Enhancing Aged Care through Human-Robot Collaboration: A Case Study of Chore Robots.

Valeria Alessandra Macalupu Chira*

School of Design, Queensland University of Technology, v.chira@qut.edu.au

Glenda Caldwell

School of Architecture, Queensland University of Technology, g.caldwell@qut.edu.au

Evone Miller

Design Lab, Queensland University of Technology, e.miller@qut.edu.au

Robots are not yet mainstream in aged care, despite decades of experimentation and technological advancements. Alongside technological, regulatory, and societal considerations, part of the challenge has been limited to end-user engagement in co-designing robots for aged care. This project engaged ten leaders in aged care to participate in a co-design workshop to collaboratively imagine and design a chore robot for aged care, focusing on identifying tasks or activities where robotic assistance could be most beneficial. The study also examined workforce implications and the economic rationale needed to justify this change. Alongside documenting the co-design processes and tools deployed, this article shares the expectations and experiences of executive leaders in aged care, reflecting on the challenges and opportunities for robotic design and adoption in the unique setting that is aged care.

CCS CONCEPTS • Human-centered computing • Human computer interaction (HCI) • HCI design and evaluation methods

Additional Keywords and Phrases: aged care, co-design, chore robot, human-robot collaboration, technology adoption, robotics.

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1 INTRODUCTION

While numerous successful demonstrator and pilot studies have showcased the potential of robots to improve the lives of older people in residential aged care (see, for example, the therapeutic robot Paro the Seal [1][2] and the transport/chore

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robot, Rosie [3]), the leap to widespread adoption of robots has proven elusive –partly because of limited end-user engagement in the design phase. This study builds on the extensive body of work in Human-Robot Interaction (HRI) and co-design methodologies for aged care. Previous research has demonstrated the potential of co-design in creating effective and user-friendly robotic solutions for elderly care settings [4][5][6]. These studies highlight the importance of involving multiple stakeholders, including residents, care workers, and executives, in the design process to ensure the robots meet the diverse needs of their users. The paradigm shift has caused the development of robotic technologies to increasingly use a human-robot collaboration lens, and research documenting how to co-design a robot for aged care to expand. Yet robots are still to become an integrated technology in everyday workflows, perhaps guiding to understanding how to break into the field in the first place. Therefore, this paper addresses the expectations decision-makers in aged care have in order to facilitate the initial adoption of robots.

2 BACKGROUND

Robots, best defined as "*information technology in a physical embodiment, providing customized services by performing physical as well as nonphysical tasks with a high degree of autonomy*" [7], come in various forms, each designed for specific tasks, needs and environments. Service robots are particularly valuable in interacting with, assisting, or providing services to humans in non-industrial and non-manufacturing environments, including the home, retail, hospitality, healthcare, and aged care.

In the context of aged care, interactions between humans and service robots can be broadly categorised into three key activity domains: chores, companionship, and care activities, as visually depicted in Figure 1. To date, the majority of research has focused on companionship robots for socialisation (e.g., limited conversations, playing bingo, quizzes, collaborative singing) and basic care tasks (e.g., monitoring health vitals, exercise, movement), such as Pepper (humanoid robot) and Paro the Therapeutic Seal (animaloid robot) [1] [10] [11].

While several studies have demonstrated Paro has a positive impact on quality of life and pain medical usage [1], Pepper - which was trialled in libraries, banks, stores, and aged care as a friendly interactive robot – often failed due to limited functionality and unreliability, and was withdrawn from the market in 2021 [8] [9]. Some studies with Pepper in aged care [10] [11] [12] recorded an increase in caregivers' responsibilities to ensure the correct functioning of the robot and to facilitate its social acceptability with residents, particularly those with dementia. Moreover, in some instances where caregivers were skilful, they found Pepper's standardised activities and programs to be too limiting and hinder their care performance and relationships with residents. When interacting in scenarios with multiple residents who spoke in diverse tones and dialects, Pepper's performance fell short of understanding commands, disregarded residents' dynamic feelings and emotional needs, and impacted and confused them with its responses. These limitations have been found in other social robot prototypes like Kompai [13], SCITOS G5 [14], and YORISOI Ifbot [15]. These failures highlight ongoing challenges in the field of Human-Robot Interaction (HRI), particularly concerning the reliability, acceptability, and usability of robots in complex care environments.

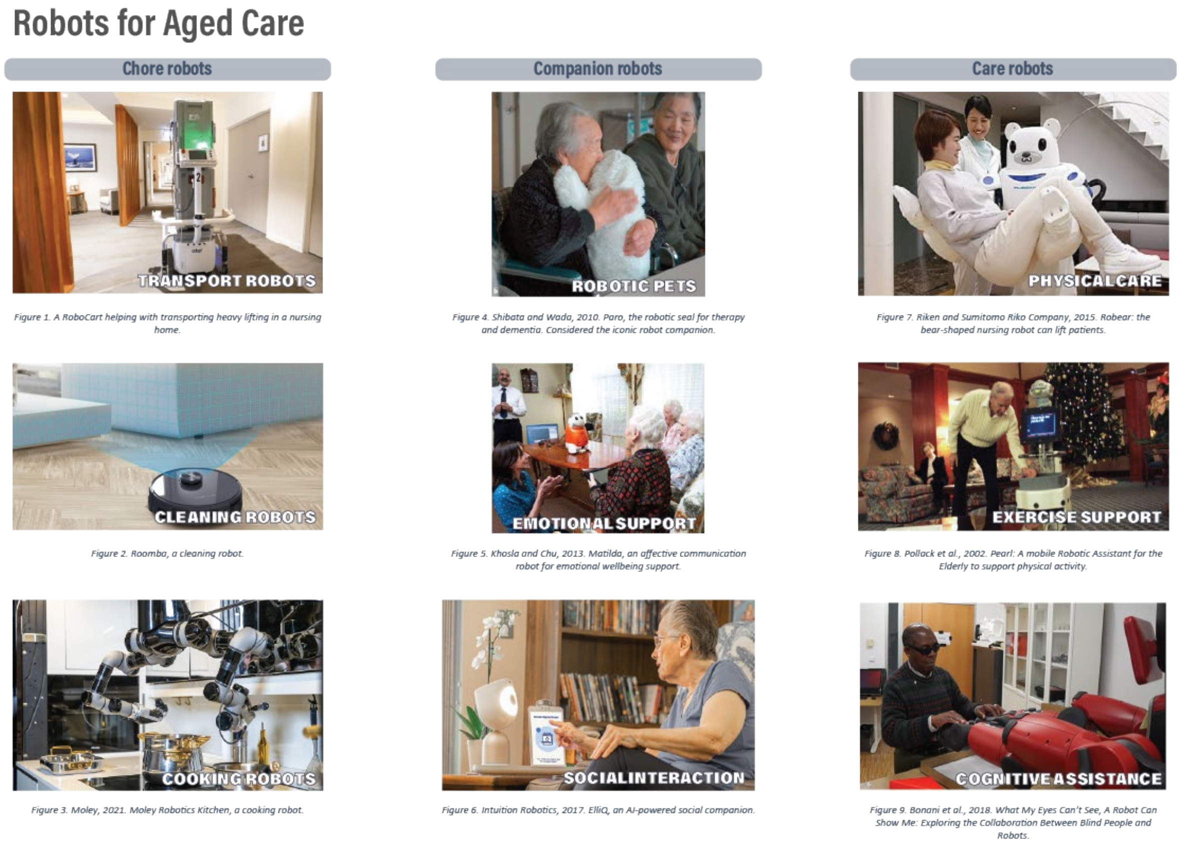

Fig. 1. Chore, companion, and care robots in aged care (Source: Project Team).

The current focus on social companion/ entertainment/ physical and cognitive impairment robots [16] has left a research gap in chore robots, which could relieve staff of physically demanding and time-consuming tasks. Given that chore robots could handle more routine or so-called “dirty” tasks (laundry, cleaning, showering, toileting), which involve urine, faeces, and bodily fluids [17] [18], their limited adoption is surprising. Performing these tasks can be physically demanding, time-consuming and challenging for caregivers, who may experience physical strain from lifting, moving and manoeuvring residents (lifting, bending, carrying tests strength and endurance, straining muscles) and their belongings.

The current reality is that there is simply not enough skilled staff in aged care [19] [20], which leads to increased workloads for existing caregivers, leading to burnout, increased staff turnover, and higher recruitment and training costs. The reduced and often changing care staff can negatively impact residents’ quality of care, resulting in “missed” or “unfinished” care: residents wait because staff are busy elsewhere [21]. Miller [22], for example, documents how one aged care resident felt that staff were “*always rushed, always sharing everybody and everything...*” (p.122). Staff want to deliver quality care, but aged care is a busy environment, limiting caregivers' availability to engage in more meaningful, person-centred interactions; as one staff member explained:

> "We have a roster of what we are supposed to... including taking people for walks at 9.30 am. That time, we have just finished showers, we have got to make the beds, do the pad bins... then at 10 am it's morning tea... supplement drinks, 10.30 am activities start... so we don't always get to it. We all try and spend that five minutes here and there to talk to them" [23].

Moreover, between 25 – 30% of Australian carers are from Culturally and Linguistically Diverse (CALD) backgrounds, increasing the complexity to meet their needs in terms of communication, social and cultural awareness [24]. By leveraging robotic assistance, caregivers can optimise their workflow and focus more on engaging with residents while the technology handles routinie tasks. To date, although technology has the potential to help alleviate some of the challenges facing care staff, the adoption of service robots into residential aged care – especially those focussed on reducing the physical workload by assisting with chores while responding to the multicultural background of the limited workforce - remains limited and piecemeal.

A notable exception is the Lamson AMR RoboCart, used in a regional aged care facility in South Australia, where robots are employed to transport items such as linen, clean clothes, and food across large, dispersed facilities. The trial, supported by government grants and partnerships with robotic manufacturers, has shown that chore robots can handle up to 25% of tasks traditionally performed by humans. This has led to significant cost savings, with the equivalent of 2.5 full-time positions and an estimated $200,000 annually being redirected to increase staff care hours [7]. However, the adoption process has been challenging due to the need for substantial facility modifications, such as door replacements, Wi-Fi upgrades, and lift adjustments. These logistical challenges underscore the importance of usability, acceptability, and functionality for successful integration, as the robots must align with staff workflows and meet resident needs to add real value [23][25].

As Hornecker et al. [26] remind us, social robots require significant human (staff) oversight to integrate into practice, and are not, in fact, the social-cultural, scientific and media portrayal of "*skilful, autonomous and quasi-conscious entities… acting in isolation, working independently, and replacing human work*" (p.2). As the context of aged care involves both residents and staff, Hornecker et al. [26] suggest that the field of care should move from HRI (Human-Robot Interaction) to HHRI (Human-Human Robot Interaction) so as to account for both the "*physical reduction of the caregivers' workload but also to an emotional enrichment for the residents*" (p.9). Alongside moving from a dyadic to a triadic interaction structure, it is essential that robotic developers have a better understanding of what senior management (those who make the ultimate decision about technological adoption) in aged care think robotic technology could and should do for them, and what they would prioritise paying for. Research that includes decision-makers in the hands-on co-design process of robotics in aged care is relatively limited. Existing studies generally involve these stakeholders through surveys or occasional prototype testing, rather than through comprehensive, interactive co-design activities. These studies recommend prioritising key ethical concerns, including privacy and task appropriateness, to ensure that robotic solutions align with the values and needs of aged care settings [27; 28]. Additionally, they emphasize the importance of addressing practical considerations such as procurement processes and regulatory compliance, which are essential for the sustainable adoption of robotics in this sector [29].

The gradual adoption of robotic technology in aged care can be further understood through Everett Rogers' Diffusion of Innovation theory [36]. This theory categorises adopters into groups—innovators, early adopters, early majority, late majority, and laggards—based on their willingness to embrace new technologies. Given the risk-averse nature of the aged care sector, early adopters and innovators play a pivotal role in introducing robotic technologies. They serve as examples for the broader sector, demonstrating tangible benefits and encouraging the early and late majority to consider adoption.

By understanding these adoption patterns, we can better anticipate and address the factors that may influence the successful integration of chore robots in aged care settings, laying the foundation for more widespread and effective adoption.

While chore robots have shown potential in aged care settings, existing research has predominantly focused on companionship robots, leaving a gap in understanding the role and impact of chore robots that could alleviate physical burdens for caregivers. Additionally, challenges such as the sector's risk aversion, limited adoption due to facility constraints, and the need for culturally inclusive designs highlight the complexity of integrating robotics in aged care. This study addresses these gaps by exploring the design and application of chore robots with aged care decision-makers, emphasising trust-building, technology adoption patterns, and considerations for diverse care staff, thereby contributing to the emerging dialogue on Human-Human-Robot Interaction (HHRI) and the practical adoption of robotics in this sector.

3 CO-DESIGNING A CHORE ROBOT FOR AGED CARE

The current study, therefore, asked executive aged care stakeholders to collaboratively imagine and co-design a chore robot for aged care, focussing on (1) identifying the tasks or activities where robotic assistance would be of most value; (2) assessing expectations and past experiences of robots in aged care; and (3) conceptualising the ideal chore robots appearance, features, and functionality. This study sought to engage the "higher-up" stakeholders in providing their perspectives on the economic and investment value of aged care robots, and their feasibility in workflows. However, in future work, the study also aims to continue the co-design process with caregivers and residents to compare and extrapolate initial findings with their respective perspectives.

Leveraging an existing real-world functional prototype of a chore robot, HELPII, from our robotic colleagues (with a mobile base, grasping technology, AI-enabled voice command, and a personality [30]), this co-design research explored the wishes, expectations, and preferences of executive aged care stakeholders. Co-design directly involves users in the design process, to design with, not for, so that end users have an active role in knowledge development, idea generation, and concept development – thus helping to ensure the final product truly meets their requirements [31].

The co-design process is a necessary step to assist the mechatronic engineers and the designers to better understand the needs of the chore robot's end-users. There are numerous design factors that need to be addressed and taken into account when considering the development and implementation of robotic technology, more specifically collaborative robots (cobots) and for human-robot collaboration.

Human-robot collaboration (HRC) refers to the collaboration resulting from a human and a robot working on the same task or in close proximity to one another [32]. Safety is a primary factor driving how a human and a robot can collaborate and interact with one another typically mitigated by sensors, monitoring, power limitations and force control [33]. Cobots have a number of attributes and characteristics ranging from payload, reach, degrees of freedom to costs and programming [33]. Additional factors to consider are the context and environment of robot use, purpose of use or task definition, experience of users, control of the robot, size and weight.

For the aged care sector, all of these factors are relevant to the design of a chore robot requiring input from stakeholders beyond researchers, engineers and designers. Therefore, including the perspectives of experts from the aged care sector is a first step in developing a chore robot that can work alongside humans safely and collaboratively, one that is fit for purpose, aesthetic, user friendly, and acceptable to residents and families, and that aged care decision-makers would support and pay for. This study is a starting point for engaging executive stakeholders that will open the design space and the opportunity to engage direct stakeholders in further studies, being residents and carers.

4 METHODOLOGY

The overall project is guided by Participatory Design, chosen for its focus on engaging diverse stakeholders and collaboratively exploring their needs to ensure the design reflects practical, real-world applications in aged care. Leveraging the knowledge and expertise of executive aged care stakeholders, we conducted a qualitative co-design study comprising of a tour around a robotics lab, a workshop/roundtable and individual follow-up interviews. The study focussed on understanding, imagining and co-designing what a chore robot designed for aged care should look like and do. Participant selection criteria included working in an Australian residential aged care or service provider within the industry, holding a management or decision-making role within the industry, having commercial knowledge in the industry, having previous experience in roles that directly interacted with residents, and holding an interest in robotics for aged care. Having previous experience with assistive technology and/or robots was also fundamental.

Ethics approval was granted by our university ethics committee (7765), with the research conducted in late 2023. A 2-hour engagement was held in our university seminar room in late November 2023, with executives in residential aged care recruited through our professional networks and snowball sampling. Participants included seven representatives from 4 care providers in the Greater Brisbane area (Australia), as well as a venture capitalist (1), an architect (1) and an accountant/business advisor (1). As an exploratory study, it sought a small participant sample to encourage qualitative, rich data in a variety of themes and in-depth understandings [34].

4.1 Robotic tour and demonstration

We invited industry leaders to participate in a tour of the robotics research centre, where they could observe the diverse projects and robotic prototypes being developed by our university. Following, our research colleagues held a demonstration of the prototype robot, HELPII. The 20-minute demonstration presented HELPII's main attributes: voice activation, mobilisation and robotic arm movement to pick up a cup from a desk on command. The demo also included an informal short round of Q&A from participants. The aim of the tour and demonstration was to introduce participants in the topic of chore robots for aged care with an interactive, hands-on example of robotic capabilities. Moreover, the robot HELPII was the focus of the following co-design workshop.

4.2 Workshop/Roundtable

After the demo, industry leaders participated in a co-design workshop, starting by reflecting on their own knowledge, beliefs, and experience with robotics in care settings. We asked participants to collectively share and discuss: "*What do we know about robots in aged care? Has your organisation deployed a robot? What was the experience like? What about the sector experience?*". We followed the discussion with a presentation of current robots in aged care (Figure 1) and similar conceptual robots to elicit provocation for the following design session. Finally, we conducted a co-design/design thinking sprint to re-design this chore robot, HELPII. Based on the Royal Commission into Aged Care Quality and Safety outcomes [20], the aim of the chore robot they were to design was to free up carers' time by supporting certain routine tasks. In order to guide the robot design, figure 2 outlines the custom co-design canvas we developed for teams to complete, with 8 reflective/prompting questions: (1) activities, routines and tasks - the purpose of the robot; (2) its location; (3) who it interacts with; (4) its physical form; (5) how it communicates; (6) its impact on the aged care home; (7) ethics to consider; and (8) the narrative that would convince the aged care board to fund, invest in, and/or trial this robot. The canvas sections were informed by the foundational principles of design. Rather than adhering to a specific framework, we identified the core aspects of a chore robot around functionality, usability, safety and aesthetics.

Groups then completed a one-page pitch outline, with a sketch of their idea, a robot name, and the key compelling points (from design features to business model), before verbally presenting their solution (see Figures 5-8). Comparing the various robot designs during the workshop allowed participants to evaluate different features and interaction styles, which led to discussions that enriched our understanding of usability challenges, user preferences and practical applications in the industry.

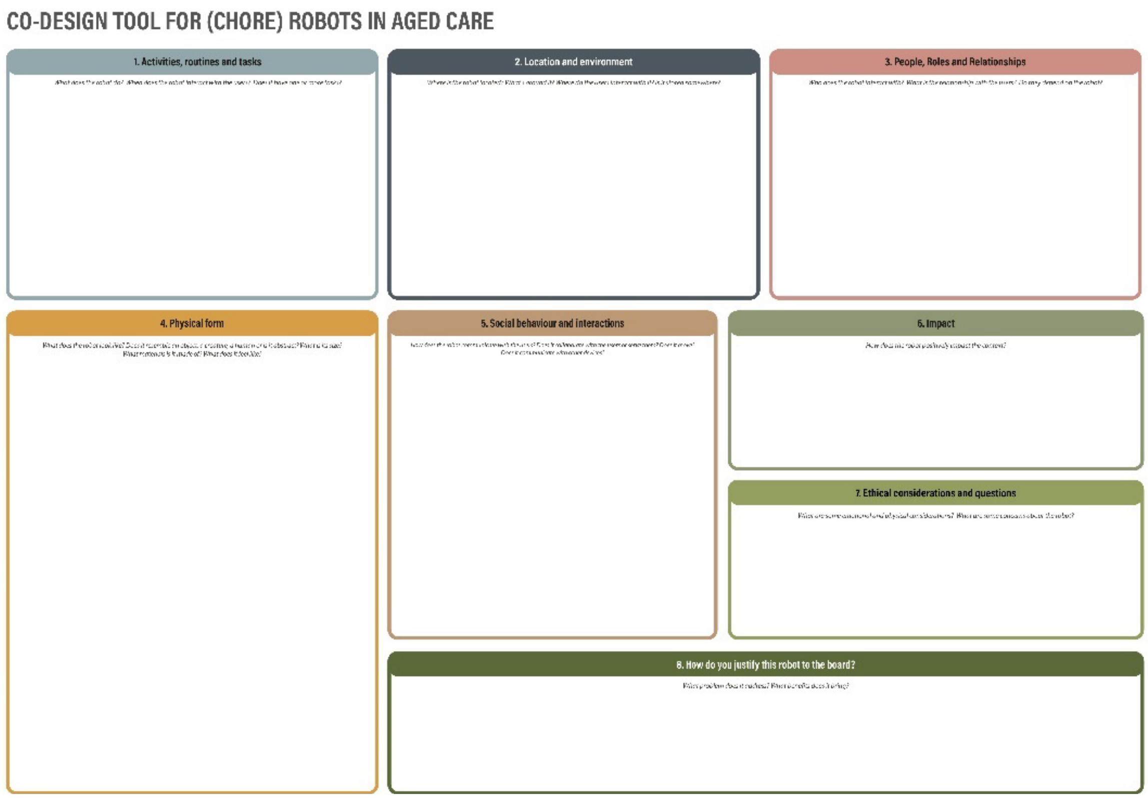

Fig. 2. The robot in aged care co-design canvas.

4.3 Individual Interviews

In the month after the roundtable/workshop, follow-up online semi-structured interviews (~30 minutes) were held with 5 representatives of the main aged care providers from the original participant pool. We developed a survey to guide the interview around the following themes: a. the most important and time-consuming tasks a chore robot can do to help carers, b. the Full Time Equivalent workload (FTEs) corresponding to the tasks, and c. characteristics of their aged care facility that impacted their previous experience with robots. We also clarified the final decision concepts and narrative that would best engage and convince aged care leaders that a chore robot would be of value to their organisation. The semi-structured interviews were developed based on the preliminary data presented at the workshop.

4.4 Data collection and analysis

Data collected from the workshop and interviews took the form of audio recordings, annotations, photographs and participants' worksheets. Audio recordings were transcribed and used with annotations and worksheets. Data was analysed using thematic analysis from Braun and Clarke [35]. During the analysis process, activities, locations, interactions, aesthetics, communication forms, impacts, ethics, and business model characteristics were prioritised based on frequency, participant emphasis and their perceived impact on aged care workflows. Additionally, findings were reviewed by the research team to ensure consistency and accuracy in the themes identified. Key themes were identified through repetitive topics reported below.

5 FINDINGS

The co-design workshop and interviews revealed several critical insights. Executives highlighted the importance of designing robots that can seamlessly integrate into existing care workflows, emphasising tasks that alleviate care worker burdens while enhancing resident satisfaction. Unique to the executives' perspective were considerations of economic feasibility and workforce implications, aspects less frequently addressed by care workers or residents.

5.1 Findings from the co-design workshop

5.1.1General sector knowledge of robotics is low

The session started with an open discussion about what participants knew about robotics, asking if (1) they had deployed a robot, and their experience, as well as (2) what the sector experience was. Overall, participants had very low levels of knowledge, awareness, and practical experience of robotics. Two organisations had direct experience with a service robot, a chore robot (also a Lamson) and a humanoid robot (Pepper). Both returned them after 2 months, as described below.

Pepper, the Robotic Receptionist - from "wow" to "what".

This aged care facility was excited to trial Pepper (Figure 3), describing how they thought it was "novel and nice... the funkiest, coolest little thing". Pepper was deployed to act as receptionist in their gym area, to enable bookings for exercise programs. However, despite the original excitement, there was ultimately a sense of disappointment in that Pepper did not really add significant value, with the initial "wow" factor becoming "so what?". While they acknowledged that they did not fully activate the robot, there was a sense that Pepper did not significantly enhance the experience or streamline processes – and after two months, they returned the robot.

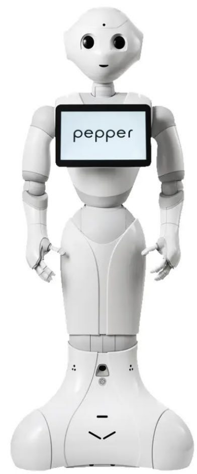

Figure 3: Pepper the robot [RobotsGuide]. (https://robotsguide.com/robots/pepper)

Rosie, the Lamson transport robot – "excitement became struggle".

A second aged care facility described their experience, in 2019, with a robotic laundry and food transport system in their new 150 bed facility. Intentionally designed to be non-institutional without long corridors, there were 5 x 30-bedroom communities (each with their own dinning and lounge rooms) featuring widened corridors to enable a robot transport system. Their chosen system was a Lamson Autonomous Mobile Robot (AMR) designed to save staff time by automating trolley transport and transporting meals, linen, waste, supplies, and clothing, see Figure 4.

Fig. 4. Lamson's AMR (Source: https://www.lamson.com.au/solutions/aged-care/).

This RACF was an early adopter, working with a USA-based supplier. Unfortunately, they were unable "to get the robot to the point of efficiency". As the CEO explained, "excitement became struggle", with two months of challenge where "more time was spent re-setting the robot than using". It was unable to operate autonomously and always seemed to require one person to supervise it, "stopping at every turn, always needing someone to follow up – it needed to be able to do things away from the team... and that was not our experience".

They experienced three specific issues. Firstly, navigation challenges. Despite intentionally designing wider corridors to facilitate movement, the robot was unable to efficiently navigate the shorter corridors and the dynamic, often cluttered, environment of aged care – which meant it could not reliably and independently transport laundry and food without supervision. Secondly, operational errors. They reported that the robot frequently experienced operational errors (technical malfunctions, software issues, difficulties in handling various tasks), leading it to often being "in a thousand pieces, on the floor". The robot required continuous supervision, with "more time spent re-setting the robot than using it". Thirdly, safety concerns. They described a notable incident where the robot failed to sense the presence of an older resident in an elevator, leading to the resident being trapped. While this was a one-off event, combined with the ongoing operational challenges and the fact that the robot could not operate autonomously, they ultimately decided to return the robot after only two months of use.

Their experience with robotic transport was disappointing, with their original high expectations not met. The challenges they encountered, including navigation issues, operational errors, a notable safety incident and the need for constant supervision, highlight the complexity of adapting robotic technology to real-world environments. However, they noted that occurred several years ago, in 2019, and felt that many of the problems they encountered had likely been resolved – and thus were keen to experiment with robots again.

5.1.2Reimagining and co-designing a chore robot for repetitive tasks

Most of the workshop centred on reimagining the chore robot, HELPII, with teams (2-3 industry participants, working with 1 research team member) completing the custom design canvas we developed. First, however, there was a group brainstorming session to consider what the robot could do, as reported in Table 1. Teams then picked one idea (or generated another) to develop as a concept, completing the canvas in Figure 2. They were also given a printed image of HELPII with a series of pre-cut pieces of papers with textures, colours, and robot parts to use for collaging and drawing their concept further.

Table 1: Tasks assigned to chore robot

Category	Task
Kitchen/Garden	Clear tables and serve residents.
	Garden weed, water and mow.
Clean/Laundry	Clean bathrooms.
	Operate laundry machine – washing, folding, sorting, and delivery.
	Shampoo carpets.
Move and Fetch	Move residents to and from activities.
	Move furniture and set up activity spaces and rooms (before/after meals).
	Fetch things, such as tissues; remote control: pick up rubbish; socks; water, etc.
	Install a vending machine on top, and have it circulate offering food (note that it is restricted to the resident's diet).
Social and Care tasks	Prompt residents: meals, activities, medications.
	De-escalate behaviour, distract or influence moods (people with dementia).
	Monitor health: sleep, blood pressure, etc.
	Provide therapeutic touch, especially in palliative care context, for example, by holding a warm wheat bag.
	Link with nurse call system.

Each group developed and then pitched their ideas, articulating the value proposition, the business model, their design concept, and the name of their chore robot. Three teams focussed on versions of cleaning robots, and one on catering food.

Group 1: The Green, Clean, Calming Machine.

Group 1's robot concept, named the Green, Clean, Calming Machine, is an environmentally friendly cleaning robot. This robot performs cleaning tasks, including vacuuming, mopping, upholstery cleaning, air filtering and scent diffusing, while simultaneously monitoring residents in the background for distress or hazards. The robot's features include retractable arms for dusting and mopping, multidirectional wheels, and a height that allows it to fit beneath dining tables like a Roomba.

To enhance its usability, the robot is operated and programmed by cleaning staff using tablets and voice commands, considering the staff's diverse multicultural and language skills. The robot's soft, fabric-based material covering, soft edges, and warm-toned calming glow aim to make it approachable but still look like a machine, especially for patients with dementia. It is strategically placed in common areas, with one robot per facility wing, collaborating with the cleaning staff.

Apart from its cleaning functions, the Green Cleaning Machine incorporates UV sterilization for infection control, and it is designed to clean its own body, including wheels and the outer shell. The group envisions that the implementation of this robot will not only free up staff time but also help in hazard identification and preventing trips and falls. The overall goal is to positively impact the quality of life for aged care residents.

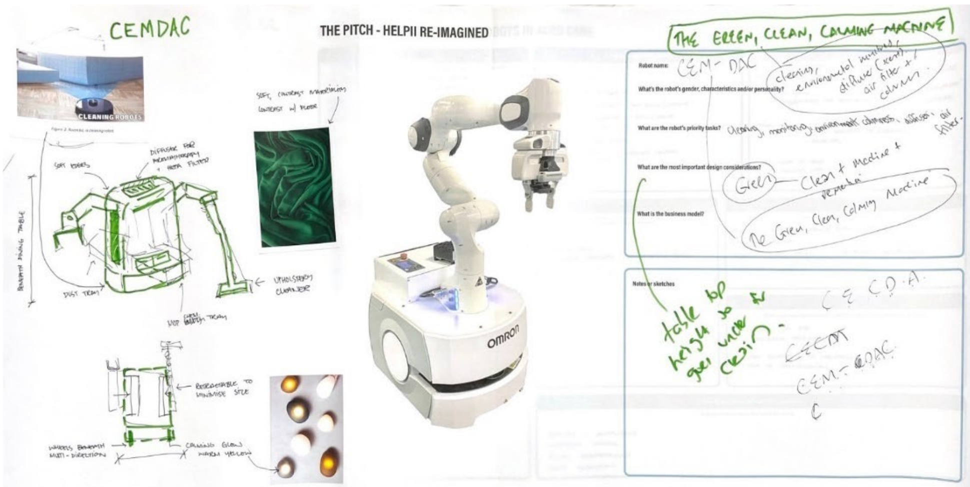

Fig. 5. Group 1. final pitch – The Green, Clean, Calming Machine.

Group 2: Sadie.

Group 2 reimagined the chore robot as a professional, engaging, and non-gender-specific robot designed for a variety of tasks within an aged care facility. The robot's primary responsibilities include cleaning general areas three times a day (post-meals), air purification, utilising fresheners, and implementing infectious disease prevention measures, such as those against viruses like coronavirus. Also, it is designed to comply with food safety standards.

The robot's physical attributes are characterized by friendly eyes, a small and functional design in white, and multiple arms equipped for tasks like picking up items, using microfiber cloths, vacuuming, dusting, and sanitising. As an additional touch, the robot might even play music. Group 2 considered that residents will actively participate in its design.

Practical considerations involve a docking station, but the robot is intended for routine work throughout the entire aged care facility. Importantly, it respects privacy by requiring consent before accessing individual rooms. The robot is designed to interact with both staff and managers, fostering a collaborative environment.

To ensure ongoing performance and support, the robot will be contracted through a lease plan, with maintenance and support services readily accessible locally. At the end of each day, the robot provides a comprehensive report, contributing to transparency and accountability in its operations.

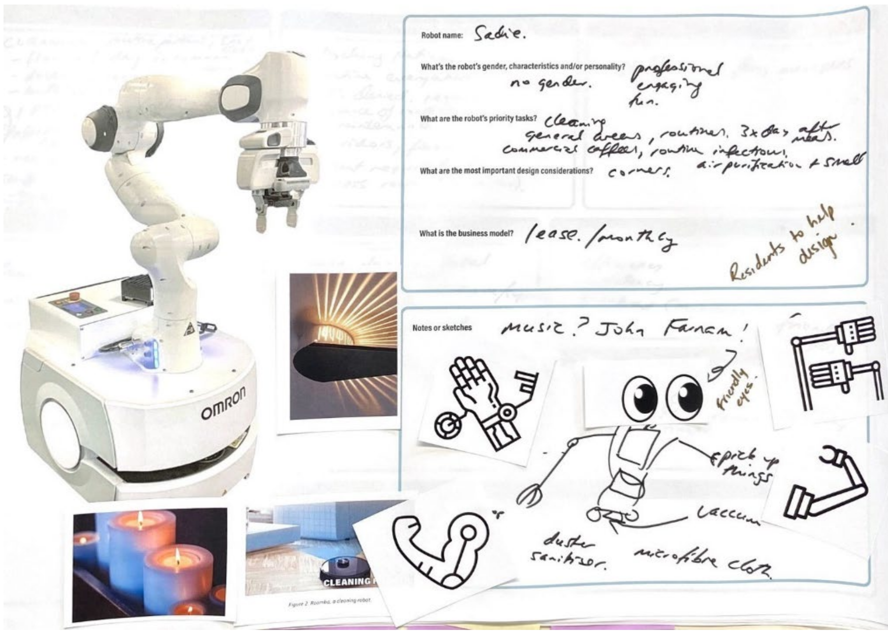

Fig. 6. Group 2 final pitch – Sadie.

Group 3: Speedy x3.

Group 3 envisions "Speedy x3," a functional and unassuming robot with a primary focus on efficiency in completing laundry chores and navigating residential aged care settings. Unlike other concepts, Speedy x3 does not have a gender or personality, prioritising a purely functional role to support residents in tasks they can no longer perform themselves.

The robot's core responsibilities focus on "getting the basics right," emphasizing seamless navigation through various environments within the aged care facility, including lifts, ramps, indoors, outdoors, and open doors. Its inconspicuous design ensures it does not stand out, contributing to a quiet and unobtrusive presence. Speedy x3's priority tasks revolve around the laundry process. It adeptly collects laundry, transfers it to laundry machines, turns the machines on, folds the laundry, re-labels items, and returns them to residents' rooms. The design considerations include a focus on being inconspicuous, quiet, equipped with a smell eliminator, capable of remote maintenance, and autonomous based on staff schedules while allowing for manual override.

The business model is structured to be more cost-effective than a staff member, with the robot's annual cost not exceeding $130,000. Speedy x3 operates seven days a week, responding to voice commands and central control on the robot. The main impact Group 3 aims for is to free up staff time, minimise facility damage, and reduce exposure to noise and smells, contributing to an enhanced and efficient care environment.

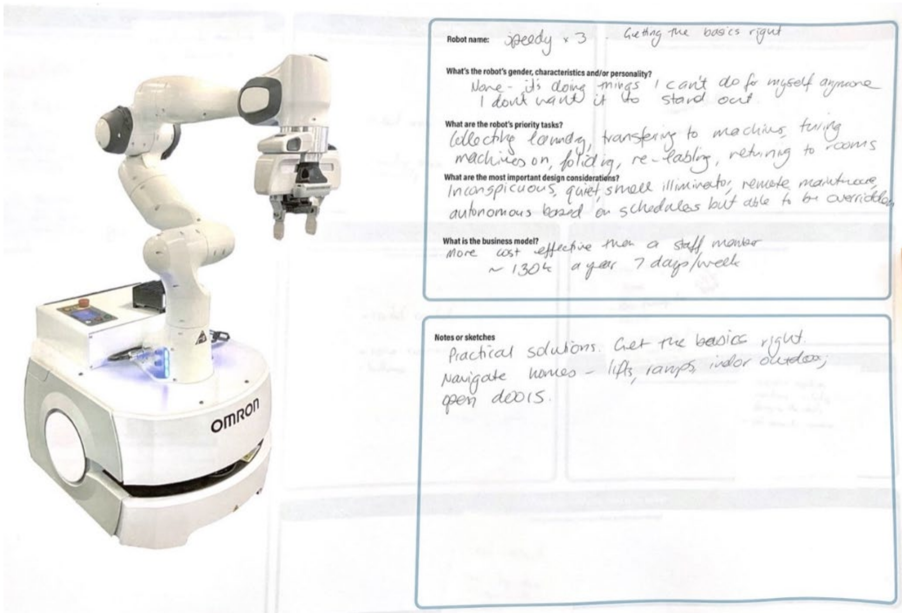

Fig. 7. Group 3 final pitch - Speedy x3.

Group 4: Cookii/ Foodii, your friendly catering companion.

Group 4's concept, named "Cookie" or "Foodii" (name yet undecided), presents a friendly catering companion for the aged care facility. Gender-neutral and characterised by a loving personality, this robot takes on priority tasks such as menu ordering, delivery and cleanup, food quality control compliance, and engaging in social interactions with residents, staff, and all stakeholders. Designed for easy manoeuvrability and multifunctionality and equipped with visual and voice interaction capabilities, Cookie or Foodii is a versatile addition to the care environment. The robot adopts a human-like appearance with two arms and features warm colours to stimulate appetites. Limbs are uniquely coloured to assist residents in identifying safe interaction points.

In terms of functionalities, Cookie or Foodii communicates through voice-to-text or iPad technology, collaborating seamlessly with staff to serve both them and residents. It moves about as needed, ensuring it reaches various locations within the facility. Special attention is given to residents suffering from social isolation, as the robot interacts with and accompanies them, motivating social engagement during meals. Importantly, Cookie or Foodii avoids delivering an automated, impersonal service. It recognises declines in a resident's well-being and promptly reports it, showcasing a commitment to personalised care. The robot can also assist in the physical positioning of residents before feeding, ensuring their comfort and safety.

The main impact of Cookie or Foodii is the realignment of staffing priorities, allowing staff to focus more on direct care. By handling catering tasks and providing companionship to residents, the robot aims to enhance the overall care experience while fostering meaningful connections within the community. Communication through voice-to-text or iPad technology further facilitates seamless collaboration between the robot, staff, and residents.

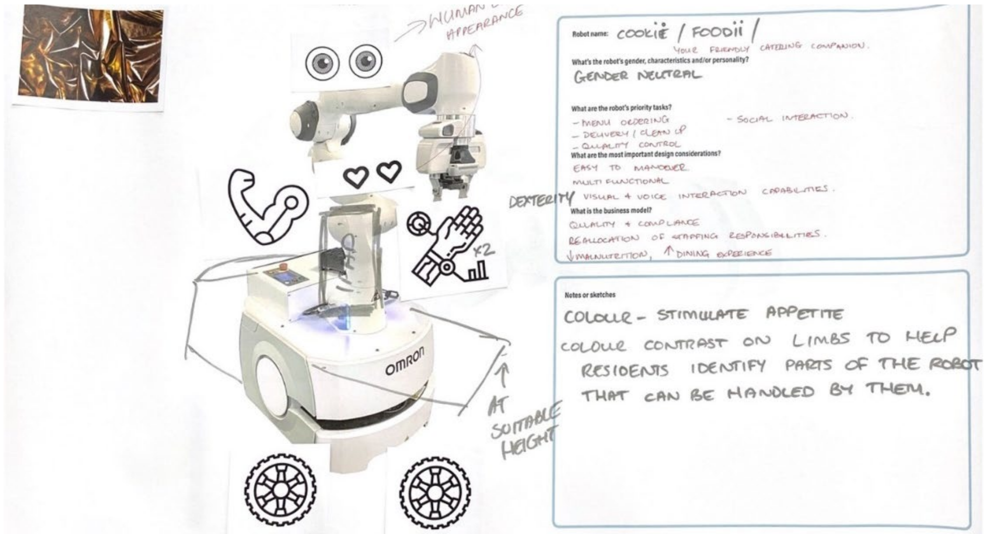

Fig. 8. Group 4 final pitch - Cookii/ Foodii.

The collaborative re-design of HELPII revealed a consistent vision of what a chore robot should be: a functional, efficient, and user-friendly assistant that integrates seamlessly into aged care environments. All designs—whether focused on cleaning, laundry, or catering—emphasised enhancing operational efficiency, reducing staff workload, and improving resident experiences. The robots were envisioned to be versatile, approachable, and capable of autonomous operation, with features like voice commands, soft materials, and safety measures to ensure they are helpful and non-intrusive in daily care routines.

5.2 Findings from the Individual Interviews: Industry priority for time-consuming tasks

In the follow-up interviews, which focussed on the practicality of deployment, participants (4 aged care providers and one architect) remained excited about how a chore robot might benefit, with all providers volunteering to trial the robot when needed. There was agreement that general cleaning and laundry are massively time-consuming tasks. In larger aged care facilities, such tasks are performed by cleaners and catering staff. However, in many, care staff often have to perform cleaning duties as well. Overall, there was a sense that a chore robot might potentially replace 1.5- 2FTE for general cleaning, laundry services and infection control, and this value proposition was of significant interest. Laundry, in particular, was a massive issue, especially for many regional facilities where the laundry is often externally located up to 1km from rooms [3].

6 DISCUSSION

In the process of identifying the value proposition for 'chore' robots in aged care, our study found that executive stakeholders exhibited a strong promising view of robotic technology, which aligns with existing research suggesting that robots can relieve staff of physically demanding tasks, allowing for a greater focus on resident care [16][17][18], despite having limited direct experience. Several key aspects emerged from the discussion.

6.1 Value - Cost and Task Efficiency

Participants acknowledged the potential cost savings and increased task efficiency that chore robots could bring to aged care facilities, making robotics a financially attractive option. Automating various tasks could lead to reduced operational costs and improved resource allocation towards quality care, which is increasingly prioritised following the recent Royal Commission into Aged Care Quality and Safety recommendations [20]. These have mandated that, from 1 October 2023, residential aged care homes will be required to deliver at least 200 care minutes per resident per day, including 40 minutes with a registered nurse [20].

The discussion highlighted the potential for robots to free up staff time, allowing for more personalized care delivery. For instance, Group 1's Green, Clean, Calming Machine combines cleaning functions with monitoring capabilities, aiming to free up staff time for more personalised care delivery. Group 2's Sadie focuses on professional cleaning tasks, air purification, and infectious disease prevention, aligning with food safety standards. Group 3's Speedy x3 streamlines laundry chores efficiently, prioritising cost-effectiveness. Group 4's Cookie or Foodii, the catering companion, aims to reallocate staffing responsibilities, enhancing the dining experience and decreasing malnutrition. By alleviating routine tasks, robots could help facilities meet these requirements, supporting the literature's argument that robots can directly impact care quality by enhancing workforce efficiency.

6.2 Trust in Technology

Trust is crucial for the acceptance and successful implementation of chore robots in aged care settings as demonstrated by the previous trials with robots like Pepper, which often failed due to limited functionality and an inability to effectively respond to residents' needs [10][11][12].

The diverse concepts of reimagined HELPII showcased different approaches to building trust. Group 1 emphasised the collaborative operation of their robot with cleaning staff, considering their multicultural and language skills. Group 2 aimed to engage residents in its design, fostering a sense of participation and ownership. Group 3 prioritised an unassuming and functional design to ensure acceptance and minimal disruption. Group 4 focused on personalised care, recognising declines in residents' well-being and avoiding automated, impersonal service.

Our findings reinforce the importance of building trust through reliable and responsive design, with participants emphasising that a chore robot's utility is dependent on its ability to integrate seamlessly into daily operations. This reflects the literature's focus on the need for Human-Robot Interaction (HRI) models that not only address functional reliability but also consider the robot's capacity to gain social acceptability among staff and residents. Participants suggested that successful implementation would require chore robots to be carefully integrated, with user-friendly interfaces and consistent performance to foster trust, particularly among younger caregivers who expressed enthusiasm for engaging with new technology.

6.3 The design, the tasks and the users

In this study, participants envisioned the potential tasks for a chore robot, proposing various features tailored to the aged care environment, such as clearing tables, operating machines, shampooing carpets, serving residents in personalised care support, menu choice/prompting, baseline observations, pain checks, and vital assessments for potential fractures. Incorporating a residents' database was deemed crucial to personalise interactions based on individual conditions, likes, and dislikes. Special attention was given to providing assistance with falls, bathroom cleaning, rubbish collection, and linen distribution, aiming to alleviate mundane, repetitive tasks for staff and enhance the overall resident experience.

Interaction modes were discussed, with voice commands, scheduled tasks, and reporting back findings highlighted as essential features. The diverse language skills of staff highlighted the importance of easy commands with voice activation and use of current familiar technologies, like tablets. The robot's ability to navigate corners safely was identified as a key issue, and leasing was considered a preferred option due to the need for ongoing service and maintenance.

These findings align with HRI literature emphasising that robots must be specifically designed to meet the distinct needs of aged care settings, where usability, safety, and comfort are paramount [26]. Findings also reflect broader design considerations in HRI research, which advocate for user-centred and dementia-friendly features, including recognisable interfaces, simple commands, and visually appropriate designs. Moreover, the participants expressed that robots should avoid humanoid or animalistic forms to prevent distress, further supporting the need for context-specific design in aged care robotics. Participants' concepts were cleaned up to represent each team's ideas and potentially use as tangible consequences in a following iteration session with personal care workers (staff) and residents (Figure 9).

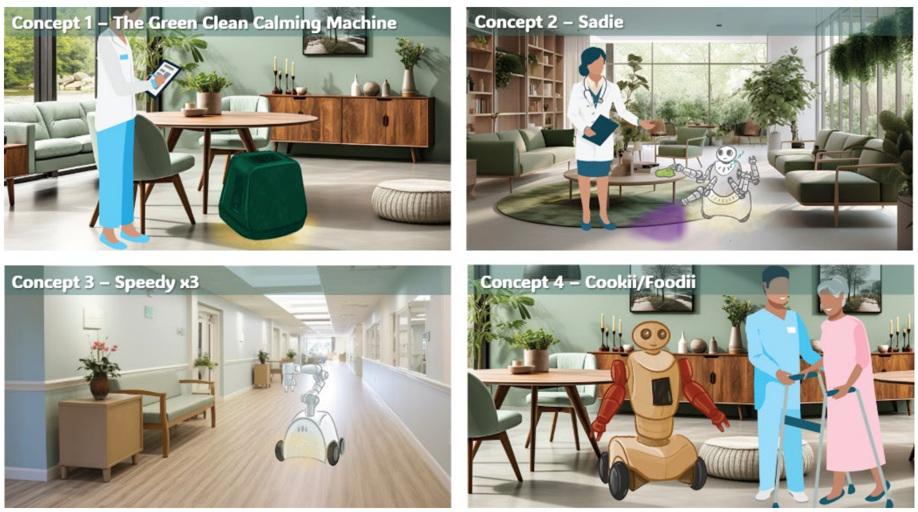

Fig. 9. Polished concepts resulting from the workshop with industry leaders.

6.4 Technology literacy of staff, especially CALD

Our findings also revealed the significant impact of staff diversity on technology adoption, especially for those from culturally and linguistically diverse (CALD) backgrounds. Participants observed that CALD staff members often face additional challenges in using new technologies due to varying levels of digital literacy. This theme highlights the need to design chore robots with intuitive and adaptable features, such as multi-language voice interfaces, which can facilitate adoption among diverse users. This insight remarks the importance of inclusivity in design. The use of adaptive technologies that accommodate language and literacy differences could empower CALD staff, improving overall workforce engagement with robotics and ensuring that technology adoption aligns with the diverse needs of the declining aged care workforce.

6.5 Diffusion of robotics in the aged care sector.

Participants, representing early adopters and the early majority, expressed interest in exploring the transformative potential of chore robots in aged care, though they also noted challenges related to limited exposure to robotic technologies. This aligns with the literature, suggesting that early adopters play a pivotal role in introducing new technologies within the aged care sector, helping to build momentum toward broader acceptance [32]. However, participants also noted the risk aversion prevalent in the industry, which often hinders technology adoption. This observation reinforces the literature's emphasis on the need for strategic engagement and pilot programs that allow stakeholders to see tangible benefits before committing to full-scale implementation. By framing this study's findings within the Diffusion of Innovation theory, we underscore the importance of co-design workshops as critical tools for facilitating early-stage engagement, promoting stakeholder buy-in, and ultimately fostering the adoption of chore robots in aged care.

7 CONCLUSIONS

This study addresses the pivotal gap in aged care research by exploring the co-design of chore robots, shedding light on the challenges faced by existing service robots and presenting innovative concepts to enhance the caregiving landscape. The research highlights the transformative potential of chore robots, offering relief to caregivers by addressing routine and physically demanding tasks. Concepts from industry leaders envision not only improved task efficiency but also a more personalised and compassionate care experience for residents. Collaboration, trust-building, and user-friendly interfaces emerge as critical elements for successful implementation.

While acknowledging challenges such as limited technology literacy among staff, the study identified a willingness among early adopters and the early majority within the aged care sector to explore the benefits of chore robots. The value proposition aligned with evolving care standards, emphasising cost savings, task efficiency, and improved care delivery. Participants believed that robots should not "take jobs", and, as senior leaders charged with ensuring financial viability, they needed to be convinced of the value and return on investment.

As we navigate the path toward chore robot integration, ongoing human-robot collaboration, usability testing, and functionality assessments become paramount. This research serves as a catalyst for further exploration involving personal care workers (staff) and potentially older adult residents, envisioning a future where chore robots seamlessly contribute to a technologically empowered and compassionate caregiving environment in aged care [37]. Through continued engagement and openness to innovation, we can pave the way for a more efficient and transformative era in aged care.

Building on our findings, future studies should investigate the long-term impact of chore robots in aged care settings, focusing on real-world deployment and user adaptation [38]. Additionally, exploring the integration of robots with other assistive technologies could provide a more holistic approach to elder care.

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