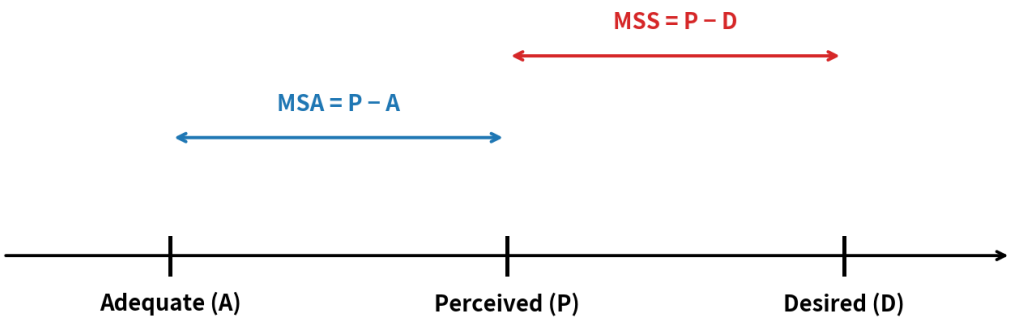

Fig. 3. Logic of the Measurement of Service Adequacy (MSA) and Service Superiority (MSS).

4. Procedure

Before enrolment, participants received a bias-neutral orientation covering device functions, safety precautions, and questionnaire items. They then used the assigned robot in their usual care setting for four weeks, after which the post-use SUXES survey was administered. The study was approved by the Institutional Review Board of Hanyang University, and all participants provided written informed consent.

III. Results

1. General characteristics

Table 1. General characteristics of participants (N = 60).

Variable	Category	Excretion group (n = 30) n (%) / M ± SD	Meal-assistance group (n = 30) n (%) / M ± SD
Sex	Male	1 (3.3)	1 (3.3)
	Female	29 (96.7)	29 (96.7)
Age (years)		57.13 ± 3.93	58.20 ± 8.92
Education	Middle school	1 (3.3)	—
	High school	21 (70.0)	15 (50.0)
	College or higher	8 (26.7)	15 (50.0)
Caregiver type	Certified caregiver	30 (100)	18 (60.0)
	Family caregiver	—	12 (40.0)
Care experience (years)	Overall mean	5.99 ± 3.10	6.13 ± 4.55
	Family subgroup	—	17.25 ± 9.20

2. Perceived level, Adequate level, and MSA

For the excretion care robot, MSA values were positive on eight of the nine measured attributes and ranged from −0.1 (cost) to +2.6 (durability). The four highest values were durability (+2.6), effectiveness (+2.4), convenience (+2.2), and safety (+2.0), indicating that the device substantially exceeded the caregivers' minimum acceptable expectations for its core clinical function. For the meal-assistance robot, MSA values ranged from −0.6 (cost) to +0.8 (ease of use), with environmental compatibility at 0.0 and most other attributes clustered between +0.3 and +0.7. Cost was the only attribute with a negative MSA for both devices.

Fig. 4. Measurement of Service Adequacy (MSA) values by attribute

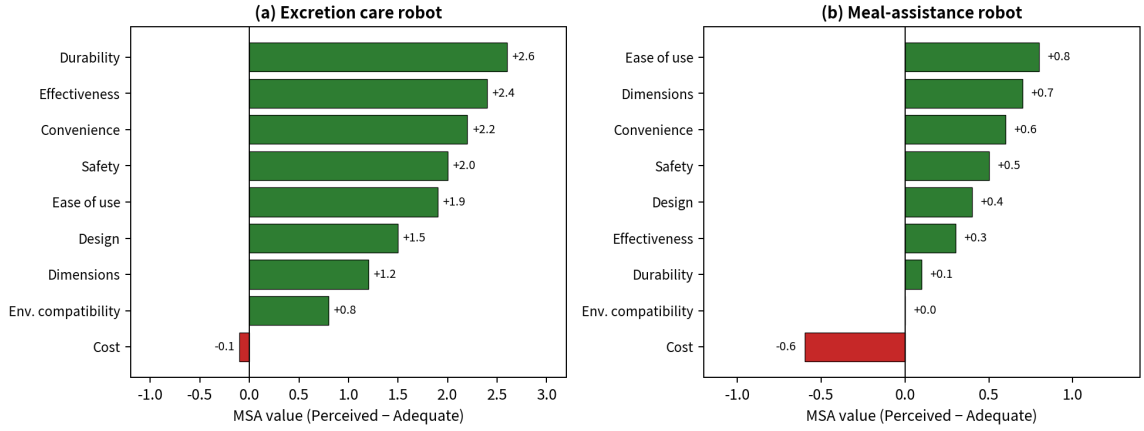

Fig. 4. MSA values (Perceived − Adequate) for the excretion care robot and the meal-assistance robot.

IV. Discussion

The excretion care robot delivered uniformly positive MSA values on functional attributes, consistent with previously reported reductions of approximately 25.6% in lumbar load and 34.9% in upper-limb load during excretion care [25]. Caregivers rated durability and effectiveness particularly high, which reflects both the clinical intensity of manual excretion care and the robot's reliability during sustained daily use. Cost was the sole negative attribute (−0.1), a shortfall consistent with the current absence of formal reimbursement coverage for excretion care robots.

The meal-assistance robot yielded positive but smaller MSA values, driven by ease of use (+0.8) and the compact physical dimensions of the device. Safety concerns raised at baseline — notably fear of aspiration during robotic feeding — were not corroborated in the post-use ratings. However, environmental compatibility was flat (0.0) and cost markedly negative (−0.6), indicating that the current form factor and price point are poorly aligned with typical Korean home and facility settings. Two policy-relevant conclusions follow: (i) reimbursement pathways such as inclusion in the long-term care insurance welfare-equipment list or a rental subsidy programme are essential to address the cost gap, and (ii) form-factor design must accommodate the spatial constraints of shared bedrooms, multi-bed wards, and small dining tables.

V. Conclusion

The MSA framework provided a quantitative, expectation-anchored basis for evaluating care robots and enabled a direct comparison of two distinct devices on the same metric scale. The excretion care robot exceeded caregivers' minimum acceptable level on virtually every clinical attribute, while the meal-assistance robot satisfied the minimum only marginally. Both devices require improvement in economic accessibility, and the meal-assistance robot additionally requires design work to fit real caregiving environments. Future studies should replicate the MSA analysis in larger, multi-site cohorts and extend it to additional device categories such as transfer, bathing, and cognitive support robots.

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