

Facilitators and Barriers to Sustained Use of Social Robot Ivy for People with Intellectual Disabilities: A Qualitative Study on Healthcare Professionals' Experiences

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Abstract

Background: Labor shortages in healthcare pose significant challenges to sustaining high-quality care for people with intellectual disabilities (PwID). Social robots show promise in supporting both PwID and their healthcare professionals, yet few are fully developed and embedded in productive care environments. Implementation of such technologies is inherently complex, requiring careful examination of facilitators and barriers influencing sustained use.

Objective: This research aims to evaluate the value creation and implementation of social robot Ivy for PwID and healthcare professionals, examining facilitators and barriers to sustained use across six care organizations.

Methods: A qualitative field study was conducted involving 19 cases of robot implementation across six care organizations in the Netherlands; each case consisted of PwID (client) and the involved healthcare professionals. The study examined actual robot deployment in daily care practice between April-October 2023. Semi-structured interviews were conducted with healthcare professionals after two months of implementation. Analysis followed a thematic approach guided by the NASSS framework and a model for tracing facilitators of and barriers to the adaptive implementation of the robot. Facilitators were classified as key drivers (complex), enablers (complicated), minor benefits (simple), while barriers were categorized as deal-breakers (complex), obstacles (complicated), or minor hurdles (simple). Robot's sustained use (i.e., robot use continuance at two months post-implementation) served as a key indicator of success.

Results: After two months, robot use was sustained in 12 of 19 cases (63%). For successful cases, key value emerged for both clients (enhanced daily structure, improved emotional well-being through non-judgmental interactions, increased independence) and healthcare professionals (reduced workload through automation, improved quality of client interactions, reduced emotional burden). Sustained use was determined by client characteristics (cognitive capabilities, care predictability), healthcare professional factors (available time, digital competency), contextual conditions (timing, connectivity), and organizational support (training, resources). Main implementation barriers included complex/unpredictable care needs, insufficient programming time, and contextual factors influencing care environments.

Conclusions: The findings inform long-term care organizations on the implementation and value of sustained use of social robot Ivy for both PwID and their caregivers. Social robot Ivy demonstrates potential for supporting care delivery to PwID when implemented under appropriate conditions. Success requires careful matching of robot capabilities with client needs, sufficient time and support for healthcare professionals, and stable care environments. Future research should examine longer-term sustainability and integrate direct client feedback.

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Original Manuscript

Facilitators and Barriers to Sustained Use of Social Robot Ivy for People with Intellectual Disabilities: A Qualitative Study on Healthcare Professionals' Experiences

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Keywords: assistive technology; social robots; healthcare innovation; implementation; adaptive implementation; intellectual disability care; barriers; facilitators; field study; technology continuance; adoption

Introduction

Labor shortages in the healthcare sector pose significant challenges to sustaining high-quality care worldwide. According to the World Health Organization, a global shortage of 10 million healthcare workers is projected by 2030, with the quality of care heavily dependent on the availability, accessibility, and expertise of healthcare workers [1]. In mental health care, these challenges are further amplified by the growing demand for care services for people with intellectual disabilities (PwID), which places additional strain on already overstretched resources [2]. This pressing reality threatens the sustainability of high-quality, person-centered care for PwID. In response, there is growing interest in technological solutions that could help address staffing shortages while maintaining the envisioned care.

Reflecting this growing interest in technological solutions, intelligent assistive technologies (IAT) are increasingly being used to support care for PwID [3]. These empowering technologies, aimed at maintaining or improving an individual's functioning and independence, and thereby promoting their well-being, include a range of digital devices, ranging from smart home systems and tablets to wearable devices and humanoid robots [4-5]. Among these technologies, social robots have emerged as a particularly promising innovation. These robots have the potential to offer support to various target groups with complex needs, addressing a wide range of domains in daily life, including communication, social interaction, interpersonal relationships, emotional well-being, and functioning in everyday contexts [6-7].

Systematic reviews in mental health care suggest that social robots have the potential to improve mood, social interaction, and activity participation for individuals with intellectual disabilities through both verbal and non-verbal interactions [8-9]. However, challenges such as unmet expectations, time constraints, limited technical capabilities, and ethical concerns have been reported, highlighting the need to carefully manage implementation processes to ensure long-term success [10]. These preliminary insights underscore a pressing need for empirical studies that examine both implementation processes and outcomes to better understand the potential role of social robots in mental healthcare, address implementation enablers and barriers, and determine their value for PwID and their personal caregiver(s). So far, few robots are fully designed and deployed in long-term care, and hence the opportunities to conduct this necessary research have been limited.

One notable example of a social robot that is already operational in the care process is Ivy, recently implemented as part of a regional collaborative initiative across six care organizations in the Netherlands [11-12]. Ivy is designed to support and accompany PwID in their daily lives, whether in care facilities or at home, by stimulating cognitive functions through personalized interactions. By doing so, Ivy also intends to support healthcare professionals by enhancing efficiency, enriching client care, and contributing to greater work satisfaction. Healthcare professionals can customize Ivy to tailor its support to each client's needs, providing assistance with their daily structure, personalized reminders for appointments and medication, and facilitating social interactions. The robot communicates through time based preprogrammed verbal interactions and displays supportive visual information on its screen.

The care organizations decided to introduce these social robots to their clients with intellectual disabilities due to Ivy's intended impact on both clients and healthcare professionals. Its real-world deployment offers a unique opportunity to examine the value created by the robot for PwID and their professional caregivers, as well as the facilitators and barriers influencing its ability to create value for these two key stakeholders.

Implementing robots in health- and long-term care settings is inherently complex [11], with little evidence guiding their use [13]. To understand the implementation process and outcomes, we draw upon two complementary theoretical frameworks. First, the NASSS framework (Non-adoption, Abandonment, Scale-up, Spread, and Sustainability) helps to analyze implementation challenges across multiple interacting domains: the condition, the technology, the value proposition, the adopter system (comprising professional staff and clients), the organization(s), the wider context, and the interaction between these domains over time [14]. This framework categorizes implementation challenges as simple (straightforward, predictable barriers that are easily addressed), complicated (multiple interacting components requiring significant work to overcome), or complex (dynamic, unpredictable barriers that may lead to abandonment if not effectively managed).

Second, we employ Meiland *et al.*'s [15] theoretical model for tracing facilitators and barriers in the adaptive implementation of innovations in care settings. This model examines implementation across four phases (preconditions, preparation, execution, and continuation) and three levels (micro, meso, and macro). While preconditions and preparation were addressed prior to our study, we focus specifically on the execution and continuation phases at the micro level, examining how the end-users, clients with intellectual disabilities and professional caregivers, experience and use robot Ivy over the first two months of implementation.

Together, these frameworks guide our investigation of both facilitators and barriers to successful adaptive implementation. To begin, the NASSS framework allows us to classify barriers by their level of complexity and likely impact on sustained use. By applying the same classification framework to facilitators as we do to barriers, we can better assess their relative impact on the success of implementation. We analyze these facilitators and barriers separately for each key stakeholder (i.e., PwID and healthcare professionals), while also considering contextual factors unique to each implementation case and organizational factors. In the case of social robot Ivy, this categorization can help identify which facilitators to strengthen or further leverage, as well as which barriers to continued robot use are straightforward and manageable versus those that require more sophisticated support strategies. In this study, we apply these complementary frameworks to analyze the adaptive implementation of social robot Ivy in care for PwID, focusing in particular on micro-level factors within the adopter system domain (PwID and healthcare professionals), and the technology and value proposition domain (perceived value for these users). However, as we are investigating both the execution and continuation phases of implementation of social robots across 19 PwID and their professional caregiver(s) in actual productive care environments, our analysis also includes contextual and organizational factors from the caregiver's perspective, offering implications for the broader healthcare organization. Through semi-structured in-depth interviews with healthcare professionals (in this study also referred to as professional caregivers) after two months of implementation, we generate an understanding of facilitators and barriers to successful implementation, categorizing them by their level of impact on sustained use. We investigate the staff perspective, as their perceptions play a key role in the adoption of social robots [16-17]. Our research questions are:

- 1) What value does sustained use of social robot Ivy create for PwID and healthcare professionals?
- 2) What facilitators and barriers influence the continuation versus abandonment of social robot Ivy during the execution and continuation phases of implementation?
 - What client and healthcare professional characteristics influence sustained use?
 - What contextual and organizational factors affect implementation success?

Methods

Study Design, Participants, and setting

This study was conducted between April 2023 and October 2023 across six care organizations in the southeast region of the Netherlands. A qualitative design was employed to assess the added value and user-friendliness of the social robot Ivy, as well as to identify facilitators and barriers to its sustained use for PwID receiving care under the Long-Term Care Act (Dutch: Wet langdurige zorg) [18]. The study followed 19 robot Ivy devices implemented within these care settings. Data were collected through semi-structured in-depth interviews with key stakeholders. While multiple stakeholder groups were involved in the implementation of the robot—including clients, healthcare professionals, and relatives and/or legal representatives—this study specifically focused on the perspectives of healthcare professionals. As they played a central role in introducing and integrating Ivy into daily care, their insights provided the most consistent and detailed account of the implementation process. Clients' cognitive limitations posed challenges for conducting meaningful or extensive in-depth interviews, and relatives were generally less engaged in the robot's daily use. Therefore, we recruited healthcare professionals who were directly responsible for introducing and integrating robot Ivy into client care. Participants were selected through purposive sampling, ensuring a diverse representation of perspectives across the participating organizations. The qualitative approach allowed for an in-depth exploration of how Ivy was integrated into daily care routines, the perceived value and challenges, and the contextual factors influencing long-term adoption.

The clients had moderate to severe intellectual disabilities requiring 24-hour care or continuous supervision. This population includes individuals with a congenital or later-developed disorder in intellectual functioning who also experience limitations in adaptive behavior, such as conceptual, social, and practical skills, as described by Schalock *et al.* [19]. Throughout this study, we use the terms PwID and clients interchangeably to refer to people with intellectual disabilities, with 'client' denoting their status as recipients of care services. For context, clients were eligible to use the robot if they: (1) had sufficient visual, auditory, and cognitive capabilities to process information from the robot, (2) could maintain appropriate attention to interact with the robot, and (3) were residents at one of the participating care organizations.

In total, we studied 19 unique cases, each comprising a robot implementation with a client and their involved healthcare professional(s). For each case, we conducted interviews with the healthcare professionals two months after the robot was implemented.

The technology - Robot Ivy

Robot Ivy (see Figure 1) is a lightweight, small-size stationary social robot that healthcare professionals can customize through a browser-based platform to support each client's needs, providing clients assistance with their daily structure, personalized reminders for appointments and medication, and facilitating social interactions [12, 20]. As such, the technology consists of two distinct interfaces, namely the physical robot which faces PwID and healthcare professionals, and the browser-based online platform where healthcare professionals set up and customize client interactions.

The client-facing interface consists of the physical robot itself, which communicates with clients through a human-like voice, which can be accompanied by pictograms and text on its touch screen. While Ivy communicates through spoken messages, it does not respond to voice commands. Clients can interact with Ivy through the touch screen and receive various types of

personalized support, such as daily structure, appointment and medication reminders, cognitive stimulation, entertainment, social interaction, and companionship. Whenever the robot is not offering an interaction to the client, it displays a friendly, dynamic face to maintain an engaging and approachable presence (see Figure 1). The robot requires its own access point for internet connectivity and operates independently from existing healthcare information systems. Ivy executes pre-programmed tasks without independent decision-making capabilities.

Healthcare professionals design and customize client interactions through a separate browser-based online platform, which allows them to tailor interactions specifically for the needs of individual clients. Interactions can either be scheduled at specific time slots for plannable care (e.g., a morning routine), or made available for proactive activation by clients (e.g., when a client wants the robot to tell a joke or help communicate on their behalf). This interface allows healthcare professionals to configure and continuously adapt various types of interactions including reminders, questions, stories, display of photos and music playback using voice-only communications, voice with touch screen response options or voice with pictogram responses.

--- INSERT FIGURE 1 HERE ---

Data collection

In this research we investigated 19 cases of robot implementation, meaning 19 individual PwID who made use of a social robot Ivy. Data were collected through semi-structured in-depth interviews with the healthcare professionals responsible in those cases, which were conducted two months after robot Ivy got introduced to their respective client. The interviews explored professionals' experiences with implementing the robot, perceived value and user-friendliness for both staff and clients and factors influencing whether the robot's use was continued or discontinued after the initial implementation period.

The interviews lasted approximately 45-60 minutes each and were conducted by two researchers (authors MS and CH). Most interviews were conducted face-to-face, and audio recorded. Some interviews were conducted via Microsoft Teams video conferencing due to scheduling constraints and were video recorded. While most interviews were one-on-one, four cases involved multiple professionals in group interviews (where multiple professionals were involved in implementing Ivy for that client). The 2-month timing allowed for a systematic and meaningful evaluation of the experiences of healthcare professionals and the identification of key facilitators and barriers influencing sustained use versus non-adoption or abandonment, in line with our theoretical frameworks (NASSS and Meiland).

Data analysis

All interviews were (audio/video) recorded and transcribed verbatim. A structured thematic analysis was conducted, guided by Meiland *et al.*'s [15] implementation model and the NASSS framework [14]. Codes for facilitators and barriers per stakeholder (e.g., PwID/ client & healthcare professional), as well as contextual and organizational factors were created. The type of barriers resulted from the NASSS framework [14] and are categorized as deal-breakers (high impact or complex), obstacles (medium impact or complicated) and minor hurdles (low impact or simple). Facilitators were constructed to mirror the severity of impact that these barriers have on sustained use (high/ medium/ low) and are categorized as key drivers, enablers, and minor boosters.

To ensure coding reliability and develop a shared understanding of the data, three researchers independently coded five interview transcripts. Through detailed discussion of

discrepancies, the team developed a consistent interpretation of the coding framework, which guided one researcher in coding the remaining transcripts.

Ethical considerations

The study was approved by the Medical Ethics Review Committee (In Dutch Medisch Ethische Toetsingscommissie Zuyderland-Zuyd) [21] and is known under approval number METCZ20230028. Written informed consent was obtained from all participants. Participants were informed they could withdraw from the study at any time without consequences for their employment.

Results

Participants

In total, 19 interviews were conducted with 23 healthcare professionals, all of whom were directly involved in implementing 19 social robot Ivy devices as part of their clients' care. Of these professionals, 19 (82,6%) identified as female, and 4 (17,4%) identified as male. Table 1 presents the distribution of research participants across cases nested in the six care organizations. The presentation of cases follows a chronological order, representing the sequence of data collection. One professional (#1) participated in two separate cases, as this caregiver was responsible for the direct care of two clients using the robot. While most interviews were conducted one-on-one, in four cases (cases 1, 6, 9, and 12), multiple professionals participated in group interviews, as they were all involved in the implementation of social robot Ivy for a client in those cases.

Table 1. Research participants across cases and across care organizations

Case	Care organization	Research participants
1	A	#1, #2
2	F	#3
3	F	#4
4	B	#5
5	C	#6
6	D	#7, #8
7	C	#9
8	A	#1
9	C	#10, #11
10	A	#12
11	F	#13
12	F	#14, #15, #16
13	F	#17
14	B	#18
15	E	#19
16	E	#20
17	A	#21
18	A	#22
19	D	#23

Sustained use of Social Robot Ivy

Answering the first research question, this section presents our findings on the value of sustained use of social robot Ivy, based on healthcare professionals' perspectives after two months of

implementation. The robot demonstrated distinct value for both PwID and healthcare professionals.

Value for PwID

For PwID, the primary value emerged in three areas: (1) enhanced daily structure through consistent reminders and routines, (2) improved emotional well-being through non-judgmental interactions and companionship, and (3) increased independence in daily activities through empowerment.

(1) *Enhanced daily structure.* As professionals noted the robot supported in providing an enhanced daily structure, as illustrated by several quotes. *Using Ivy has enabled the client to independently start their day, which increases their self-confidence and saves us as professionals time and energy*" [#1].

"The robot provides structure which gives her more independence, and her emotional well-being has improved. The robot has become like a friend to her" [#3].

(2) *Improved emotional well-being.* The robot's value for emotional well-being was particularly evident through its role as a companion and source of non-judgmental support. The robot's emotion-free and non-judgmental communication proved particularly valuable for clients who tend to interpret human interactions negatively or seek excessive validation. As one professional explained: *"Ivy is just the same every day, she doesn't need to shop around between me or a colleague if she gets a 'no' from one person and wants a 'yes' from another. So, I think that provides a lot of peace. And Ivy is just the same every day, she can't negotiate with it. I think that also provides a piece of clarity and peace"* [#8].

This consistent, neutral communication style helped reduce anxiety-inducing dynamics that could arise from varying responses between different care professionals, while providing clear structure and boundaries. Healthcare professionals observed that the robot contributed to building clients' self-confidence, reducing restlessness, and promoting emotional attachment.

(3) *Increased independence through empowerment.* According to one healthcare professional: *"We do this because he is very proud to mention that care staff no longer needs to come in with him, he is very proud that he can now do this independently. So his self-confidence is growing"* [#1]. The robot provided support in daily activities like getting up on time, brushing teeth, showering, eating, drinking, and taking medication, which increased clients' control over their daily routines and enabled them to perform certain tasks independently. Moreover, beyond fostering greater independence for PwID, the increased autonomy supported by the robot also has meaningful implications for both clients and caregivers. One healthcare professional highlighted how the robot reduces their need for constant reminders, reinforcing the client's sense of control and dignity: *"Of course, we are not always with her, and the fact that we no longer have to give certain reminders helps. I'm not going to remind her to take her medicine, if I know she already got the reminder from Ivy. That would be redundant and unnecessary [...] It gives her control and autonomy, and with that, a sense of self-worth"* [#3]. Another healthcare professional described how the robot actively encourages social participation: *"We notice that the robot encourages him to join the group, to ask others what his needs are"* [#7].

Value for healthcare professionals

For healthcare professionals, the value manifested in several ways: (1) reduced workload through automation of routine tasks, (2) improved quality of client interactions by freeing up time for meaningful engagement, (3) reduced emotional burden by having the robot absorb repetitive

client interactions, and (4) enhanced work satisfaction through more efficient care delivery.

(1) *Reduced workload through automation of routine tasks.* Healthcare professionals reported that Ivy helped them achieve a better balance between delivering efficient care and maintaining meaningful human interactions. As one professional explained: *"For us as professionals, it's about the tasks it performs without us having to repeat instructions to the client over and over. This allows us to be with the client at other moments, and instead of saying 'do this, do that,' we can say 'come, let's have a coffee together.' Ivy has already handled the rest - that's our gain"* [#13].

(2) *Improved quality of client interactions by freeing up time for meaningful engagement.* Furthermore, professionals highlighted how the robot reduced workload while improving client relationships: *"Yes, the moments that Ivy takes over, like waking up and medication reminders, reduce our workload. Ivy also provides structure and clarity, which makes the relationship with the client more stable"* [#7].

(3) *Reduced emotional burden.* The robot's ability to handle repetitive client interactions without emotional fatigue was particularly valuable. As one professional noted: *"Where staff might have an emotional reaction after hearing the same story multiple times... that will never happen with Ivy"* [#9].

(4) *Enhanced work satisfaction through more efficient care delivery.* Additionally, the robot's 24/7 availability provided valuable support during staff absences, ensuring continuity of care and allowing professionals to focus more on personalized support. See the quote by research participant #3 in the section on *"increased independence through empowerment"*, where this participant highlighted how the robot reduces the caregivers' need to give constant reminders, reinforcing the client's sense of control and dignity.

In some cases, the robot contributed to a more stable environment and improved client well-being. As a result, staff spent less time managing crises, enabling them to prioritize meaningful engagement and individualized care for clients. For healthcare professionals, benefits emerged when the robot successfully engaged clients. During these moments of engagement, staff gained opportunities to attend to other care tasks. As one professional stated: *"In those ten-fifteen minutes you are again a bit more available for others. So, I do see the advantages in that."* [#15].

However, the extent of value creation and perceived value for clients as well as healthcare professionals varied significantly across cases. Healthcare professionals defined client-specific care goals for the robot prior to implementation, with these goals fully achieved in 5 cases, partially achieved in 6 cases, and not achieved in 8 cases. After two months, the robot remained in use for 12 clients while it was discontinued for 7 clients, demonstrating that certain conditions need to be met for sustained use. Having multiple cases of both outcomes proved highly valuable for investigating facilitators and barriers, enabling a more nuanced understanding of the factors influencing the sustained use of the robot.

Facilitators and Barriers to Implementation of Social Robot Ivy

Following our theoretical frameworks, we categorized both facilitating and impeding factors affecting the sustained use of robot Ivy. For barriers, following the NASSS framework, we classified them into three categories: deal-breakers, which often lead to non-adoption or abandonment; obstacles, which require significant effort or time to overcome; and minor hurdles, which are relatively easy to address. To mirror the impact of these barrier levels, facilitators are categorized as key drivers, enablers, and minor boosters.

In the following, guided by the second set of our research questions, we present our findings across four key areas that emerged from the data: (1) client-related factors, examining characteristics and needs of PwID that influence robot use; (2) healthcare professional-related factors, focusing on staff experiences and capabilities; (3) contextual factors, exploring implementation conditions across the 19 cases; and (4) organizational support factors, addressing meso-level elements that enable or hinder implementation of social robot Ivy in the micro environment, with end-users. Table 2 provides a comprehensive overview of these client, healthcare professional, context and organizational related facilitators and barriers. The following sections present findings on these four key areas, highlighting frequently occurring and impactful facilitators and barriers, supported by illustrative quotes from our interviews with healthcare professionals. While our research primarily focused on micro-level implementation factors related to the end-users (Clients and their healthcare professionals), the interviews with healthcare professionals also revealed broader organizational, meso-level influences on sustained use of social robot Ivy and thus implementation success.

Client-related factors influencing sustained use of robot Ivy

Client characteristics and behaviors emerged as crucial determinants of successful robot implementation. All interviews around the 19 cases revealed that certain client traits consistently facilitated or impeded sustained robot use, particularly regarding cognitive capabilities, care needs predictability, and receptiveness to technological intervention. These characteristics significantly influenced whether the robot could effectively support clients' daily activities and emotional well-being. The following elaborates on frequently mentioned and impactful factors across the interviews, with numbers corresponding to their listing in Table 2.

As highlighted by several healthcare professionals, matching client needs with robot capabilities was essential for successful implementation. Most professionals emphasized key driver 1.1 - sufficient cognitive capabilities: *"There are moments that Ivy gives an instruction and then the client executes that, but there are also still many moments that it doesn't work. We are still looking at what exactly this is due to? Does the client not hear it or does the transition still pose difficulties?"* [#22]. Impactful deal-breakers to the sustained use of the robot include clients experiencing distress, mental health challenges, or instability (barrier 1.6), resulting in reduced or no capacity to engage with Ivy. This was observed in clients at risk of epileptic seizures, those relapsing into substance use, displaying compulsive behaviors, or experiencing negative emotions. As one professional noted: *"Client XYZ is currently doing so poorly that he's not open to anything new. But once that peak of tension subsides, he becomes more accessible, and we can work with him. That's when Ivy has the greatest chance of succeeding."* [#5]. Another stated: *"We are now dealing with interventions, bed, bath, food and after that we might be able to work with Ivy again if the entry point comes"* [#6].

Another dominant theme throughout the interviews was the importance of setting accurate expectations regarding the robot's capabilities. Multiple interviews revealed enabler 1.5 - positive initial response to the robot, as most clients were comfortable with Ivy's one-way communication style, as their primary need was expression rather than reciprocal conversation. Ivy's role as a passive listener proved sufficient for clients to experience emotional unburdening, even without receiving a response. As one care professional described, *"He doesn't need an answer, but just the part where he feels like, okay, I've let it out"* #11. However, healthcare professionals also indicated that for some clients Ivy's interactivity seemed too restricted in their impression, in some cases leading to discontinued use. This represents barrier 1.5 - a mismatch

between client expectations and robot functionality turned out to be a deal-breaker for sustained use. The robot's inability to engage in two-way conversations limited its effectiveness in addressing feelings of loneliness. As one care professional noted: "...she lost interest as she had expected Ivy to be more socially interactive" [#17].

Moreover, professionals emphasized the challenges of complex and unpredictable care needs (deal-breaker 1.1): *"In reality, care for clients is not so plannable as initially assessed. This makes timing of interactions extremely difficult. Especially when interaction follow up fast, when one interaction's timing goes wrong, the whole day gets out of sync"* [#5]. In contrast, facilitator 1.8, early client engagement in robot programming emerged as an enabler for sustained use. Healthcare professionals emphasized that involving clients in customizing Ivy's functionalities enhanced their sense of ownership of the robot. As one professional noted: *"We involve the clients in everything. We don't do anything without them—they lead the process"* [#3]. This collaborative approach helped ensure that the robot's capabilities aligned with specific needs and preferences of PwID. However, it is important to note that across the 19 cases, not all PwID were capable of such engagement due to cognitive limitations, highlighting the need for tailored implementation approaches.

Healthcare professional-related factors influencing sustained use of robot Ivy

Healthcare professionals' attitudes, digital competencies, and available time emerged as critical factors influencing successful robot implementation. Their ability to effectively set-up and maintain the robot, combined with their willingness to integrate it in daily care routines, and the robot's embeddedness in the care delivery, significantly impacted implementation success. The following presents some striking facilitators and barriers from Table 2, as evidenced by their frequent occurrence in successful versus discontinued cases.

The most critical barrier affecting sustained use was deal-breaker 2.1 - insufficient time for programming and adapting the robot over time. As one professional explained: *"At the beginning, I actually experienced more work instead of less, because it was mainly figuring out how to set those interactions"* [#13]. Another interviewee noted the ongoing time investment required: *"I have to plan time to be able to do that... Nothing can be done in between... It takes time to really program it well"* [#17].

Key drivers 2.1 and 2.2 - willingness to learn and adapt to new technology and the ability to program basic client interactions - emerged as essential facilitators in cases of successful implementation, as one professional noted: *"I find it really exciting to explore new things and see what's possible ... I enjoy figuring out creative ways to make it work for a specific case. At first, programming was a bit tricky because I didn't have the right permissions in the system, but once that was sorted out, it became much easier. Over time, I learned the steps, and now I know exactly what to do—it just takes practice. The more you use it, the faster and easier it gets"* [#17]. However, obstacle 2.4 - inconsistent use across team members - often undermined these positive factors, stemming from varying levels of knowledge and skill or perceived lack of effectiveness of the robot. One healthcare professional notes: *"If the client does not respond to the robot or any of the robot interactions... so, there is no match or success... people (referring to colleagues) also become less motivated to use the robot and program interactions ... When it is visibly successful and truly benefits the client, then the motivation is there for the staff as well, because it has a certain impact"* [#1].

Table 2. Client, healthcare professional, contextual and organizational related facilitators and barriers influencing the sustained use of robot Ivy

	Facilitators	Barriers
Client	Key drivers 1.1. Sufficient cognitive and sensory capabilities to process robot interactions 1.2. Ability to maintain attention during robot interactions	Deal-breakers 1.1. Complex, unpredictable care needs requiring frequent adjustments 1.2. Inability to process or follow robot instructions independently
Healthcare professional	Key drivers 2.1. Willingness to learn and adapt to new technology 2.2. Ability to program basic client interactions 2.3. Additional dedicated time for robot setup and adaptation 2.4. Understanding of individual client needs Enablers 2.5. Team-wide commitment to robot implementation 2.6. Regular evaluation and adjustment of robot interactions 2.7. Creativity and ability to personalize robot interactions based on client-knowledge 2.8. Adding an mobile app for the platform allows for more agile programming (in addition to the browser-based version)	Deal-breakers 2.1. Insufficient time for robot setup and adaptation 2.2. High staff turnover Obstacles 2.3. Time constraints during busy shifts 2.4. Inconsistent use across team members, often caused by ○ a lack of knowledge and skill, or ○ a perceived lack of the robot's effectiveness 2.5. Challenges in programming complex interactions 2.6. Use of robot intervention in care not part of DNA yet Minor hurdles 2.7. Initial learning curve with programming interface
Context	Key drivers 3.1. Clear integration with existing care routines (integral part) Enablers	Deal-breakers 3.1. Structural issues with connectivity and robot technology 3.2. Poor timing of implementation
Organization	Key drivers 4.1. Management support for implementation ○ Time and training Enablers	Deal-breakers 4.1. Lack of organizational commitment 4.2. Diverging from implementation roadmap (introducing a robot to client prior to staff training in use of robot)

Contextual factors influencing sustained use of robot Ivy

Implementation environments varied significantly across the 19 cases, encompassing differences in care settings, team dynamics, and implementation timing. These contextual elements proved crucial in determining implementation success, particularly regarding the stability of the care environment and availability of support resources. Table 2 summarizes the key contextual facilitators and barriers identified across cases. Below, we elaborate on these factors.

Healthcare professionals highlighted how deal-breaker 3.2 - the timing of implementation was affected by contextual factors related to organizational challenges such as sick leave. These temporary organizational challenges were also highlighted: *"At the moment, it's extremely restless in the living room. We have a lot of sick clients and colleagues, a lot of people who have decided to leave. So, there's just a lot of unrest. A lot of unfamiliar staff that we've had to fly in, freelancers (in Dutch: ZZP'ers) because we just can't handle it ourselves anymore ... And I really notice that permanent staff, such as the colleagues doing the night shift and other fixed team members, use the robot and program it for the client. But now, due to the unrest in the team, working with lots of freelancers, it's starting to be forgotten again."* [#20]. In line with this, another professional reflects on other circumstances that cause coordination challenges (obstacle

3.3): *“When Ivy arrived, a colleague of mine set it up. She also programmed the reminders for the client at that time. So, I did reach out to her and asked, ‘Hey, can you help me with this?’ At one point, we tried to do it over the phone because meeting in person wasn’t possible. But the reality is, over the past few months, we’ve been dealing with extra workload due to a lot of staff being sick. We have a few colleagues on long-term sick leave, and there have also been vacations. So, in that sense, scheduling was also quite challenging”* [#4].

Organizational support factors influencing sustained use of robot Ivy

While this research primarily focused on micro-level implementation factors, healthcare professionals' experiences revealed that organizational support was crucial for successful implementation. Though not directly investigating organizational implementation strategies, professionals' reflections highlighted how organizational factors enabled or hindered their ability to effectively utilize the robot in client care. The following presents further context to some of the frequently occurring organizational factors from Table 2.

Our analysis revealed a hierarchy of organizational support elements. Key driver 4.1 - management support through training provision and resource allocation proved essential. Training effectiveness varied significantly across organizations. When properly implemented, training sessions combined with accessible support channels enhanced professionals' confidence and capability. As one professional noted: *“The training, the help desk. We can go anywhere with our questions. The facilities. We have a space to literally practice. And the people—I think they are easy to reach”* [#6]. These essential elements facilitate sustained use of the robot. However, inconsistent training deployment created significant barriers. This was evident in one professional's observation: *“We should have immediately trained the whole team at once in how the system works instead of me having to do it staff member by staff member”* [#1].

Resource allocation posed another crucial organizational factor. While some organizations provided dedicated implementation time (enabler 4.2), others required integration within existing workflows. As one professional described: *“I close the office door and take a moment to focus, away from the residents. Staying an extra hour after my shift just to work on the robot would actually make things much easier. Right now, I have to manage it during my shift, and just when I spend 10 minutes on it, another resident needs my attention.”* [#21]. Cases that succeeded in implementation typically demonstrated strong organizational commitment, characterized by dedicated implementation teams, regular training opportunities and thorough documentation of successful use cases (enablers 4.1 - 4.3). However, findings show that deal-breakers, such as a lack of organizational commitment (4.1) and failure to adhere to the implementation roadmap (4.2), jeopardize the sustained use of the technology. In one case, where the robot was discontinued, a care professional shares: *“I wasn’t there when Ivy was first introduced to us colleagues... so, I assume that a training on how the robot works could have helped. I also heard from colleagues that more people had the same issue. If you have to figure everything out on your own, it becomes very time-consuming, especially in a hectic period like this”* [#4].

Discussion

Principal findings

The sustained use of social robot Ivy in 63% of cases (12 out of 19) demonstrates both the potential and challenges of integrating social robots into disability care. Building on prior

research on intelligent assistive technologies in disability care [3,5], this study examined the value of sustained use of social robot Ivy for PwID and their healthcare professionals across 19 cases. The mixed results—where robot use continued in 12 cases but stopped in 7—highlight the complex process of adopting technology in long-term care for PwID. Our analysis revealed three key findings. First, where implementation was successful, social robot Ivy created distinct value for both clients and healthcare professionals through three key mechanisms: First, the robot's consistent and non-judgmental nature provided structure while reducing emotional burden - supporting clients' independence and wellbeing while allowing professionals to focus on meaningful interactions rather than repetitive tasks. Second, the automation of routine activities enhanced efficiency, enabling more person-centered care delivery. Third, successful implementation appeared to create a virtuous cycle where increased client independence and improved care experiences contributed to greater work satisfaction among professionals.

Second, inspired by the NASSS framework [14] and Meiland's implementation model [15], our analysis categorizes barriers to sustained use according to their level of impact and complexity and distinguishes between deal-breakers, obstacles, or minor hurdles. By applying the same classification framework to facilitators as we do to barriers, we distinguish between key drivers, enablers, and minor boosters to assess their relative impact on the success of implementation. This classification emerged from analyzing both the 12 cases where robot use was sustained and the 7 cases where it was discontinued after two months.

Third, we categorized both barriers and facilitators not only by their level of impact on sustained use of the robot but also across four key domains: client characteristics, healthcare professional capabilities, contextual conditions, and organizational support. This domain-based classification allowed us to systematically examine how different factors shaped implementation success or led to discontinuation.

Facilitators

The analysis revealed essential enabling factors required across all four domains for successful adaptive implementation. For clients, cognitive and sensory capabilities to process robot interactions, combined with a need for structure and predictable routines, were key drivers. This aligns with previous findings regarding the importance of matching technological capabilities to client needs in disability care [4]. The data showed that clients who could maintain attention during robot interactions and were receptive to neutral, consistent communication were more likely to benefit from sustained robot use.

For healthcare professionals, willingness to learn and adapt to new technology, ability to program basic client interactions, and available time for robot setup and maintenance emerged as critical factors. Using the robot, particularly its backend programming interface essential for customization, emerged as a significant challenge, requiring both time and adaptability from professionals. Adequate training, dedicated programming time, and ongoing organizational support were identified as critical factors influencing the sustained use of the technology. These findings align with recent studies [8-9, 13] stressing the importance of healthcare professional engagement in successful implementation of social robots in long-term care settings, as well as research highlighting the need to optimize interfaces for all end-users, including staff [22]. Moreover, healthcare professionals consistently emphasized the importance of dedicated time for programming and ongoing adjustments to maintain effective robot use.

Contextual analysis demonstrated that clear integration with existing care routines was essential for sustained use. The data revealed that support from informal caregivers, often family

members, enables successful implementation. Sustained use is jeopardized by issues related to the technology. Moreover, successful implementation depends on appropriate timing relative to staff availability. This highlights how organizational instability and high staff turnover can directly undermine technology adoption, as temporary staff lack the knowledge and commitment needed to maintain consistent robot use.

Organizational support through management commitment, dedicated implementation time, and training opportunities emerged as key drivers. Healthcare professionals specifically highlighted the importance of systematic team training and shared learning opportunities. Providing professionals with the capacity and time to engage with the technology fosters sustained use. Our findings suggest that such support shifts the perception of the robot from a burden to an opportunity to enhance care. This is especially critical in healthcare, where overstretched resources demand solutions that benefit not only clients, but also caregivers [2]. Sustained use of social robots depends on their ability to deliver value to all actors involved, including clients and caregivers [23]. Particularly for social robot Ivy, whose setup and functionality heavily rely on caregiver input, organizational support is necessary to ensure it creates value for both groups.

Barriers

The interviews revealed distinct categories of barriers affecting implementation success. Following the classifications outlined in the NASSS framework [14], barriers were classified as deal-breakers (complex), obstacles (complicated), or minor hurdles (simple). For clients, deal-breakers included complex and unpredictable care needs requiring frequent adjustments, along with severe cognitive limitations affecting comprehension. Obstacles included fluctuating health conditions affecting engagement, while minor hurdles involved technical difficulties with touchscreen operation. These findings align with previous research highlighting the importance of matching technology capabilities to client characteristics [24]. Additionally, our study underscores that beyond matching technological features (button- and text-size), factors such as the pace of interaction—how much time a client has to respond—are key in ensuring successful and sustained use, particularly for PwID with varying levels of cognitive and physical abilities.

For healthcare professionals, deal-breakers centered around insufficient time for programming and maintaining the robot, combined with high staff turnover. Obstacles included inconsistent use across team members and challenges in programming complex interactions. Minor hurdles involved initial learning curves with the programming interface. These findings echo recent studies emphasizing the need for dedicated time and resources in healthcare technology implementation [25].

Contextual deal-breakers included unstable connectivity and poor implementation timing, particularly during this period. Obstacles included coordination challenges during holiday periods, while minor hurdles involved occasional technical glitches. This underscores the importance of stable care environments for successful technology implementation.

At the organizational level, deal-breakers included lack of systematic support and divergence from implementation roadmaps. Obstacles included unclear implementation responsibilities and fragmented initiatives within organizations. In line with recent research, this highlights the critical role of organizational commitment and structured implementation approaches in achieving sustained use of social robots in care settings [12].

Limitations and Strengths of the Study

Some limitations of this study should be considered. First, our analysis relies primarily on healthcare professional perspectives, as client interviews across all 19 cases were not feasible due to cognitive limitations. Second, although our study investigates adaptive innovation during the execution and continuation phases of early adoption, the two-month implementation period captures only initial adoption and early use, not long-term sustainability.

The strength of this study lies in its analysis of 19 cases across 6 different care organizations, encompassing both sustained use and discontinuation, which provided rich comparative insights. The inclusion of both successful and discontinued cases allowed for a nuanced understanding of facilitators and barriers across multiple care settings. Unlike much of the existing body of literature, which primarily consists of scoping/systematic reviews [25-28]; and lab or controlled studies [29-30], this field study investigated adaptive robot implementation in 19 actual productive care environments over a duration of 2 months. This approach offered a unique opportunity to explore long-term real-world experiences that go beyond an early pilot phase [7, 10] and hypothetical or controlled scenarios [29, 30]. Field studies in this area and at this scale are scarce, especially those examining the execution and continuation phases of adaptive innovation. By investigating 19 unique cases of robot deployment rather than focusing on a single robot, this research provides particularly valuable insights. Furthermore, the use of established theoretical frameworks (the NASSS framework and Meiland's implementation model) ensured a structured and complete analysis of the value of sustained use and related facilitators and barriers.

Scientific, Clinical, and Societal Relevance of the Study

This study makes several important contributions to the field. First, it provides a novel analysis of sustained versus abandoned use of social robots within the adopter system domain, focusing on value for the two key end-user groups: PwID and professional caregivers in real-world care settings. The findings present user value of the technology, including improved daily structure, greater independence, and enhanced emotional well-being for PwID, and support for healthcare professionals in delivering efficient, person-centered care. Second, it presents classifications of facilitators and barriers across four critical domains: client characteristics, healthcare professional capabilities, contextual conditions, and organizational support. These findings advance both research and practice by offering concrete implementation guidance while illuminating crucial prerequisites for successful robot deployment in disability care at both the micro-level, focusing on end-users, and the meso-level, addressing organizational factors.

By examining the execution and continuation phases of implementation [15], rather than early-stage preconditions and preparation, this study provides unique insights based on actual user experiences over a two-month period. The findings reveal how social robots can create distinct value: enhancing mental and social health for people with intellectual disabilities and complex needs while simultaneously reducing workload and improving care delivery efficiency for healthcare professionals.

This dual focus on value creation and implementation factors is particularly significant given projected global healthcare worker shortages [1]. While previous research on intelligent assistive technologies has primarily emphasized client benefits [3], our findings demonstrate that successful implementation requires creating value for both end-user groups. Intelligent assistive technologies (IAT) can effectively address workforce challenges and meet the growing demands for disability care services only when they meaningfully support both clients and caregivers, and

when implementation factors for both groups are adequately considered. By studying implementation in real-world care environments with their inherent staffing pressures and organizational dynamics, our research offers high external validity regarding the dual value creation needed for both clients and caregivers. The classifications of facilitators and barriers across four domains provide organizations with concrete guidance for identifying and addressing critical implementation factors for both end-user groups.

Implications for practice

Our findings provide several practical implications for long-term care organizations implementing social robots for PwID. Firstly, careful client selection is crucial. Organizations should focus on individuals with sufficient cognitive capabilities and predictable care needs to ensure meaningful and effective interactions with social robots. Secondly, healthcare professionals must be provided with dedicated time and resources to manage robot programming and maintenance. Without these, the integration of such technology into care routines may face significant challenges. Thirdly, the timing of implementation must take into account both staff availability and client wellbeing. Properly aligning these factors can help avoid non-adoption or disruptions of robot use. Findings show that social robot Ivy can contribute to well-being, while a certain threshold of client well-being is required to accept the robot in the first place. Fourthly, organizations should deliver systematic training and support to entire care teams. This ensures that all staff members are equipped with the knowledge and skills needed to prevent disruptions of maintenance and frequency of use, thereby maximizing the value of social robot use. Finally, regular evaluation and adjustment of robot interactions are essential for sustained use. Continuous monitoring and fine-tuning help maintain engagement and ensure that the robots continue to meet the evolving needs of both clients and staff. These practical implications can guide organizations in creating optimal conditions for successful robot implementation in long-term care settings.

Recommendations for Future Studies

Continued research is needed in three key areas. First, longitudinal studies beyond the initial 2-month implementation period should evaluate sustained robot use and integration into care practices. Second, mixed-methods studies combining direct client assessments with quantitative interaction data would provide more comprehensive insights into robot usability and impact. Future work incorporating direct client feedback could provide a more complete evaluation. Essential metrics should include frequency of use, types of interactions, and objective measures of client engagement. Third, participatory design studies involving clients, care professionals and technologists are needed to systematically improve both the robot's client interface and the professional programming platform. Additionally, studies investigating organizational implementation strategies can shed light on how to optimize social robot integration at scale. In the current study, we interviewed healthcare professionals that are directly involved in client care, resulting in a strong focus on micro-level factors related to clients, employees, and the specific context of implementation. Nonetheless, our findings also highlight organizational insights, suggesting that dedicated implementation teams and streamlined training programs may enhance the sustained use of service robots across diverse care environments. Future meso-level research should examine managerial strategies and organizational activities that enable healthcare professionals to seamlessly integrate social robots into existing care routines.

Conclusion

Building on growing evidence supporting the potential of social robots in disability care [4, 6-8], this study demonstrates that sustained use of social robot Ivy can create value for both PwID and healthcare professionals when implemented under appropriate conditions. Success requires careful attention to user needs and preferences, client characteristics, healthcare professional capabilities, contextual factors, and organizational support. The classifications of facilitators and barriers provide structured guidance for healthcare organizations implementing social robots for people with intellectual disabilities.

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Conflicts of Interest

None declared.

Abbreviations

IAT: intelligent assistive technologies

NASSS: Non-adoption, Abandonment, Scale-up, Spread, and Sustainability

PwID: people with intellectual disabilities

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Supplementary Files

Figures

Robot Ivy.

