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OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

Title: Implementation strategies for the use of social robotics in the context of dementia

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A thesis submitted to the College of Medicine, Nursing and Health Sciences, University of Galway, in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Health Studies

Month of Submission: September 2022

Research Supervisors

Professor Dympna Casey, Dr Elaine Toomey

Graduate Research Committee

Professor Declan Devane, Dr Linda Biesty, Professor Louise Hopper

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Declaration

I, Wei Qi Koh, confirm that I have not obtained a degree in the National University of Ireland Galway, or elsewhere based on the work contained in this thesis. I am the author of this thesis and the principal author of the eight papers included in this article-based PhD. Contributions by others are included under the 'Statement of contribution' section.

Signature: Date: 22 September 2022

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The funding body had no role in study design, data collection and analysis, decision to publish any of the research papers, or the preparation for this thesis.

Acknowledgements and Preface

If just one person believes in you,
Keep enough and strong enough, believes in you
Hard enough, and long enough
Before you knew it, someone else will think
"If he can do it, I can do it"

- *Snoopy the Musical*

There are so many people I have to thank, without whom this research and thesis wouldn't have been possible. I can vividly recall the interview for this fellowship-cum-PhD, and my delirious state upon waking up to an email offer at dawn. I am profoundly grateful to my supervisor **Professor Dympna Casey**, for the opportunity to undertake this piece of work, and for her patience and guidance throughout this journey. Thank you Dympna, for your faith in me and for supporting me to work towards being an autonomous researcher. Thank you for nurturing my learning, for trusting me and for giving me the freedom to learn and work at my pace. I am extremely thankful to my wonderful co-supervisor, **Dr Elaine Toomey**, for sharing her wisdom, her compassion and for challenging me to do my best, while being mindful of my mental wellbeing. Your pockets of encouragement made this journey brighter. Thank you, Elaine, you've been an inspiration to me. I am also grateful to my Graduate Research Committee (GRC) members, **Professor Declan Devane, Dr Linda Biesty** and **Professor Louise Hopper**, for their thoughtful input and advice during annual meetings.

Many individuals have supported my qualitative study. I would like to thank **Fergus Timmons** and **Mary Hickey** from the Alzheimer Society of Ireland (ASI) for the generous loan of the robotic pets, and the **Dementia Research Advisory Team** for connecting me with **Kevin Quaid**, who has been such a wonderful and inspiring dementia advisor to this project. Thank you Kevin for sharing your expertise, your advocacy for dementia has helped to steer this project in a more inclusive direction. I am grateful to the **eight Dementia Café organisers** in Ireland, who have graciously allowed me to reach out to prospective participants through the virtual cafés. I would also like to thank all the **nursing homes** that supported their staff to participate in the study and **all participants** for contributing to this project.

For my Delphi study, I have also received support from many individuals and organisations. I would like to thank **Marie McKeon** from the All Ireland Institute of Hospice and Palliative Care **(AIIHPC)**, **Dr Fawn Harrad-Hyde** and **Dr Sandra Prew** from Enabling Research in Care Homes **(ENRICH)**, **David Evans** from the Contact, Help, Advice and Information Network **(CHAIN)**, and Early, Timely and Quality Psychosocial Interventions in Dementia **(INTERDEM)** for disseminating information about the study. Many individuals also actively disseminated information on this study with their networks. This support was extremely encouraging and helped to progress my research. I have so much gratitude for **all the nursing and care homes, participants and stakeholders** for contributing their time, experiences and expertise to the Delphi study, without whom this project would have not been possible.

I had the privilege to work with two brilliant librarians, **Rosie Dunne** and **Hardy Schwamm**. Thank you, Rosie, for being so helpful in supporting my reviews, and Hardy for warmly involving me in the Open Scholarship/Open Science Community in Galway and internationally. I feel honoured to have collaborated with and learned so much from other wonderful researchers and supervisors. These opportunities were extended through my research secondments at the Amsterdam University Medical Centers (VUmc/Amsterdam Public Health Research Institute, Amsterdam) and the End-of-Life Care Research Group (Vrije Universiteit Brussel, Brussels). I would like to thank **Simone Felding, Beliz Budak, Pascale Heins, Viktoria Hoel**, **Aisling Flynn, Dr Sally Whelan, Prof. dr. Rose-Marie Dröes, Dr Tijs Vandemeulebroucke, Prof. Chris Gastmans, Dr Rose Miranda, and Prof. Lieve Van den Block** for the great collaborations, and for being so generous in sharing your knowledge**.** I am thankful for different opportunities to keep my occupational therapy roots close, be it through dialogue or formal collaborations with an internationally diverse group of occupational therapy clinicians, researchers and educators: **Pascale Heins, Aisling Flynn, Aysan Mahmoudi, Lesley Garcia, Prof. Camilla Malinowsky, and Prof. Anna Brorsson.** All these collaborations have enriched my learning journey - personally and academically. Of course, I must thank all the **journal editors** and **peer-reviewers** who took the time to review my papers; all the feedback that I have received has helped me hone my analytical and writing skills.

Being a part of a wonderful and supportive network in the **DISTINCT consortium** has been an invaluable experience and such an honour. I would like to thank all my fellow **DISTINCT ESRs**. You are such a great bunch of colleagues and friends, and it's been so fun working and learning alongside all of you. I am also grateful to the **DISTINCT management** team for putting together such a wonderful research and training program for us. I am very thankful for the support and funding that I received as a Marie-Curie Research Fellow; this has supported my learning and research (e.g., token of appreciation for my Patient and Public Involvement advisor, open-access publishing, attending training programs and international conferences). I am well aware that it is a privilege to not have to worry about funding and focus solely on advancing my research and personal development. Unfortunately, not every PhD student has had the same privileges, and I sincerely hope that moving forward, there will be more equal support and opportunities for other early career researchers.

I would also like to mention the less 'glamourous' parts of my PhD journey. I guess most (or at least many) researchers would agree that doing a PhD is not easy, especially during the Covid-19 pandemic. However, struggles are not always visible or easily glazed over. The pandemic hit Ireland in February 2020, when I was four months into the PhD. Since then, I have mostly been working from 'home', before I had the chance to establish a support network in Galway, a place that felt somewhat foreign to me as an international PhD student. The housing crisis did not make the journey any easier. I did not have many 'colleagues' or 'peers' in Ireland and felt quite isolated. For this, I am extra thankful for my loved ones, the DISTINCT network and virtual collaborations with other researchers, which made me feel less alone. I am also grateful to Dympna for supporting me to work remotely from Singapore for a good few months. Another downside to working alone was the difficulty of drawing a balance between work and life. I was often anxious about not completing this PhD within my 3-year funding period, and the pressure was unhealthy at times. The pandemic made it harder for me to plan and conduct my research and in the beginning, I worried about not making sufficient progress. Paper rejections also have to be mentioned; they are always tough. Support from my loved ones and peers, and learning to appreciate little steps, have played a pivotal role in helping me navigate tougher times. All-in-all, I would like to think that these experiences made me a more resilient researcher and human.

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Abstract

Introduction

Dementia is a global health challenge, and the number of people living with dementia (PLWD) is expected to continue to rise worldwide. Pet robots have been developed to support the psychosocial well-being of PLWD. Although the existing body of research suggests that pet robots can have positive impacts on the psychosocial health of PLWD in long-term care settings, there is a critical lack of knowledge to support the translation of pet robots into real-world practice. Previous research has identified some barriers to their uptake, one of which is their affordability. With technology development, lower-cost alternatives have emerged in more recent years. The affordability of lower-cost alternatives may address cost-related implementation barriers. However, there has been no reviews which have broadly examined the literature to understand the impact of low-cost pet robots on PLWD. In addition, no previous studies have explicitly investigated the multi-level barriers and facilitators affecting their adoption in long-term care settings. Furthermore, there is limited guidance in the existing literature on how pet robots can be implemented in routine dementia care.

Aim and Objectives

This research aims to develop knowledge to support the translation of pet robots from research into routine dementia care in long-term care settings. The objectives are to 1) synthesise existing evidence to understand the impact of low-cost pet robots on the psychosocial health of older adults and PLWD, given their potential to mediate cost-related implementation barriers; 2) explore multi-level determinants influencing the implementation of pet robots for PLWD in long-term residential care facilities, and 3) achieve expert consensus on strategies for implementing pet robots for dementia care in long-term residential care facilities.

Methods

To address *objective one*, two studies were conducted. A scoping review was conducted to synthesise evidence on the impact of low-cost pet robots on older adults and PLWD. Next, a qualitative content analysis of publicly available, user-generated data was performed to explore the usability and impact of a low-cost pet robot for older adults and PLWD. Data were analysed using inductive qualitative content analysis. To address *objective two*, two studies were conducted. A scoping review was conducted to broadly examine the literature to understand the multilevel barriers and facilitators influencing the implementation of social robots, including pet robots. The Consolidated Framework of Implementation Research (CFIR) was used to guide the review. Next, a qualitative study guided by the CFIR was conducted to explore multilevel determinants of implementing pet robots in nursing homes for dementia care. Individual, semi-structured interviews were conducted with 12 care professionals and 10 organisational leaders from eight nursing homes in Ireland. Data were analysed using framework analysis. To address *objective 3*, a two-round modified Delphi study was conducted. Implementation determinants identified in chapters 5 and 7 were mapped onto the Expert Recommendation of Implementing Change, a taxonomy of implementation strategies. This generated a list of potentially relevant strategies, which were contextualised using empirical data and consultation with stakeholders.

These constituted the initial statements for the Delphi survey. The expert panel comprised an international panel of care professionals, organisational leaders and researchers. Consensus was pre-defined as ≥ 75% agreement. Descriptive statistics and inductive content analysis were used to analyse numerical and textual data.

Findings

Objective one: Nine articles were included in the scoping review. The positive impacts of low-cost pet robots included (i) improved mood and affect, (ii) communication and social interaction, and (iii) companionship. Issues and concerns relating to their use included (i) misperception and attachment, no impact or negative impact (ii) and practical challenges. In the qualitative content analysis, 1,327 user-generated reviews that contained information about using a low-cost pet robot for older adults and PLWD were included for analysis. Five themes were generated: prior expectations, perceptions, engagement in meaningful activities, impact and practicalities. *Objective two*: 53 articles were included in the scoping review. Most barriers relate to the characteristics of social robots (including pet robots), and most facilitators relate to the ability of the robots to address the needs and resources of older adults and PLWD. Few studies explored the contextual influences on implementation, and none explicitly investigated multi-level implementation determinants. In the qualitative study, participants described determinants relating to the design of pet robots, their supporting evidence, relative advantage, external influences such as national regulations and networks with other facilities, workflows, staff attitudes, and implementation processes. *Objective 3*: Forty-eight contextualised implementation strategies were used as initial statements for the modified Delphi process. Fifty-six experts participated in round one, and 52 participated in round two. Experts reached consensus on 13 strategies, of which 12 were established as important and/or critical. These were: 1) obtain and use residents and their family's feedback, 2) involve residents and their family members, 3) assess readiness and identify barriers and facilitators, 4) promote adaptability, 5) conduct ongoing training, 6) conduct local consensus discussions, 7) organise clinician implementation team meetings, 8) purposely re-examine the implementation, 9) provide local technical assistance, 10) conduct educational meetings, 11) access new funding, and 12) develop resource sharing agreements. Reasons for variations in experts' responses included contextual variations across countries and organisations, such as resource availability.

Conclusion

This body of work contributes significantly to knowledge by bridging critical knowledge gaps that are necessary to support the implementation of pet robots for dementia care in long-term care settings. Findings from this thesis suggest that low-cost pet robots demonstrate promise in supporting the psychosocial health of PLWD. Their relative affordability, as compared to existing alternatives, has the potential to address pertinent implementation barriers related to cost. However, more high quality and adequately powered studies are necessary to confirm their impact. This is the first study to characterise the multi-level determinants of implementing pet robots in long-term care settings, and to use a Delphi technique establish a list of evidence-based implementation strategies. These strategies can be used as a pragmatic starting point for researchers, organisations, and technology developers to implement pet robots as part of routine dementia care in long-term care facilities. Future work is needed to further tailor and specify, test and evaluate these strategies for different organisational contexts.

Article-based PhD requirements

This PhD meets the requirements of an article-based PhD, as outlined in the guidelines by the College of Nursing, Medicine and Health Sciences at the National University of Ireland, which states that a minimum of three peer-reviewed articles should be included, with the PhD candidate as the first author. This thesis includes eight first-authored papers, which have been published in international, peer-reviewed journals. These papers form the core chapters of this thesis.

List of publications in this thesis (in order of presentation)

Published

Koh, W. Q., Ang, F. X. H., & Casey, D. (2021). Impacts of low-cost robotic pets for older adults and people with dementia: scoping Review. *JMIR rehabilitation and assistive technologies*, 8(1), e25340, 1-14. https://doi.org/10.2196/25340.

Koh, W. Q., Whelan, S. A., Heins, P., Casey, D., Toomey, E., & Dröes, R. (2021). Usability and impact of a low-cost robotic pet for older adults and people with dementia: a qualitative content analysis of user experiences and perceptions on consumer websites. *JMIR Aging,* 5(1), e29224, 1-16. https://doi.org/10.2196/29224.

Koh, W.Q., Felding, S. A., Toomey, E., & Casey, D. (2021) Barriers and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review protocol. *Systematic Reviews,* 10, 49, 1-6. https://doi.org/10.1186/s13643-021-01598-5.

Koh, W.Q., Felding, S. A., Budak, K. B., Toomey, E., & Casey, D. (2021). Barriers and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review. *BMC Geriatrics*, 21, 351, 1-17. https://doi.org/10.1186/s12877-021-02277-9.

Koh, W. Q., Toomey, E., & Casey, D. (2021). Exploring Barriers and Facilitators to the Implementation of Pet Robots for People With Dementia in Nursing Homes: a qualitative Research Protocol. *International Journal of Qualitative Methods,* 20(1), 1-9. https://doi.org/10.1177/16094069211047059.

Koh, W.Q., Toomey, E., Flynn, A. & Casey, D. (2022). Determinants of implementing pet robots in nursing homes for dementia care. *BMC Geriatrics,* 22(1), 457, 1-12. https://doi.org/10.1186/s12877-022-03150-z.

Koh, W. Q., Casey, D., Hoel, V., & Toomey, E. (2022). Strategies for implementing pet robots in care homes and nursing homes for residents with dementia: protocol for a modified Delphi study. *Implementation Science Communications*, 3(1), 58, 1-10. https://doi.org/10.1186/s43058-022-00308-z.

Koh, W. Q., Hoel, V., Casey, D., & Toomey, E. (2022). Strategies to implement pet robots in long-term care facilities for dementia care: a modified Delphi study. *Journal of the American Medical Directors Association.* https://doi.org/10.1016/j.jamda.2022.09.010.

Statement of Contribution

Paper one (Chapter 2)

WQK conceptualised the review approach and developed the review questions and review design. FXHA and WQK were involved in the screening and selection process, quality appraisal, and data extraction. WQK initiated the draft of the manuscript, and FXHA had meaningful contributions to its drafting and editing. DC read the draft and provided critical feedback on the final version of the manuscript.

Paper two (Chapter 3)

WQK conceptualised the research, developed the review questions and review design, and collected the data. WQK, SW, and PH coded and analysed the data. Preliminary results were discussed with RMD. WQK initiated the first draft of the manuscript. All authors read the draft and provided critical feedback. All authors approved the final version of the manuscript.

Paper three (Chapter 4)

WQK conceptualised the review approach, developed the review questions and the review design and initiated the first draft of this manuscript. SAF contributed to the development of the research question. SAF, ET and DC had meaningful contributions to the drafting and editing of the manuscript. The authors read and approved the final manuscript.

Paper four (Chapter 5)

WK conceptualised the review approach, developed the review questions and review design with advice from ET and DC, and conducted the literature search. WK, KB and SF undertook the screening, study selection and data charting process. WK undertook screening of the reference lists and backward citation tracing. Data synthesis was led by WK with consultation with ET. WK initiated the draft of the manuscript. ET and DC had meaningful contributions to its drafting and editing. All authors read and approved the final manuscript.

Paper five (Chapter 6)

WQK developed the study in consultation with ET and DC. WQK wrote the first draft of the manuscript. ET and DC provided intellectual contributions to the manuscript drafts. All authors approved the final version of the manuscript and take responsibility for its content.

Paper six (Chapter 7)

WQK, ET and DC contributed to the conceptualisation of the study and design. WQK recruited participants and collected data. WQK conducted the data analysis with initial input from AF, and feedback from all authors. WQK wrote the first draft of the manuscript. ET, AF and DC provided intellectual contributions to the manuscript drafts. All authors approved the final version of the manuscript and take responsibility for its content.

Paper seven (Chapter 8)

WQK conceptualised and designed the study, coordinated the ethics application and led the creation of the study protocol. ET provided guidance on the process of statement development, application of the conceptual framework and taxonomy. Both ET and DC provided guidance on the overall study design. WQK wrote the first draft of the manuscript and processed all revisions to finalise the manuscript. DC, VH and ET contributed to the reviewing of all drafts. All authors approved the final version of the manuscript.

Paper eight (Chapter 9)

WQK conceptualised and designed the study, coordinated the ethics application and led the study with feedback from DC and ET. WQK was responsible for identifying and contextualizing the modified Delphi statements, developing recruitment materials, and recruiting participants. VH contributed to the statement development process. WQK wrote the first draft of the manuscript and processed all revisions to finalise the manuscript. VH, DC and ET contributed to the reviewing of all drafts. All authors approved the final version of the manuscript.

Other publications and research outputs related to the work of this thesis

Publications in international peer-reviewed Journals

Koh, W. Q., Vandemeulebroucke, T., Gastmans, C., Miranda, R., & Van den Block, L. (2022). The ethics of pet robots in dementia care settings: Care professionals' and organisational leaders' ethical intuitions. *Frontiers in Psychiatry*. (Under review).

Koh, W. Q., Heins, P., Flynn, A., Mahmoudi, A., Garcia, L., Malinowsjy, C., & Brorsson, A. (2022). Bridging gaps in the design and implementation of socially assistive technologies for dementia care: The role of occupational therapy. *Disability and Rehabilitation: Assistive Technology,* 17(6), 1-9. https://doi.org/10.1080/17483107.2022.2111610.

Flynn, A., Barry, M., **Koh, W. Q.**, Reilly, G., Brennan, A., Redfern., & Casey, D. (2022). Introducing and Familiarising Older Adults Living with Dementia and Their Caregivers to Virtual Reality. *Int. J. Environ. Res. Public Health,* 19(23), 16343. https://doi.org/10.3390/ijerph192316343.

Felding, S. A., **Koh, W. Q**., Teupen, S., Budak, K. B., Uribe, F. L., Roes, M. (2022). A scoping review using the Almere model to understand factors facilitating and hindering the acceptance of social robots in nursing homes. *International Journal of Social Robotics.* (Under review).

Heins, P., Boots, L. M., **Koh, W. Q**., Neven, A., Verhey, F. R., & de Vugt, M. E. (2021). The Effects of Technological Interventions on Social Participation of Community-Dwelling Older Adults with and without Dementia: A Systematic Review. *Journal of Clinical Medicine*, 10(11), 2308, 1-30. https://doi.org/10.3390/jcm10112308.

Armeni, K., Brinkman, L., Carlsson, R., Eerland, A., Fijten, R., Fondberg, R., ... & Zurita-Milla, R. (2021). Towards wide-scale adoption of open science practices: The role of open science communities. *Science and Public Policy,* 48(5), 605, 1-7. https://doi.org/10.1093/scipol/scab039.

Koh, W. Q., Heins, P., Whelan, S., Toomey, E., Casey, D., Dröes, R. M. (2021). Experiences and perceptions of using a low-cost pet robot for older adults and people with dementia, *Innovation in Aging*, 5(Suppl 1), 590-590, Page 945, https://doi.org/10.1093/geroni/igab046.3385.

Koh, W. Q., Felding, S. A., Budak, K. B., Toomey, E., & Casey, D. (2021). What are the barriers and facilitators affecting the implementation of social robots for older adults and people with dementia? A scoping review. *BMC Implementation Science*, 16(Suppl 2).

Boots, L., **Koh, W. Q**., Neven, A., Verhey, F., de Vugt, M., & Heins, P. (2021). Technological Interventions and Social Participation in Community-Dwelling Older Adults With or Without Dementia. *Innovation in Aging*, 5(Suppl 1), 590-590.
https://doi.org/10.1093/geroni/igab046.2250.

International Conference Presentations

Koh, W. Q., Gastmans, C., Miranda, R., Vandemeulebroucke, T., & Van den Block, L. (2022, October 17-19). *Ethical considerations for implementing pet robots in long-term residential facilities for residents with dementia* [Virtual oral presentation]. 32nd Alzheimer Europe Conference, Bucharest, Romania.

Koh, W. Q., Casey, D., & Toomey, E. (2022, July 31-August 4). *How Can Pet Robots Be Embedded Into Nursing Homes as Part of Routine Dementia Care?* [Oral presentation]. Alzheimer's Association International Conference 2022, San Diego, United States.

Koh, W. Q., Toomey, E., Flynn, A., & Casey, D. (2022, July 31-August 4). *Determinants of implementation: Embedding pet robots in nursing homes for dementia care* [Poster presentation]. Alzheimer's Association International Conference 2022, San Diego, United States.

Koh, W. Q., Toomey, E., Flynn, A., & Casey, D. (2022, August 9-11). *A qualitative study to explore barriers and facilitators to the implementation of pet robots in nursing homes for residents with dementia* [Poster presentation]. Alzheimer Disease International Conference 2022, London, United Kingdom.

Flynn, A**., Koh, W. Q**., & Casey, D. (2022, August 9-11). *The show must go on: Early Career Researchers' reflections on recruitment & data collection during COVID-19* [Poster presentation]. Alzheimer Disease International Conference 2022, London, United Kingdom.

Heins, P., Boots, L., **Koh, W. Q**., Neven, A., Verhey, F., & de Vugt, M. (2022*). Technology can reduce isolation and loneliness, and enhance social support for older adults* [Poster presentation]. Alzheimer Disease International Conference 2022, London, United Kingdom.

Dolan, O., Flynn, A., & **Koh, W. Q**. (2022, August 28-31). *Can cognitive stimulation therapy be integrated into daily occupations by occupational therapists?* [Poster presentation]. World Federation of Occupational Therapy Conference 2022, Paris, France.

Koh, W. Q., Heins, P., Flynn, A., Mahmoudi, A., Garcia, L (2022, August 28-31). *Using novel technology for people living with dementia: An occupational therapy perspective* [Oral presentation]. World Federation of Occupational Therapy Conference 2022, Paris, France.

Heins, P. & **Koh, W. Q.** (2022, August 8-10). *Experiences of being in a multidisciplinary Innovative Training Network: Technology and Dementia* [poster presentation]. Inaugural World Occupational Science Conference 2022, Vancouver, Canada.

Koh, W. Q., Whelan, S. A., Heins, P., Casey, D., Toomey, E., & Dröes, R. M. (2021, November 10-13). *Experiences and perceptions of using a low-cost pet robot for older adults and people with dementia* [poster presentation]. The Gerontological Society of America's 2021 Annual Scientific Meeting , Arizona, United States.

Koh, W. Q., Ang, X. H. F., & Casey, D. (2021, November 29 - December 1). *Recommendations for implementing pet Robots for people with dementia in nursing homes: A mixed methods study Protocol* [Poster presentation]. 31st Alzheimer's Europe Conference, Utrecht, The Netherlands.

Felding, S.A., **Koh, W.Q.**, Teupen, S., Budak, K.B., Laporte-Uribe, F., & Roes, M. (2021, November 29 - December 1). "*At first, "At first, I thought it makes no sense. But then I began to like him" – results from a scoping review on acceptance of social robots in nursing homes* [Oral presentation]. 31st Alzheimer's Europe Conference, Utrecht, the Netherlands.

Koh, W. Q., Felding, S. A., Budak, K. B., Toomey, E., & Casey, D. (2021, July 15-16). *What are the barriers and facilitators affecting the implementation of social robots for older adults and people with dementia: A scoping review* [Rapid oral-poster presentation]. 4th UK Implementation Science Conference, London, United Kingdom. (Best rapid oral-poster presentation award).

Koh, W.Q., Felding, S.A., Budak, B., & Casey, D. (2020, October 20-22). *Barriers and Facilitators to the Implementation of Social Robots for Older Adults & People with Dementia: A Scoping Review* [Poster presentation]. 30th Alzheimer Europe Conference, Utrecht, the Netherlands.

Koh, W.Q., Ang, F., & Casey D. (2020, October 20-22). *Impacts of Robotic Cat for Older Adults and People with Dementia: A Scoping Review* [Poster presentation]. 30th Alzheimer Europe Conference, Utrecht, the Netherlands.

Other media dissemination

McCauley, R. (Host). (2022, September 15). Dementia in older adults, and the novel ways in which the social health of these adults is being addressed and improved [Audio podcast]. In *The Palliative Hub Professional*. https://pnc.st/s/ecrf-palliative-care-podcast/005882d2/episode-09-wei-qi-koh-pet-robots-a-new-path-for-dementia-care

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Irish Farmers Journal. (2021, February 15). *Social robots could address future skills shortage in care sector.* https://www.farmersjournal.ie/can-robotics-help-people-with-dementia-599689.

The Irish Times. (2021, January 21). *Social robots could address future skills shortage in care sector.* https://www.irishtimes.com/news/science/social-robots-could-address-future-skills-shortage-in-care-sector-1.4464148.

Koh, W. Q . (2021, March 1). DISTINCT project researchers find that low-cost robots may have the potential to improve the psychosocial health of people with dementia. *Alzheimer Europe Newsletter, 2021, issue 3*. https://www.alzheimer-europe.org/resources/publications/alzheimer-europe-newsletter-march-2021

Workshops & seminars facilitated

- Can low-cost pet robots be used to support dementia care? 12 July 2022
  Durham and Darlington Care Home Liaison Hub [Invited presentation]

- Implementing pet robots in long-term care facilities for dementia care? 23 June 2022
  End-of-Life Research Group [Vrije Universiteit Brussel]

- Social robots in Dementia Care, February 2020-2022
  day postgraduate research workshop for students enrolled in postgraduate gerontology program [National University of Ireland Galway]

- Social robots: their implementation in research and practice, May 2021
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Structure of the thesis

This thesis is comprised of ten chapters.

Chapter 1 (Introduction) provides an overview of the background, research problem, and the aim and objectives of this PhD thesis.

Chapters 2 to 3 present a review of the literature and an examination of existing data to understand the impact of low-cost pet robots on the psychosocial health of older adults and PLWD, given their potential to address cost-related barriers that can influence their uptake in real-world practice. Two papers are presented: 2) impacts of low-cost robotic pets for older adults and people with dementia: scoping review, and 3) usability and impact of a low-cost robotic pet for older adults and people with dementia: a qualitative content analysis of user experiences and perceptions on consumer websites.

Chapters 4 to 5 present a comprehensive review of the literature to understand determinants (i.e., barriers and facilitators) affecting the implementation of social robots, including pet robots. Two papers are presented: 4) barriers and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review protocol; and 5) barriers and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review.

Chapters 6 to 7 present a qualitative study that was undertaken to explore the determinants of implementing pet robots in nursing homes. A protocol paper and a descriptive qualitative study are presented: 6) exploring barriers and facilitators to the implementation of pet robots for people with dementia in nursing homes: a qualitative research protocol, and 7) determinants of implementing pet robots in nursing homes for dementia care.

Chapters 8 to 9 present a modified Delphi study that was conducted to identify the most relevant strategies for implementing pet robots to support dementia care in long-term care facilities, such as nursing homes. Two papers are presented: 7) strategies for implementing pet robots in nursing homes for people living with dementia: protocol for a modified Delphi process; and 8) strategies to implement pet robots in long-term care facilities for dementia care: a modified Delphi study.

Chapter 10 presents the discussion, which includes an overview and discussion of the key research findings, and the implications of this PhD thesis on research, practice and policy. Finally, the contributions of this body of work to knowledge, the strengths and limitations of this thesis, and the conclusions are presented.

List of Abbreviations

AACODS scale	Authority, Accuracy, Coverage, Objectivity, Date, Significance scale
BPSD	Behavioural and psychological symptoms of dementia
CFIR	Consolidated Framework of Implementation Research
CINAHL	Cumulative Index of Nursing and Allied Health Literature
CREDES	Conducting and REporting DElphi Studies
DISTINCT	Dementia: Intersectoral Strategy for Training and Innovation Network for Current Technology
ENRICH	Enabling Research in Care Homes
ERIC	Expert Recommendations for Implementing Change
EWGPWD	European Working Group of People with Dementia
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HCP	Healthcare professionals
HIQA	Health Information and Quality Authority
HSE	Health Service Executive
ICR	Intercoder reliability
INTERDEM	Early detection and timely INTERventions in DEMentia
ITN	Innovative Training Network
JfA	Joy for All
LTC	Long-term care
MEDLINE	MEDLINE is the online counterpart to MEDLARS (MEDical Literature Analysis and Retrieval System)
NIH	National Institutes of Health
OL	Organisational leaders
PCC	Population, Concept, and Context
PLWD	People living with dementia
PPI	Patient and Public Involvement
PwD	People with dementia
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRISMA-ScR	Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews
QD	Qualitative description
SAHR	Socially assistive humanoid robot
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences
SRQR	Standards for Reporting Qualitative Research
TUDR	TeamUp for Dementia Research
VR-12	Veteran’s RAND-12
UCLA loneliness scale	University of California, Los Angeles loneliness scale

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Chapter 1: Introduction

Dementia is a progressive neurocognitive disorder that is characterised by a significant decline in one or more cognitive domains, which include complex attention, perception and praxis, language, learning and memory, executive function and social cognition (American Psychiatric Association, 2013). As the prevalence of dementia is strongly correlated with age (Béjot & Yaffe, 2019), dementia is one of the biggest challenges associated with a rapidly ageing population worldwide. Globally, there were 57 million people with dementia in 2019, and this figure is expected to triple to 152 million by 2050 (Global Burden of Diseases 2019 Dementia Forecasting Collaborators, 2022). Other than affecting cognition, the social behaviours, motivations and emotional control of individuals with dementia are also impacted (World Health Organization, 2016). Even though people living with dementia (PLWD) may want to remain socially connected and be involved in activities that are personally meaningful, cognitive and psychosocial impairments reduce their capacities and confidence (Dröes et al., 2006; Birt et al., 2020). Correspondingly, PLWD are disposed to an increased risk of depression and further cognitive and functional decline (Kuring, Mathias & Ward, 2018; Laver et al.,2016). PLWD who live in nursing homes are especially susceptible to reduced social health as compared to community-dwelling PLWD (Olsen et al., 2016), and have described life in long-term care settings as a life of isolation (Mjørud et al., 2017). Due to the irreversible and progressive nature of the disorder, it is imperative to investigate and implement interventions to help individuals live well with dementia (Vernooij-Dassen et al., 2019), especially in long-term care settings. Psychosocial interventions are non-pharmacological interventions that facilitate the use of underlying capacities, provide compensations for disease-related impairments, and assist with the regulation of emotions without having harmful side effects (Vernooij-Dassen et al., 2019).

Social robots in dementia care

Technological advancements have facilitated the development of innovative psychosocial interventions (Meiland et al., 2017), one of which is the use of social robots. Social robots are robots designed with the social intelligence and capacity to interact with people in a socially appropriate way (Dautenhahn, 2007), and are considered promising technology with the capability to improve the social health of older people (Vandemeulebroucke et al., 2018). They can be categorized into three groups based on their functions: socially assistive robots, telepresence robots and pet robots. Socially assistive robots have a range of functions to assist users with different tasks apart from facilitating social interactions (Feil-Seifer and Mataric, 2005). Examples include *MARIO* (Whelan et al., 2020) and *Pepper* (Blindheim et al., 2022), which can be programmed with various functions such as weather alerts and/or cognitively stimulating games. Telepresence robots have a video conferencing system mounted on a mobile robotic base and hold the primary function to provide social interaction between individuals (Stahl et al., 2018). Examples include *Double* (Double Robotics, 2021) and *Giraff* (Telepresence Robots, 2020). Finally, pet robots are robots that resemble and behave like animals. They may be considered as technology-based substitutes to live animals or pets (Leng et al., 2019) to provide physiological and emotional benefits for PLWD (Abbott et al., 2019).

Pet robots in dementia care

Animal-assisted therapy (AAT) entails using suitable animals as therapeutic interventions for individuals (International Association of Human-Animal Interaction Organizations, 2018). AAT is a form of psychosocial intervention which has been used to reduce loneliness, provide companionship, elicit relaxation (Banks & Banks, 2002; Le Roux & Kemp, 2009) and improve communication (Rodrigo-Claverol et al., 2020) among PLWD. A recent systematic review which synthesised evidence from 11 randomised controlled trials found that AAT led to statistically significant reductions in depression and BPSD amongst PLWD (Chen et al., 2022). Nevertheless, the use of live pets has led to concerns about adverse effects such as the potential transmission of zoonotic diseases and compromised animal welfare (Lai et al., 2019). Pet robots are technology-based alternatives to circumvent the challenges of using live animals. There are several types of robotic pets with varying design attributes, such as different levels of familiarity and realisticness. Examples of pet robots that are designed to resemble an unfamiliar animal include *Pleo,* a robot dinosaur and *PARO*, a baby harp seal robot. Familiarly-designed pet robots are designed to resemble familiar animals such as domestic animals. Some examples include *AIBO*, a robot dog, *NeCoRo cat*, and the *Joy for All (JfA)* cat and dog. Pet robots also vary in terms of how realistic they look (i.e. lifelikeness). For example, while Pleo and AIBO are non-realistic looking with plastic covered shells, the JfA pets and PARO are designed realistically with fur-covered shells.

Among the different pet robots, PARO has been most widely researched and used (Pu et al., 2019; Hung et al., 2019). PARO is designed based on its developers' notion that people will be more amenable to accepting it since they would have fewer preconceptions or expectations of an unfamiliar animal (Shibata and Wada, 2011). However, the design preferences among older people and PLWD have not been well-investigated (Bradwell et al., 2019). In most research studies involving pet robots, older people and PLWD were typically given one robot to engage with, chosen based on the research needs rather than users' preferences (Koh et al, 2022). Previous studies revealed that the realistic features of PARO, including its large eyes and soft fur, were generally well received by older adults and PLWD. In particular, its soft fur has evoked affective behaviours, such as stroking and hugging (Wada and Shibata, 2007; Robinson et al., 2013; Moyle et al., 2019). Bradwell et al. (2019) had similar findings that older people preferred fur-covered and realistic-looking pet robots. The researchers found that when presented with choices, older adults reported stronger preferences for the JfA pets as compared to six other alternatives. On the contrary, none chose PARO as their preferred pet robot. These sentiments were shared by formal and informal caregivers (Jung et al., 2017; Moyle et al., 2019), who felt that pet robots that resemble a cat or dog would be better suited for use in dementia care. These studies suggest that while individual design preferences can vary, pet robots with fur covering and realistic features are preferred by older adults and PLWD. Familiarly designed robotic pets may also be desirable.

Effectiveness of pet robots in dementia care

Three recent reviews have been conducted to synthesise evidence on the effectiveness and impacts of social robots, including pet robots. Most or all studies included in the reviews were focused on older people with dementia or cognitive impairment and were conducted in long-term care settings.

In a systematic review, Pu et al. (2019) synthesised findings from 11 randomised controlled trials (RCTs) to evaluate the effectiveness of social robots. PARO was the subject of investigation in most studies (n=8). Although this review did not begin with a specific focus on PLWD, most participants (80%) who were included in this review had dementia or cognitive impairment. Most studies were of low to moderate quality and were prone to biases, especially in the allocation of concealment and blinding (Pu et al., 2019). Results showed that social robots elicited positive psychosocial impacts, such as reducing agitation, anxiety and loneliness, reducing medication use and improving quality of life. However, these effects did not reach statistical significance, which could be due to the marked heterogeneity of the interventions and small sample sizes (Pu et al., 2019). The authors did not conduct subgroup analyses for PLWD due to insufficient information from included studies. Findings on how the severity of dementia influenced the intervention outcomes were conflicting; while some found that people with higher cognitive abilities had more engagement with the robots, others found that those with advanced dementia reaped more benefits.

A mixed-methods systematic review by Abbott and colleagues (2019) evaluated the impacts of pet robots on residents in long-term care facilities. In addition, they sought to understand residents, staff and family members' experiences and perceptions of interacting with the robotic pets. Five pet robots were used across the studies. They included: PARO, AIBO, NeCoRo cat, Justocat (robotic cat) and CuDDler (robotic bear). Apart from AIBO, all pet robots were realistically designed and had a fur-covered shell. Similar to Pu and colleagues' review, PARO was also the subject of investigation in most studies (n=15). Twenty-seven articles from 19 studies were included for synthesis, and over half focused specifically on PLWD. Most were qualitative studies (n=10), randomised trials (n=7) and mixed-methods studies (randomised trials with qualitative elements) (n=2). Most quantitative studies had risks of biases, especially with blinding. Although the quantitative synthesis showed that pet robots reduced agitation amongst residents, there was no statistically significant impact on other psychosocial domains such as depression and quality of life (Abbott et al., 2019). However, the qualitative synthesis provided rich information regarding their positive impacts. They included stimulating engagement, encouraging responses such as reminiscence, providing opportunities for social interactions, and reducing loneliness and the behavioural and psychological symptoms of dementia. Nevertheless, not all residents benefited from the robots (Abbott et al., 2019). Four studies reported that some residents were uninterested or responded negatively, and their responses fluctuated; care staff attributed the fluctuations, disinterest and negative responses to the severity of dementia, however, no further information on the relationship between dementia severity and residents' responses was provided.

Finally, based on the notion that PARO is the most studied pet robot, Hung et al (2019) conducted a scoping review to synthesise evidence on the key benefits of and barriers to using PARO, specifically for older people with dementia in care settings. Twenty-nine articles were included; most were exploratory and had small sample sizes. Results resonated with findings from the two abovementioned reviews. The benefits of using PARO included reduced negative emotional and behavioural symptoms, and improved social engagement and mood. Not every PLWD wanted to interact with PARO (Hung et al., 2019). Barriers influencing the implementation of PARO in care settings will be discussed in the next section.

Overall, there is evidence that pet robots - including PARO, AIBO, NeCoRo cat, Justocat and CuDDler - have the potential to improve the psychosocial health of most PLWD living in long-term care settings (Abbott et al., 2019; Hung et al., 2019). The cost of these robots falls within the price range of approximately €1,300 to €6,000 per unit (Paro Therapeutic Robot., 2022; Reuters., 2001), and none of these studies investigated the impact of lower-cost alternatives. Most studies are insufficiently robust due to issues such as small sample sizes and potential biases; more studies with larger samples and more rigorous designs are required to confirm their impacts and effectiveness.

Understanding the research-to-practice gap

The existing body of research on pet robots has been largely focused on studying their effectiveness on PLWD in long-term care facilities. While such research trials are usually supported by resources, such as time, manpower or finance, these resources are usually absent in real-world settings (Bauer et al., 2015). This means that barriers and facilitators that can manifest in the real-world implementation of pet robots may be absent (or have not been the focus of investigation) in research trials.

In the scoping review by Hung et al (2019), three key barriers to the adoption of PARO in care settings were identified. First, the cost of PARO, priced at approximately €6,000 per unit, was flagged as a concern by family members and care staff (Moyle et al., 2019; Mervin et al., 2018; Sung et al., 2015). According to PARO's developer, about 7,000 units of PARO have been acquired in over 30 countries for individuals with different conditions (Shibata et al., 2021). However, most countries worldwide do not have PARO. To elucidate, while over 80% of care organisations in Denmark have a unit of PARO (Hung et al., 2019), there were approximately five units of PARO in the Republic of Ireland as of late 2019; furthermore not all were owned by care facilities, and at least one was owned by an academic institution for research use (Jahangir. A, personal communication, 12 December, 2019). Like other technology, the cost of acquiring pet robots can therefore impede their implementation in real-world practice by restricting equal access to this technology (Ienca et al., 2016). It may be paradoxical to note that research studies that underlined concerns about the high costs of pet robots were from high-income countries such as Finland, the Netherlands and Australia (Niemelä, Määttä, & Ylikauppila, 2016; Jung, van der Leij & Kelders, 2017; Moyle et al., 2019), where assistive technologies are typically more financially accessible (World Health Organization, 2021b). Assistive technology broadly refers to devices and items to support individuals with disabilities and may include robotic devices (Koh et al, 2022). However, over 60% of people with dementia are from low and middle-income countries (World Health Organization, 2021a). The World Health Organisation (2018) highlighted that a strikingly low proportion of 1 in 10 people with disabilities including people with dementia, do not have access to assistive technology, primarily due to their affordability. Given that interest in employing social robots to support dementia care continues to increase, as evidenced by the increasing body of research in this field, there is substantial and pragmatic value in exploring the potential of lower-cost alternatives as they have the potential to address cost-related implementation barriers. Examples of low-cost pet robots are the JfA pets, which cost between €110 to 130 per unit. Although these robot pets are less technologically advanced than Paro, some studies suggest benefits for older adults and PLWD, such as reducing agitation and improving mood (McBride et al., 2017; Brecher, 2020). However, there have been no previous reviews synthesising evidence on the impact of lower-cost pet robots.

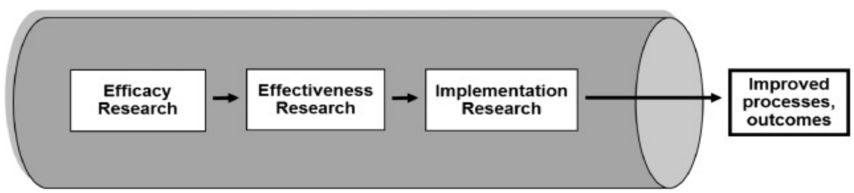
Second, the issue of infection control pertaining to the adoption of PARO was raised. Infection prevention and control are pivotal, as the shared use of fur-covered pet robots in care facilities has been found to generate a high microbial load (Bradwell et al., 2020). This could increase the potential transmission of infections, and dispose PLWD to associated health risks (Montoya & Mody, 2011). One study evaluated an infection control protocol to ensure PARO's hygiene (Dodds et al., 2018). While necessary, care providers perceived the procedures to be tedious and time-consuming (Dodds et al., 2018). Similar to the previous barrier, this barrier may also potentially be circumvented with the use of low-cost pet robots. Since lower-costed robots may increase the affordability of individual purchases for users, the risk of direct (or indirect) contact transmission of infections relating to shared use may be ameliorated. This iterates the potential of low-cost robots to overcome barriers to implementing pet robots. Thirdly, the perceived additional workload on caregivers and staff was described as a barrier to the adoption of PARO in care facilities. Similar barriers have also been identified in other studies which have investigated the implementation of new interventions in dementia care settings (Griffiths et al., 2019; Surr et al., 2020). Additionally, care providers raised concerns about stigma and ethical issues, and were concerned that the use of PARO entails a risk of infantilisation and dehumanisation of care for PLWD.

Most studies that were included in Hung et al's (2019) review did not set out to explicitly explore factors that can affect the implementation of pet robots. Rather, implementation-related issues were identified as a by-product of their primary research question. Implementation barriers relating to cost and infection control may potentially be addressed by considering lower-cost alternatives. The review also reflects a scarcity of studies that have explicitly investigated the barriers and facilitators that can manifest at different levels to affect the adoption of pet robots in real-world settings, which could slow the implementation and uptake of technological innovations in dementia care (Meiland et al., 2017; Vernooij-Dassen and Moniz-Cook, 2014).

Bridging the research-practice gap

Despite the body of research that has been conducted to evaluate the effectiveness of pet robots, there has been little research that has explicitly investigated their implementation, which can be defined as the "constellation of processes intended to get an intervention into use within an organisation" (Nilsen & Bernhardsson, 2019; Rabin et al., 2008). This is because traditionally, research follows a stepwise process (Figure 1), where the focus is on confirming the efficacy and effectiveness of an intervention before its implementation is investigated (Glasgow et al., 2003; Tunis et al., 2003). However, this traditional research approach has been argued to lead to a time lag between research discovery and research uptake in real-world practice (Glasgow et al., 2003; Tunis et al., 2003). To improve the speed of knowledge creation and to support the real-world application of pet robots for PLWD, it is important to pursue knowledge on their implementation alongside investigations of their effectiveness (Curran et al., 2012; Landes et al., 2019).

Figure 1: Traditional research pipeline



(Landes et al., 2019)

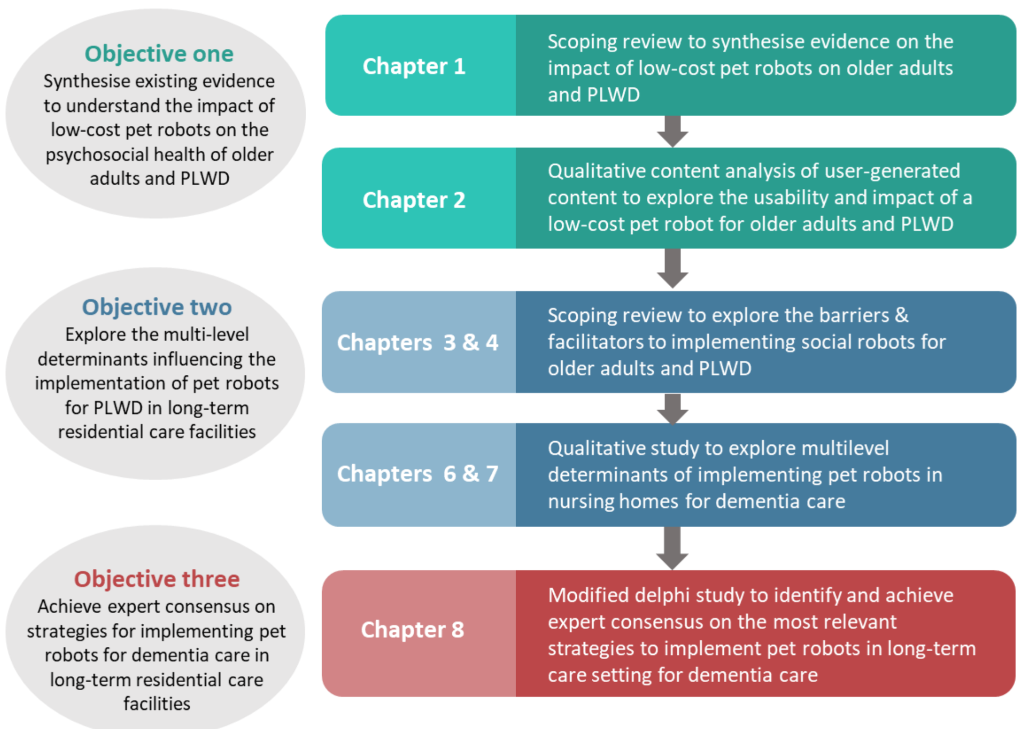
While more studies are necessary to confirm the effectiveness of pet robots, the existing body of evidence has highlighted their promise to benefit the psychosocial health of PLWD. As such, it is important to pursue knowledge on their implementation in parallel to support the translation of pet robots from research to long-term care settings for PLWD. The affordability of pet robots has hindered their uptake in real-world practice and although lower-cost alternatives could mitigate such challenges, little is known about their potential impact on the psychosocial wellbeing of PLWD. Furthermore, more research is needed to investigate the multi-level determinants of implementing pet robots. Although current research has been primarily focused on studying their impacts on PLWD, the uptake of interventions (particularly in a long-term care context) involves more than just the end user. Organisational decision makers and care providers in care facilities, play important roles that can influence the adoption of pet robots for dementia care. However, their views on the implementation of pet robots for PLWD in long-term care have not been well investigated.

The overall aim of this research is to develop knowledge to support the translation of the research on pet robots into real-world practice in long-term care facilities. The research objectives are as follows:

1. Explore the impact of low-cost pet robots on the psychosocial health of older adults and PLWD
2. Understand the multi-level determinants influencing the implementation of pet robots for PLWD in long-term care facilities
3. Identify and achieve expert consensus on the most relevant strategies for implementing pet robots for PLWD in long-term care facilities

A summary of the objectives and research that were conducted to meet each objective is presented in Figure 1.

Figure 1: Summary of objectives and research conducted



The **first objective** is to explore the impact of lower-cost pet robots on the psychosocial health of older adults and PLWD. This is directly relevant to the research aim since the affordability of lower-cost robots has the potential to address cost-related implementation barriers. The focus of the research inquiry is on familiarly and realistically designed robots, as previous studies suggested that these features are preferred by older adults, PLWD, their family members and care staff. Two studies were conducted to address this objective. First, a scoping review was conducted to synthesise evidence on the delivery and impact of low-cost pet robots for older adults and PLWD (chapter 2). Next, a qualitative content analysis of user-generated data from consumer websites was conducted to explore the usability and impact of a low-cost pet robot, based on experiences and perceptions of its use with older adults and PLWD (chapter 3).

The **second objective** of this research is to thoroughly explore the multi-level determinants of implementing pet robots for PLWD in long-term care facilities, such as nursing homes. First, a scoping review was conducted to gain a comprehensive overview of the determinants (i.e., barriers and facilitators) affecting the implementation of social robots including pet robots, for older adults and PLWD across all care contexts (chapters 4 and 5). Next, a descriptive qualitative study was conducted to explore the determinants of implementing pet robots in nursing homes for PLWD (chapters 6 and 7).

The **third objective** is to identify and achieve expert consensus on the most relevant strategies for implementing pet robots. Based on findings on the implementation determinants that were identified in chapters 5 and 7, a list of potentially relevant implementation strategies was identified, contextualised and brought forward for a modified Delphi study (chapters 8 and 9) for a consensus-building process to identify the most relevant strategies.

Chapter Summary

Overall, chapter 1 provided an overview of the use of pet robots in dementia care, the evidence-base on their effectiveness, the research-to-practice gap, and the need to investigate their implementation. The overall aim and objectives of this PhD thesis are presented. Chapters 2 through 9 will comprise papers which address objectives one, two and three.

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Chapter 2: Impacts of low-cost robotic pets for older adults and people with dementia: Scoping review

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Prologue

This chapter presents paper one, a scoping review which systematically examined and synthesised findings from studies which examined the impacts of low-cost pet robots on older adults and people living with dementia.

Chapter 2: Impacts of low-cost robotic pets for older adults and people with dementia: Scoping review (Paper one)

Abstract

Background: Older adults and people with dementia are particularly vulnerable to social isolation. Social robots, including robotic pets, are promising technological interventions that can benefit the psychosocial health of older adults and people with dementia. However, issues such as high costs can lead to a lack of equal access and concerns about infection control. Although there are previous reviews on the use of robotic pets for older adults and people with dementia, none have included or had a focus on low-cost, familiarly and realistically designed pet robots.

Objective: The aim of this review was to synthesise evidence on the delivery and impact of low-cost, familiarly and realistically designed interactive robotic pets for older adults and people with dementia.

Methods: The Arksey and O'Malley framework was used to guide this review. First, the research question was identified. Next, searches were conducted on five electronic databases and Google Scholar. Studies were selected using a two-phase screening process, where two reviewers independently screened and extracted data using a standardized data extraction form. Finally, the results were discussed, categorised and presented narratively.

Results: A total of nine studies were included in the review. Positive impacts related to several psychosocial domains, including mood and affect, communication and social interaction, companionship, and other well-being outcomes. Issues and concerns associated with its use included misperceptions of the robotic pets as a live animal, ethical issues of attachment, negative reactions by users, and other pragmatic concerns such as hygiene and cost.

Conclusions: Overall, findings resonate with previous studies that investigated the effectiveness of other social robots, demonstrating the promise of these low-cost robotic pets in addressing the psychosocial needs of older adults and people with dementia. The affordability of these robotic pets appeared to influence the practicalities of real-world use, such as intervention delivery and infection control, which are especially relevant in light of COVID-19. Moving forward, studies should also consider comparing the effects of these low-cost robots with other robotic pets.

Keywords: social robot, robopets, assistive technology, pet robots, older adults, dementia, low-cost robot, psychosocial intervention, psychosocial rehabilitation

Introduction

The incidence of dementia increases with age (5), as such it is one of the biggest challenges associated with a rapidly ageing population worldwide (6). Older adults and people with dementia are especially susceptible to social isolation and loneliness (7-9), which can further dispose them to other morbidities such as decreased resistance to infection (10), depression, as well as further decline in cognitive functions (11). This issue is especially pertinent with the ongoing COVID-19 pandemic (12), where older adults have been largely confined within the home or care settings. Therefore, there is a need for innovative solutions to address the psychosocial needs of this population.

With technological advancements, promising innovations such as social robots have been developed to render emotional support and companionship (13, 14). A social robot may be defined as “an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact” (15). Robotic pets are a type of social robot with the appearance and behaviors of pets or companion animals (16). A recent systematic review was conducted to understand the experiences and effects of older adults’ interactions with robotic pets in residential care facilities (17). A total of five types of pet robots were identified across 19 studies, including two robotic cats (NeCoRo and JustoCat), a dog-like robot (AIBO), a robotic teddy-bear (CuDDler), and a seal-like robot (Paro). The review showed that these robotic pets had positive benefits on psychosocial domains, such as reduced agitation, reduced loneliness, and improved quality of life. These findings aligned with findings from another recent systematic review which similarly found that social robots had positive psychosocial benefits in improving engagement, interaction, and reducing loneliness for older adults and people with dementia (18).

Despite positive benefits, there are important issues which may impede the uptake of robotic pets beyond the research setting. Some authors have argued that researchers appear to have a selection bias towards using Paro (19), which is one of the most widely deployed social robots in research to date (20). Paro was designed to resemble an unfamiliar animal to improve its acceptability to users, based on the premise that users would have less pre-conceptions or expectations of it as compared to a familiar animal (21). Nevertheless, it is worth considering that design preferences are unique and may differ across individuals. For instance, a recent study (19) showed that while roboticists chose Paro as their preferred design, none of the older adults chose it. Instead, most chose the Joy for All robotic cat and dog as their preferred designs and reported stronger preferences for familiarly designed robotic pets over unfamiliar ones such as Paro. Non-realistic robotic pets such as Pleo, a robotic dinosaur, were also not preferred by older adults. Such preferences have been demonstrated in other studies (22-24), where older adults and people with dementia reported a preference for more familiar and realistic robotic pets, such as a cat or dog. Hence, there is value in exploring the impacts of pet robots that are both familiarly and realistically designed.

Another impediment to the uptake of robotic pets relates to cost, which has been widely cited as a pragmatic concern by multiple key stakeholders including older end users (25), family members (22), as well as organizations and researchers (26-28). For instance, each unit of the Justocat costs about USD$1,350, an AIBO dog costs USD$3,000, and a Paro costs approximately USD$6,000. Cost and affordability can therefore influence equal access to such innovations by older adults and people with dementia (29). Furthermore, the high cost of social robots may make it difficult for older adults to own individual social robots. Instead, they are often shared among users (17). This then raises concerns about hygiene and infection control (26, 30). In light of COVID-19, the issue of infection control is especially pertinent, as shared use may increase the risk of transmission of infections between users (31, 32). In fact, the shared of use of robotic pets within care settings have recently been advised against (33). Therefore, there is value in exploring lower cost alternatives.

Bradwell et al (19) identified several commercially available robotic pets. Among them, those that are low-cost, realistically and familiarly designed, include the Perfect Petzzz pets as well as the Joy for All (JfA) robotic pets (19). The Perfect Petzzz cats and dogs costs between USD$15 to 35, however they are non-interactive in nature and they may be considered to be toys rather than social robots (34). On the other hand, the Joy for All (JfA) robotic cat and dog have interactive features, and contain touch and light activated sensors to enable autonomous responses through vocalizations and movements for the purpose of social interaction. Although they are objectively less technologically advanced and cannot be programmed, older adults perceived them to be highly interactive as compared to another more technologically advanced robot (35). As each unit of the JfA robotic pet costs between USD$110 to 130 (November 2020) (36), they are significantly more affordable to acquire. Furthermore, a cost-effectiveness study evaluating the use of a robotic pet with advanced touch capacities for people with dementia in long-term care settings showed that a plush toy alternative offered marginally greater value for money (37). Therefore, even though the Joy for All robotic pets have less technological features, they may be promising as a low-cost solution to address the psychosocial needs of older adults and people with dementia.

Figure 1: Low-cost, familiarly designed robotic pets/toys

(Left to right: JfA cat, JfA dog, Perfect Petzzz Cat, Perfect Petzzz Dog)

Although there has been previous reviews on the use of robotic pets for older adults (17), none have included or had a focus low-cost, familiar and realistically designed robotic pets. To the best of our knowledge, the JfA robotic pets are the only commercially available robotic pets that met all three criteria as established above. As such, the aim of this scoping review is to synthesize evidence on the delivery and impact of familiarly and realistically designed low-cost interactive robotic pets (i.e., the JfA robotic cat and dog) for older adults and people with dementia. A scoping review methodology was chosen as it is well suited to explore the breadth and depth of literature in this field (38).

Method

This scoping review followed the methodological framework proposed by Arksey and O'Malley (39), which includes five stages. The stages of conducting the review and analysis were as follows.

Stage 1: Identification of the research question

The research question for this scoping review is: "What is known about the impacts of low-cost, familiarly and realistically designed interactive robotic pets (i.e., the JfA robotic dog and cat) for older adults and people with dementia?"

Stage 2: Identification of relevant studies

Published articles and grey literature were identified and searched in following electronic databases: CINAHL, Web of Science, Scopus, MEDLINE via Ovid and PsycINFO via Ovid. All relevant literature that were written in English, regardless of methodological quality, were included. Since the JfA robotic pets were only developed in 2016, only studies published after 2016 were included. The search strategies were developed in consultation with a research librarian, based on the 'PCC' (Population, Concept and Context) framework that is recommended by the Joanna Briggs Institute for scoping reviews (Box 1). The full search strategy can be found in Appendix 1. To cover the breadth of available literature and to ensure that the search was comprehensive, searches were also conducted on Google Scholar, and through forward and backward citation tracing. The search was initially conducted in May 2020. To maximize the currency of this review (40) an update of the search was conducted in September 2020.

Table 1: The PCC (Population-Concept-Context) Framework

Population	Older adults (aged 60 and above) and people with dementia
Concept	Interventions using low cost, realistically and familiarly designed robotic pets (i.e., the Joy for All (JfA) robotic cat and dog)
Context	No limits applied to the study context (e.g., participants' homes, care settings)

Stage 3: Selection of studies

The selection of studies followed a two-stage screening process. Two independent reviewers (WK and FA) were involved in the screening process. Any non-consensus or discrepancies were discussed and resolved among both reviewers, and with the third author (DC) as necessary.

First, the titles and abstracts of identified articles were independently screened. We anticipated that information regarding the specific type of robotic pet (i.e., the JfA robotic cat and dog) may not be mentioned in the title and/or abstract of publications and may only be available in the body of the text. Therefore, all studies were included if they met the following inclusion criteria, based on the PCC framework: 1) Any type of primary study, 2) used a robotic cat or dog as an intervention, 3) included older adults aged 60 and above, and/or people with dementia, and are 4) published in English language. The exclusion criteria were: 1) non-interventional study, such as expert opinion and commentaries 2) used any other robotic pets such as Pleo and AIBO, 3) did not include older adults (i.e., aged below 60) and 4) published in languages other than English. If these criteria were unclear in the title and abstract screening, they were included for full-text screening. Next, the full texts of included articles were reviewed. Studies that employed the JfA robotic pets were included, and studies using any other robotic pets, such as the Justocat and NeCoRo cat, were excluded. Any disparities were discussed and resolved. A bibliographic reference management tool, EndNote, was used to ensure that all articles were systematically accounted for. The search strategy was recorded using a PRISMA flow chart (Figure 2).

Stages 4 and 5: Charting the data, summarizing and reporting the results

A standardized data extraction form was created using Microsoft Excel. The data that were extracted included: authors, country of the study, research design, research setting, participants' demographics, sample size, intervention delivery, positive impacts, and negative impacts. Authors of included studies were contacted as necessary to attain additional information. Both reviewers (WK and FA) charted the data independently before making comparisons afterwards. Both reviewers discussed to collate the extracted data into categories and refined them to develop the final themes. The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist (Appendix 2) was used to guide the reporting of the results (41).

Results

A total of nine publications (n=9) were included in the final review.

Quality Appraisal

Although quality appraisal is not necessitated for scoping reviews, it has been recommended to evaluate the methodological integrity of included articles (42). Two reviewers (WK and FA) independently appraised the quality of included studies before meeting to discuss any discrepancies, which were resolved through discussion and consensus reached.

Qualitative studies and the qualitative strand of the mixed method study were appraised using the Critical Appraisal Skills Program (CASP) qualitative checklist (43). The research aims and rationale of all studies (n=7) were clearly stated. With the exception of one study (44), most studies confirmed that ethical approval was obtained from a relevant research ethics committee. Most had appropriate research designs (n=4) (44-47) and recruitment strategies (n=5) (44, 45, 47-49). However, the data collection and analysis methods were not clearly described in four studies (50-52). These factors subject the studies to assessor bias and reporting biases (53). Emails were sent to the authors to request for more information; however, no responses were received. Most studies (n=6) did not provide sufficient information to illustrate if the relationship between the researchers and participants were adequately considered (44-47, 49, 54).

The National Institutes of Health (NIH) quality assessment tool for pre-post studies (55) was used to appraise the quantitative study and quantitative strand of the mixed method study. The tool contains 12 questions to guide reviewers' judgement of whether a study is of "good", "fair", or "poor" quality. The quality of these studies were rated as poor and fair respectively. In the mixed method study by Marsilio et al, it was unclear whether all eligible participants were enrolled, which subjected it to selection bias (49). In addition, the intervention was not clearly described, suggesting the potential for information bias. The other study by Tkatch et al had a significant attrition rate (56). Furthermore, both studies did not state whether assessors were blinded, which raised concerns about reporting biases (49, 56).

Finally, the AACODS checklist (57) for appraising grey literature was used to evaluate the quality of McBride et al's article (58). This article did not have a clearly stated aim or research design. An email was sent to the authors request for more information, and an author clarified that the study was 'unstructured', and there was no additional information beyond what was presented in the article. Hence, this article was rated to be of poor quality. The full quality appraisal tables can be found in Appendix 3.

Overall, the quality of reporting in the included studies varied from poor to good, with most classified to be of poor to fair quality. Nevertheless, all studies were included in this scoping review, as the intention of this review is to identify the breadth of literature in this topic.

Figure 2: PRISMA Flow Diagram

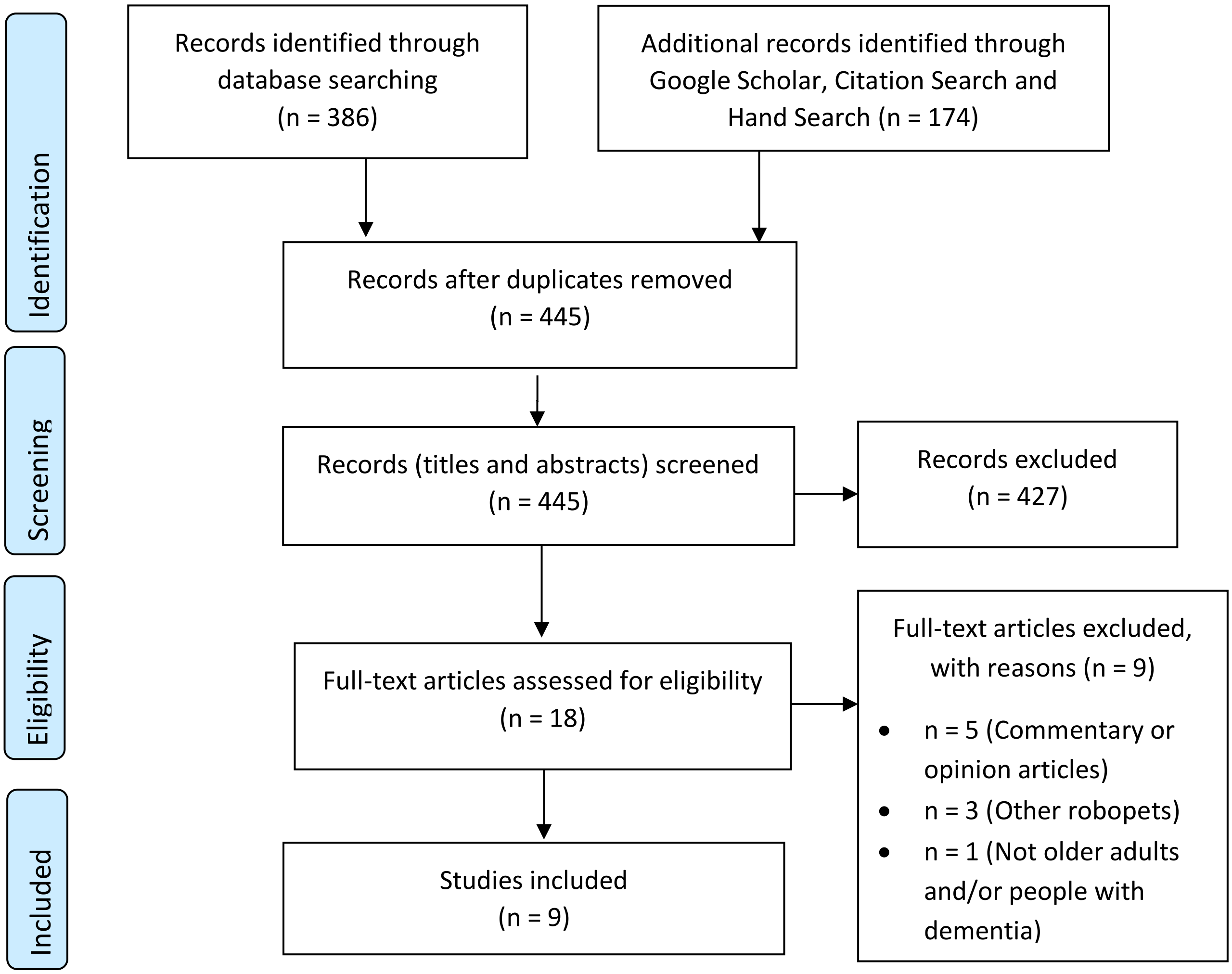

Table 2: Characteristics of Included Studies

Author	Aim	Robotic pet/cost	Method	Setting	Participants	n	Outcome measures
McBride et al, 2017	Not clearly stated, appears to have explored impacts of low-cost interactive robotic pet for older residents	JfA Cat and Dog/ $99-119 USD per unit	Not clearly stated	Nursing home	Older adults living in residential care	33	1. Clinical observation
Picking & Pike, 2017	To explore the potential of an affordable robot, with a view to making a realistic difference in quality of life for people with dementia and their carers	JfA Cat/ <£100 GBP per unit	Qualitative (Multiple case study)	Own homes	Older people with dementia	3	1. In-depth interviews with participants and carers, where they are encouraged to tell their story using aids such as photographs
Marsilio et al, 2018	To determine whether introducing a robotic companion cat into a long-term care facility may improve affect and increase participation for residents with dementia; determine potential benefits for caregiver roles and relationships with individuals with dementia	JfA Cat/ No info	Mixed method	Nursing home	Long term care facility residents with dementia (required assistance for some or all activities of daily living)	11	1. Agitation, using the Cohen-Mansfield Agitation Inventory 2. Physiological measures (heart rate and oxygen saturation) 3. Changes in the use of psychotropic and pain medications (review of the medication dispensing record) 4. Clinical observations and staff report of participants' behaviour 5. Questionnaire post study to evaluate staff perceptions of the effects of the robot on participants

Table 2: Characteristics of Included Studies

Author	Aim	Robotic pet/cost	Method	Setting	Participants	n	Outcome measures
Pike et al, 2018 (UK)	To explore the effects of a robot cat as companion robots for people living with dementia in their own homes	JfA Cat/ No info	Qualitative (Multiple case study)	Own homes	Older people with dementia or early symptoms of dementia	6	1. Interviews with people with dementia and their family, using photo elicitation when a photograph was available
Brecher et al, 2019 (USA)	To describe a case study on the effectiveness of using a robotic cat to successfully assist in the treatment of a patient with terminal restlessness.	JfA Cat/ < $100 USD per unit	Qualitative (Case report)	Veteran Affairs Community Living Center	Older person with dementia	1	1. Clinical observation
Bradwell et al, 2020 (UK)	To report ecologically valid diary data from two supported living facilities for older people with dementia or learning difficulties.	JfA Cat and Dog/ ~£100 GBP per unit	Qualitative (Descriptive qualitative)	Two supported living facilities	Older adults with dementia or learning disabilities	No info	1. Diary entry by two members of staff at each supported living facility, using event-based sampling (i.e. observations are logged after each observation), over a period of six months

Table 2: Characteristics of Included Studies

Author	Aim	Robotic pet/cost	Method	Setting	Participants	n	Outcome measures
Pike et al, 2020 (UK)	To investigate the use of robotic companion robots for people with dementia living at home with family and/or carer support	JfA Cat / £100 GBP	Qualitative (Multiple case study)	Own homes	Older adults with dementia or early symptoms of dementia	6	1. Multiple interviews with participants and their family - First interview two weeks after they receive the cat, and second interview at three months
Hudson et al, 2020 (USA)	To explore the efficacy of robotic pets in alleviating loneliness for older adults	JfA Cat and Dog/ $109.99 - $129.90 USD per unit	Qualitative (descriptive qualitative)	Own homes	Community-dwelling older adults	20	1. Individual in-depth interviews
Tkatch et al, 2020 (USA)	To determine the feasibility of an animatronic pet program, and whether ownership of animatronic pets would decrease loneliness and improve well-being among lonely older adults	JfA Cat and Dog/ $109.99 - $129.90 USD per unit	Quantitative (Cohort study)	Own homes	Community-dwelling older adults	216	1) Quality of life, using the Veteran's RAND (VR-12) 2) Loneliness, using the UCLA Loneliness scale 3) Resilience, using the Brief resilience scale (BRS) 4) Purpose in life, using the NIH Tuberculosis Meaning and Purpose Scale Age 18+ 5) Optimism, using the Life orientation test-revised (LOT-R)

Participants and Study Settings
The sample sizes in eight studies ranged from one to 216 and included a total of 296 participants. It was not possible to ascertain the sample size in one study (45). Most studies (n=6) were conducted with older adults with dementia (44-47, 49, 54). However, one study also included older people with learning disabilities (45). Two studies were conducted with healthy older people (48, 56). In the remaining study, participants were older residents in a nursing home. However, there was no information on their ages or diagnoses (58). Studies were conducted in participants' homes (n=5), and in long term care settings (n=4).

Intervention Delivery
The majority (n=5) used the JfA robotic cat (44, 46, 47, 49, 54), while the others (n=4) employed both the robotic cat and dog (45, 48, 56, 58). Only one study (n=1) offered participants' their choice of robotic pet (i.e. cat or dog), and reported no differences between the type of pet to the intervention outcomes (48). The intervention duration ranged from two weeks to six months. The majority (n=9) delivered the robotic pet as a one-to-one intervention; Only one delivered the intervention both individually and communally (45). Most (n=5) provided the robopet to participants on a full-time basis (46-48, 56). In one study (n=1), their use progressed from structured one to two hour sessions during the first, two to three months to full-time use by the third month (45). Finally, two studies (n=2) reported intervention delivery on a weekly basis, between once to three times each week (45, 58).

In most studies (n=7), minimal facilitation or instructions were provided by the researchers to guide intervention delivery with the robotic pets, to allow their use to be scaffolded naturally (44-48, 54, 56). Among studies which provided information about intervention delivery during the research, three reported facilitation by formal caregivers (45, 49, 58). In one study, staff placed the robotic pet in the resident's arm, talked about it, then left the resident alone with it (49). It was also made available during other times when residents asked for it, or when the nurses were motivated to use the robotic pet with residents. Another study reported that although the robotic pets were available in communal areas for unfacilitated interactions, structured group sessions with the robotic pets were also delivered by staff (45). In one study, staff members reported difficulties integrating their use into normal nursing routines, as they relied on therapeutic recreation staff to use the robotic pets with nursing home residents (58).

Positive impacts of the robotic pets
The positive impacts included: (i) improved mood and affect, (ii) improved communication and interaction, (iii) companionship and (iv) improved other well-being outcomes (Table 2).

Improved Mood and Affect

Five studies (n=5) reported reduced agitation among older people with dementia. Only one study used the Cohen Mansfield Agitation Inventory, physiological indexes and evaluated medication records to measure effects on agitation quantitatively (49). Results showed statistically significant improvements in participants' agitation scores and oxygen saturation. Nevertheless, there were no significant changes to participants' heart rates. There were also no changes to the use of psychotropic or pain medications. Other articles reported their results based on observational data, where use of the robotic pets was reported to reduce aggression and disruptive behaviours (44, 45, 58). The robotic pets were also found to be useful in de-escalating situations when people with dementia were agitated or anxious, through providing calming effects (47, 49, 54, 58). Brecher (44) reported that a participant's physical aggression almost completely resolved within 24 hours of interacting with the robotic pet. Similar effects were reported in other studies, where behavioral issues were described to have reduced (49, 58). This calming effect was also reported by older people without cognitive impairments (48).

Table 3: Positive impacts of the robotic pets

Author (Study setting)	**Mood & affect**	**Communication & social interaction**	**Companionship**	**Well-being outcomes**
McBride et al (58) (Nursing Home)	X	X		
Picking & Pike (46) (Participants' homes)			X	
Marsilio et al (49) (Nursing Home)	X	X		
Pike et al (46) (Participants' homes)		X	X	
Brecher (44) (Nursing Home)	X			
Bradwell et al (45) (Assisted Living)	X			
Pike et al (47) (Participants' homes)	X	X	X	
Hudson et al (48) (Participants' homes)	X	X	X	
Tkatch et al (56) (Participants' homes)				X

Communication and Social Interaction

The robotic pets were found to have positive impacts on participants' communication and social interactions (n=8). When participants used the robopets in the presence of others, conversations and social interactions were facilitated (45-49, 58). In a study which was conducted to evaluate community-dwelling older adults' experiences of using robotic pets, participants shared that their opportunities to connect with others was increased through sharing their pets in public spaces (48). For people with dementia, the robopets provided a topic of conversation, which increased social interaction between participants and their care providers, family members and other residents (45-47). Furthermore, the robotic pets' interactivity, such as movements and sounds were observed to facilitate participants' interaction with the pet or with others (45, 47, 49, 58). However, during unfacilitated robot interactions, some people with dementia were unaware that they needed to pet the cat to stimulate responses and reported concerns that their robopet had not interacted with them (49). In such instances, staff had to prompt residents to touch the robot.

Companionship

People with dementia were reported to have developed companionship with their robotic pets (45, 46, 49, 54) and in some instances had 'formed a strong bond and attachment' with the robotic pets (45). Only one study conducted a quantitative evaluation of loneliness with cognitively healthy older adults using the UCLA loneliness scale. Results showed a statistically significant decrease in older adults' perception of subjective loneliness after one month of using the robotic pets (56). This change was sustained after a second month of use. In the subsequent qualitative study, older adults shared similar sentiments that their perception of loneliness had reduced due to the presence of and interactions with the robopets (48). This sense of presence was perceived to be comforting and enjoyable (47, 48).

Other well-being outcomes

Quantitative measures of other outcomes were reported in one study (56). In this study, there were no improvements to cognitively healthy older adults' physical well-being as recorded on the physical component of the Veteran's RAND (VR-12). However, their mental well-being, resilience and purpose in life, as measured respectively on the mental component of VR-12, the brief resilience scale and, the adapted version of the NIH tuberculosis meaning and purpose scales, showed statistically significant improvements after one to two months of using the robotic pets. In a qualitative study which investigated the use of robotic cats for people with dementia living at home, interviews with family members revealed that the pet robot provided participants with a sense of purpose, which led to an overall improvement in wellbeing and function (47). As a result, one of the participants in the study did not have to move to a residential care facility.

Issues and concerns relating to use of the robotic pets

Issues and concerns related to use of the robotic pets included: (i) misperception and attachment, (ii) no impact or negative impacts, and (iii) practical issues.

Misperception and attachment

Staff members in nursing homes reported that some people with dementia misperceived the robotic pets as live animals (n=2), which had implications on participants' acceptance and interaction with the technology. In one study, some participants declined the pet robot as they did not want to be responsible for caring for the cat (49). In another study, one participant requested for a cage and collar for the robotic pet and showed concerned about its care. Correspondingly, he became frustrated because of a perceived responsibility to care for the cat (58). The issue of attachment to the robotic pets was also raised (45, 49). Some authors felt that attachment had the potential to cause emotional distress for users, if a technical fault or break down were to occur (49). In one study where participants shared the robotic pets in a group setting, some participants were reported to exhibit jealousy of others using the robot as they were hesitant to share the robotic pets with others (45).

No impact or negative impacts

Some participants with dementia declined or had no interactions with the robotic pets and reported negative preferences (i.e., dislikes) towards animals (46, 47, 49, 54). Some participants perceived the robots as "creepy", and rejected their use (45, 47). The interactivity of the robots was also raised as an issue. Vocalizations of the robopet (i.e. meowing) was reported to cause anxiety in a participant with dementia, who felt concerned about its wellbeing (47). In such instances, family members turned the robot off. Similarly, another participant with dementia who had active psychosis was reported to feel disturbed by the robopet's sounds (58). Some movements of the robotic cat, such as rolling over, also caused distress in some people with dementia as they perceived that the cat was falling down (47). A few participants exhibited agitation towards the robotic pet, and some attempted to harm the it (45, 49). In one study, staff attributed the participant's negative response to a recent change in psychotropic medications (49).

Practical issues

Practical issues, which included cost, hygiene and infection control, were raised. Although the low-cost of this innovation was cited as a reason for some researchers' choice of social robot for their studies (44, 45, 47, 56), other researchers and care staff also raised concerns about their affordability (45, 48, 56). The issue of hygiene and infection control, such as through shared use in care facilities, was also brought up by staff and researchers in two studies as potential challenges for longer term use (45, 58). The authors of one study suggested that that the robotic pets should be kept off residents' lap during mealtimes to address the issue of hygiene, and that purchasing individual robots for each resident might simplify the issue of infection control (58).

Discussion

This is the first scoping review to identify and synthesize the evidence on the delivery and impact of low-cost, familiarly and realistically designed robotic pets for older adults and people with dementia. The majority of the included studies in this review were conducted in long term care facilities and in participants' homes, and most employed the JfA robotic cat.

Overall, the positive impacts of the JfA robotic pets related to several psychosocial domains. Positive impacts include improved mood and affect, improved communication, social interaction, and companionship – these benefits resonate with findings in reviews that investigated the effectiveness of other social robots and robotic pets for older adults and people with dementia (17, 18, 20). However, the impacts on other domains, including loneliness, resilience and purpose in life, were less investigated; in this review, only one study which focused on cognitively healthy older adults reported on such outcomes (56). This corresponded with findings from a review paper which investigated the use of social robots for older people (59), and found that only three studies reported outcomes relating to loneliness among healthy older adults. Next, similar to studies using other robotic animals, the interactivity of the JfA robotic cat and dogs have been described to facilitate users' communication and interaction with the pet and with other people. Paradoxically, the interactive features of the JfA robopets caused distress among a few participants with dementia. Such issues have been reported previously, where users were disturbed by sounds produced by another robotic pet (22, 60-62). Moving forward, there is a need for robot developers to consider the customizability of the robopets' interactive features in accordance with users' preferences.

The issue of affordability has been reported to impede the use of robotic pets in the real-world (22, 25, 26, 28). The low-cost of the JfA robotic pets appeared to have an influence on intervention delivery and the conduct of research; with the exception of one study, all participants in this review received their own robotic pet for individual use. This is in contrast to findings from a systematic review, which found that higher-costed robotic pets have been shared among users and used more frequently in group settings (17). The affordability of the JfA robotic pets was also cited by researchers as one of the influencing factors in the choice of robotic pet for their studies (44, 45, 47, 56). Cost appeared to have played a role in influencing the research method in one study, where individual robopets were provided to 216 participants to enable a statistical significant analysis of their impacts (56). This strategy may be more challenging to implement with more expensive robots (20). In addition, it is worth noting that there is a relatively sizeable body of anecdotal evidence, largely stemming from individuals' reports of their experiences with this technology (63-66). This might also be attributed to their affordability, which might have enabled more users to gain access to this technology as compared to other social robots that are more expensive. For example, while Paro is one of the most researched social robots, it has significantly lesser user generated reports of its impacts. This could be because Paro is primary used in institutions (21), likely due to its cost, which renders it to be less accessible for individual users' purchases. Individual ownership of the robotic pets may be viewed as a promising way to mitigate the pertinent issue of infection control, especially in light of the ongoing COVID-19 pandemic. A recent publication by Bradwell et al reported that the acceptable levels of microbes on robopets, including one with antibacterial fur covering (21), exceeded an acceptable threshold after 20 minutes of use (67). Frequent and shared use of these robopets between different users can further increase the potential of infection transmission (31, 32). Hence, since the lower cost of the JfA robopets increases the affordability of individual purchases for each user, the corresponding risk of direct or indirect contact transmission of infections related to shared use may be ameliorated.

Next, issues related to use of the JfA robopets were identified. Like other interventions involving social robots, there were issues associated with use of this intervention. Some participants with dementia did not benefit from their use or demonstrated negative responses towards the robopets. For this population, the ethical challenge of deception also emerged (68), as some participants misperceived them as real animals or showed attachment towards them. These issues are not unique to the JfA robotic cat and dog, as they have been reported in other studies using other robotic pets (27, 69, 70). The significance of these issues should not be discounted as those who were more attached or misperceived the robopets belonged to a vulnerable population. However, from the standpoint of the capability approach, all humans, including people with disabilities, should be given the opportunity to achieve a threshold level of core capabilities to uphold the principle of social justice (71). Therefore, in consideration that the pet robot may facilitate a user's capacities that would be otherwise undermined, such as facilitating social interaction, this can be viewed as enabling technology with greater benefits than risks (72). In addition, formal and informal caregivers should also explicitly consider upholding this principle, particularly when delivering the robotic cat. When introducing this technology to users, they should introduce it as a robotic pet refrain from referring to it as a real animal (72). The understanding of potential issues, such as jealousy and attachment, may also guide future implementation and inform future robot development to ensure robustness of the technology.

Finally, users' responses towards the JfA robopets appear to be related to their profile (i.e., preference for or experience with animals). Participants who did not respond or had negative responses to the JfA robopets were reported to not like the animal. This aligned with findings from other studies which highlighted that multilevel stakeholders including people with dementia (21), family members (22) and staff (26) who liked animals had positive perceptions and reactions to robotic pets. Therefore, before considering the use of the JfA robopets to address the psychosocial needs of older adults and/or people with dementia, care providers should consider users' preferences for animals, as well as their preferred type of robotic animals, to maximize the appropriateness and meaningfulness of the intervention.

Strengths and Limitations

There are a number of strengths underpinning this work. Firstly, the methodological framework used throughout the scoping review process was transparent and rigorous. The screening and data extraction process involved two independent reviewers, which reduced the risk of reviewer bias or article selection bias. Both reviewers met at regular intervals, discussed, and resolved all discrepancies. Secondly, this paper discussed the pragmatic aspects relating to intervention delivery and the conduct of research using the JfA robotic pets, which can serve as useful considerations for researchers or users who are keen to further explore the use of this technology. However, there are limitations of this review. Articles that were published in other languages were not searched or included in this review. As non-English studies were excluded from this review, relevant studies might be missed.

Conclusions

This scoping review has mapped out current evidence on the use of and impact of two realistic and familiarly designed low-cost robotic pets (i.e., the JfA robotic cat and dog) for older adults and people with dementia. Our review contributed to the evidence-base that is necessary for more widespread awareness about the potential utility of these low-cost robotic pets to address the psychosocial needs of older adults and people with dementia, as both the positive impacts and issues related to their use largely resonate with research conducted with several other robotic animals. The affordability of these robopets appear to have an influence on intervention delivery. They also appear to have the ability to uphold the distributive justice of innovation dissemination; these are especially relevant in light of the COVID-19 pandemic, where there is an increased emphasis on infection control and equal access. However, more rigorous effectiveness trials are required to confirm their positive impacts. Future studies should also consider comparing the intervention effects of the JfA robotic pets with other robotic pets. It is also important to ascertain the design preferences of older adults and people with dementia to facilitate the development of future user-centred interventions using robotic pets.

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Chapter Summary

A review was conducted to collectively scope extant studies, to understand the potential of using low-cost pet robots to improve the psychosocial health of older adults and PLWD. Since low-cost pet robots are a relatively recent area of development, a scoping review was an appropriate methodology for the mapping and examination of the emerging evidence. This review focused on familiarly and realistically designed low-cost robots, based on previous research which suggested that such designs are preferred by older people and PLWD. Two pet robots, the JfA cat and JfA dog, were the only commercially available pet robots that met these criteria. Five databases were searched, using a comprehensive search strategy that was developed in consultation with a research librarian. Forward and backward citation tracing was also conducted. Following a two-step screening process by two independent reviewers, nine articles were included for analysis. The small number of included studies may not be surprising, since the JfA pets became commercially available in 2016.

Findings showed that most studies used the JfA cat and delivered one-to-one interventions. Positive impacts included improved mood and affect, social engagement and interaction, companionship and other well-being outcomes. Issues pertaining to their use included attachment and misperception of pet robots, no impact or negative impact, and pragmatic concerns such as infection control. These findings closely resemble findings from other studies investigating the impact of other pet robots, including PARO. Most of the included studies were of low to fair quality and had small sample sizes. Nevertheless, findings from this study suggest that low-cost pet robots show promise to benefit the psychosocial health of older adults and PLWD.

Chapter 3: The Usability and Impact of a Low-Cost Pet Robot for Older Adults and People With Dementia: Qualitative Content Analysis of User Experiences and Perceptions on Consumer Websites

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Prologue

Despite a small number of available research studies as outlined in the scoping review in Chapter 2, there was a large volume of user-generated data on consumer websites, where individuals' described their experiences of using the JfA pets with older adults and PLWD. This could be due to their affordability and commercial availability as compared to other higher-cost alternatives, which may have enabled more individuals to access them. This chapter presents paper three, a qualitative content analysis of user-generated data from consumer websites. The purpose of the study was to address objective one through understanding the usability and impact of a low-cost pet robot, based on individuals' experiences and perceptions of their use with older adults and PLWD.

Abstract

Background: Worldwide, populations are ageing exponentially. Older adults and people with dementia are especially at risk of social isolation and loneliness. Social robots, including robotic pets, have had positive impacts on older adults and people with dementia by providing companionship, improving mood, reducing agitation and facilitating social interaction. Nevertheless, the issue of affordability can hinder technology access. The Joy for All (JfA) robotic pets have showed promise as examples of low-cost alternatives. However, there has been no research which investigated the usability and impact of such low-cost robotic pets based on perceptions and experiences of its use with older adults and people with dementia.

Objective: The aim of our study was to explore the usability and impact of the JfA robotic cat, as an example of a low-cost robot, based on perceptions and experiences of using the JfA cat for older adults and people with dementia.

Methods: We used a novel methodology of analysing a large volume of information that were uploaded by reviewers of the JfA cat onto online consumer review sites. Data was collected from 15 consumer websites. This provided a total of 2,445 reviews. Next, all reviews were screened. 1327 reviews that contained information about use of the JfA cat for older adults and/or people with dementia were included for analysis. These were reviews that contained terms relating to "older adults", "dementia", and "institutional care", and were published in the English language. Descriptive statistics was used to characterize available demographic information, and textual data was qualitatively analysed using inductive content analysis.

Results: Most reviews were derived from consumer sites in the United States, and most reviewers were family members of users (i.e. older adults and people with dementia). Based on the qualitative content analysis, five key themes were generated: prior expectations, perceptions, meaningful activities, impacts, practicalities. Reviewers had prior expectations of the JfA cat, which included circumstantial reasons that prompted them to purchase this technology. Their perceptions evolved after using the technology, where most reported positive perceptions about their appearance and interactivity. The use of the robot provided opportunities for users to care for it and incorporate it into their routine. Finally, reviewers also shared about the impacts of the device, and practicalities related to its use.

Conclusions: This study provides useful knowledge of the usability and impact of a low-cost pet robot, based on experiences and perceptions of its use. These findings can help researchers, robot developers and clinicians understand the viability of using low-cost robotic pets to benefit older adults and people with dementia. Future research should consider evaluating design preferences for robotic pets, and compare the effects of low-cost robotic pets to other more technologically advanced robotic pets.

Keywords: Social robot, pet robots, low-cost robot, dementia, older adults, qualitative research, qualitative content analysis

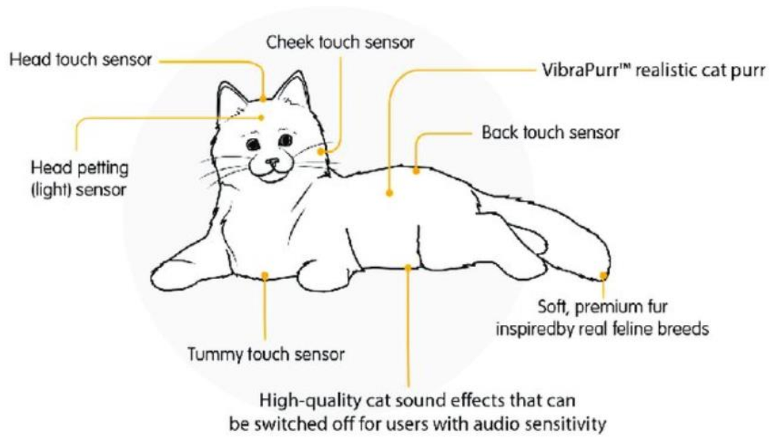
Introduction

Worldwide, the population is aging exponentially. Since the prevalence of dementia greatly increases with age, the corresponding number of people with dementia is also on the rise [1]. Older adults and people with dementia are especially at risk of social isolation and reduced psychosocial health [2]. Social robots, such as robotic pets, are innovative technological solutions that are being developed and deployed to address the psychosocial needs of this population [3]. They are defined as autonomous or semiautonomous devices that are socially evocative and socially receptive [4], with the ability to interact with humans in a socially appropriate manner [5]. Pet robots are developed to simulate and substitute animal-assisted therapy [6]. Although animal-assisted therapy can benefit the social and emotional health of older adults and people with dementia by providing companionship, eliciting relaxation, and reducing loneliness [7,8], the use of live animals can pose several challenges. For instance, there is potential for transmission of zoonotic diseases, animal aggression, and compromised animal welfare [9]. Therefore, the use of a robotic alternative is seen as a novel way to enable older people and people with dementia to reap the psychosocial benefits of animal-assisted therapy, while potential adverse effects are avoided. Overall investigations into their effects have demonstrated positive benefits for older adults and people with dementia. Their use was found to have positively affected physiological indicators through improved sleep, improved oxygenation and cardiac status, reduced use of psychotropic drugs, improved mood, and improved social engagement [10-12]. PARO, a robotic seal, was the most studied robotic pet. Other pet robots include AIBO (robotic dog), JustoCat and NeCoRo cat (robotic cats), and Pleo (robotic dinosaur). However, the affordability of the robots is one key issue that has been widely flagged as a concern by multilevel stakeholders [13-15]. For instance, the JustoCat costs approximately US $1350 and PARO costs about US $6000. The substantial cost of such technology can reduce innovation dissemination [16], posing the ethical concern of unequal access [17]. Therefore, there is a need to explore lower costed alternatives.

The Joy for All (JfA) robotic pets have been identified as low-cost and commercially available innovations that have been used for older people and people with dementia [18]. They contain sensors to respond to touch and light, through movements and vocalizations, with the purpose of providing social interaction (Figures 1 and 2). Because they are capable of autonomous responses to stimuli for the purposes of social interaction, they should be considered as social robots. As one unit of the JfA robotic pet costs between US $110 and US $130, they are significantly more affordable. Synthesized findings from a recent review showed that despite being less-technologically advanced than other robotic pets, the JfA robotic pets showed promising benefits to address the psychosocial needs of older adults and people with dementia [18]. This included improved mood and affect, improved social interaction, companionship, and other well-being outcomes [18]. The lower cost of the technology also appeared to influence the ways in which the robotic pets were being used. For example, in contrast to other higher-costed pet robots that have been shared among users [12], most older adults and people with dementia that were included in the study owned their own JfA pet [18]. This implied that the affordability of the JfA pets had an influence on the accessibility to and adoption of this technology. Furthermore, individual ownership of social robots was suggested as a way to mediate the issue of infection control by reducing the potential for transmissible diseases from shared use. This is especially relevant in residential care settings in light of the COVID-19 pandemic, where a recent study has advised against the sharing of pet robots [19]. The review also found that while a few studies used both the JfA cat and dog for older adults and people with dementia, most only used the JfA robotic cat. A study by Bradwell et al [20] presented similar findings, where the JfA robotic cat, among 7 other alternatives, was chosen by older adults as their most preferred robotic pet.

Figure 1: Joy for All robotic pets

Figure 2: Touch interaction capabilities of the Joy for All cat



Despite its potential as a therapeutic device, there is a lack of research to understand the usability and impact of the JfA cat based on perceptions and experiences of its use with older adults and people with dementia. As such, this study aims to explore the perceptions and experiences of using the JfA cat for older adults and people with dementia, using user-generated content published on consumer websites. This is a novel methodology that will be described below.

Method

Study Data

The data used for this research are located on public platforms (ie, consumer review sites). Therefore, informed consent for this study was not obtained. However, as the use of direct quotes from consumer reviews could potentially make them identifiable, the quotes that were illustrated in this study were minimally amended to ensure users' anonymity. This study was approved by the National University of Ireland Galway Research Ethics Committee (reference number R20.JUN.12).

Focus on user-led content

To date, most research that aims to understand experiences using social robots has traditionally been researcher driven [10]. By contrast, this study utilized the large volume of information uploaded by users of the JfA cat onto publicly accessible online consumer review sites. These sites contain a sizeable body of anecdotal evidence from users who have purchased and used lower costed pet robots. These individuals shared detailed accounts of their experiences, for the primary benefit of other potential users who might be seeking to gather information about the product. Examining this valuable source of information during the study was an opportunity to develop knowledge shifting away from regarding researchers and health care professionals as the sole producers of information toward eliciting the voice and empowerment of nonprofessionals [21]. This approach has been used in other research fields, such as business or consumer research, however it is a novel methodology in the field of health and social sciences which allowed for an examination of user-led content.

Data Collection: Data Sources and Search Strategy

Data collection involved 3 key steps. First, online consumer review sites were identified through a Google search, using the search terms “Joy for All cat” and “user review”. The researcher’s (WK) internet browsing history and cookies were cleared, and the search was conducted in the incognito mode. Next, the first 100 consumer sites identified from the Google search that contained consumer reviews of the robotic cat were selected as data collection sites. All reviews were manually extracted into Microsoft Excel. This step was essential to ensure a clear audit trail, as the content of a webpage may change depending on what the researcher searches for and researcher’s location [21]. Consumer reviews of all languages that were submitted up to July 24, 2020, were extracted using a standardized data extraction form (Appendix 5) containing the following data fields: (1) review title, (2) review text, (3) star rating given, and (4) review date. Demographic information about users of the technology, such as their age group, diagnoses, and setting, was also collected if these data were available. If these were not available, the data field was left empty. To ensure anonymity, no potentially identifying information, such as the reviewing authors’ name and photo attachments, was collected. Finally, all reviews were screened to identify the sampling frame for data analysis.

Inclusion and exclusion criteria

Reviews were included if they contained information about the use of the robotic cat for older adults or people with dementia in any settings and were published in the English language.
As not all reviews contained information regarding users’ age and diagnoses, innovative approaches had to be undertaken to ensure that all relevant reviews were adequately considered for inclusion. First, as the average age of becoming a grandparent is between 50 and 69 years in several countries [22-24], it seemed reasonable for the researcher to include reviews that mentioned about the use of the robotic cat for this group (ie, grandparents) as older adults. Next, reviews that contained information about the use of JfA cat in institutional care were also included, as the large majority of people living in assisted living facilities or care homes are of an older age group [25-29]. Hence, reviews that met any of the following inclusion criteria were included in the sampling frame:

- Included terms related to older adults, such as “older adult”, “elderly”, “elder”, “senior”, “grandmother” or “grandfather” or explicit comment that users of the JfA robotic cat are aged 60 years and above
- Contained terms related to dementia, such as “dementia”, “Alzheimer’s disease”, “memory loss”, “memory problems”, “cognitive impairments” or “cognitive issues”, “memory care”
- Contained terms related to institutional care, such as “nursing home”, “assisted living facility”, “retirement home”
- Published in English language

All reviews that did not meet the above inclusion criteria were excluded. Reviews that were included were cleaned and formatted on Microsoft Excel before being exported into NVivo 12 for data analysis.

Data Analysis

Descriptive statistics was applied to characterize the number of reviews, available demographic information about users of the JfA cat, and the average star ratings given by users. Textual data were qualitatively analyzed using inductive content analysis, as described by Hsieh and Shannon [30], on the NVivo12 software. This method of data analysis was chosen as it guides systematic categorization of large volumes of text-based data and facilitates the identification of patterns of occurrences [31].

The data analysis proceeded as follows: First, 3 coders (WK, SW, and PH) immersed themselves in the data by reading all data repeatedly to obtain a sense of the whole and to allow new insights to emerge [31,32]. The first 5% of reviews were read word by word by each coder, who independently generated key thoughts or concepts for each phrase and labeled them using descriptive and low-inference codes [33,34]. After that, all coders met to discuss similarities and differences, and agreed on codes that formed the initial coding scheme [30]. Next, this coding scheme was tested by WK, SW, and PH, who independently coded another 10% (n=137) of all data using the coding scheme. Data that did not fit into an existing code were assigned a new code. After this, intercoder reliability test (ICR), using the kappa coefficient (κ), was conducted to assess the similarity between the coding produced by the authors. Although there is no set consensus on what proportion of data should be analyzed to yield a reliable estimate of ICR [35], an analysis of 10%-25% of the data set is typical [36]. Conducting this test allowed the rigor and transparency of the coding framework to be ascertained [36-38]. The kappa coefficient of 0.60 was obtained, which demonstrated substantial agreement between coders [39]. Following this, all coders met to discuss and agree upon the final coding framework. In particular, they ensured that all data within the codes and categories were distinctive and that they had good coherence [40,41]. The final coding scheme (Appendix 6) was tested by WK and SW, who independently coded another 5% (n=66) of the data set. Strong intercoder reliability was established (κ=0.7). Thereafter, the coding framework was applied to the remaining reviews by WK. Research rigor was ensured through prolonged engagement with the data [42], and frequent meetings with all coders throughout the creation of the coding framework, and to develop and refine the codes and categories.

Results

Figure 3 shows the flowchart that reports the data identification and collection. A total of 100 websites were identified, of which 15 were consumer review sites for the JfA robotic cat (Table 1).

Figure 3: Flow chart (Identification of reviews)

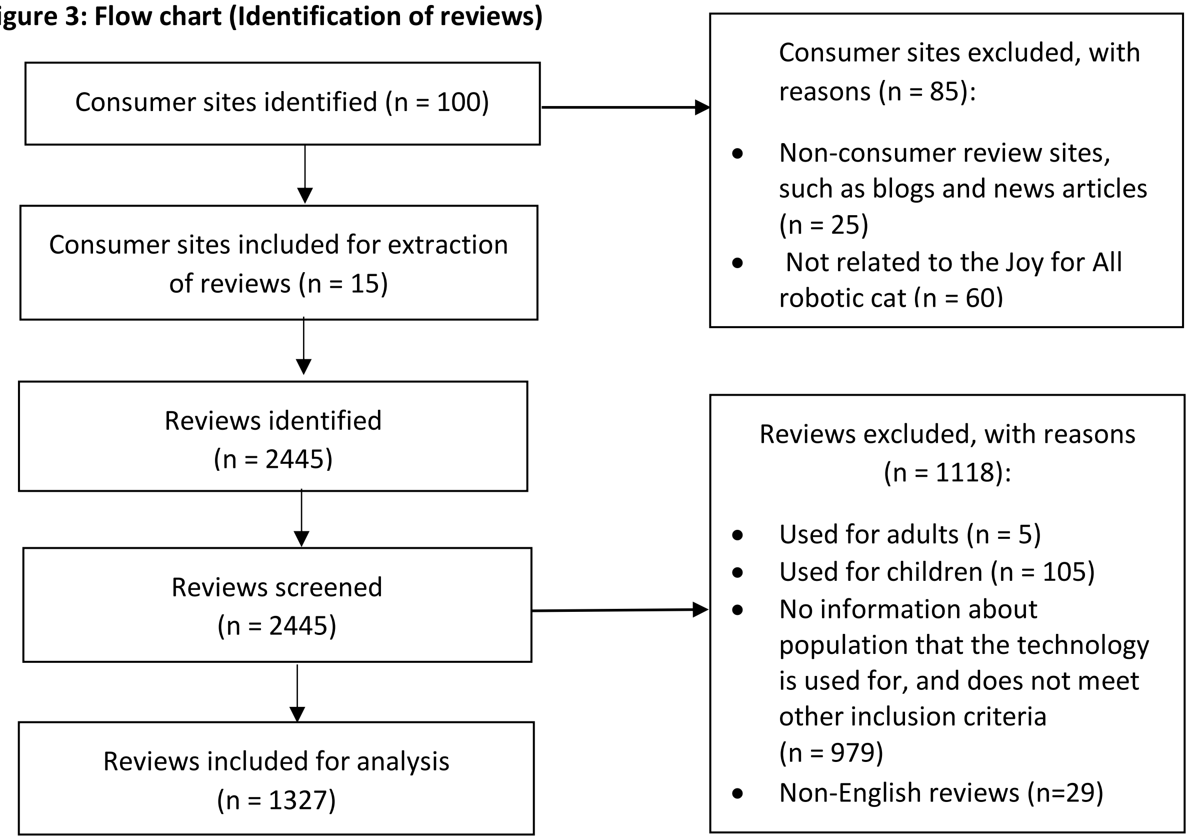


Table 1: Consumer sites and reviews identified

Consumer review sites	Number of reviews
Amazon (total: 6 sites)	2068
Joy for All (Ageless Innovation)	214
Bestbuy	25
Mindcarestore	7
Eugeria	5
Caregiverproducts	5
Alzstore	32
Alzproducts	10
Qvc	79
Walmart	0

Description of reviews

A total of 2445 consumer reviews were submitted over a 5.5-year period from December 4, 2015, to July 24, 2020. Of these, 1327 reviews met the inclusion criteria and were included for data analysis. Most reviews were derived from consumer sites from the United States (n=948), Canada (n=132), the United Kingdom (n=80), and Australia (n=13). Most reviews contained information about review date and star rating (n=1309). Overall, the number of reviews increased steadily from 2015 to 2020, and its average star rating was 4.75 (Table 2).

Table 2: Star rating and number of reviews across the years

Year of review	2015	2016	2017	2018	2019	2020
No. of reviews	15	180	222	228	372	292
Average star rating	4.13	4.63	4.86	4.74	4.76	4.76

Review Authors and Users of the Robotic Cat

Information about the review authors and users is presented in Table 3. Most review authors were family members of the primary users of the JfA cat. The majority were children (n=770), grandchildren (n=120), and partners (n=52) of older adults or people with dementia. Only 2% (n=22) of all reviewers identified themselves as users of the robotic cat. Information about the relation of other review authors with the older person or person with dementia was not available in 247 (18.61%) cases.

Table 3: Information about review authors and users

	Sample size (n, %)
Information about review authors	
Relationship to users	
Family members	1038 (78.2%)
Children	770 (58.0%)
Grandchildren	120 (9.0%)
Partners	52 (3.9%)
Other relatives	96 (7.2%)
Self	22 (1.7%)
Others (friends, care workers)	6 (0.5%)
No information	247 (18.6%)
Information relating to users	
Age/diagnosis	
Older adults	586 (44.2%)
People with dementia, cognitive impairment or memory issues	687 (51.8%)
Gender	
Female	988 (74.5%)
Male	121 (9.1%)
No information	218 (16.4%)
Setting	
Long term care facilities	399 (30.1%)
Memory care facilities	56 (4.2%)
Retirement homes	16 (1.2%)
Other care facilities	49 (3.7%)
Own homes	19 (1.4%)
No information	788 (59.4%)

The JfA cat was described as being for the use for older adults in 44.16% (586/1327) of reviews, while 51.77% (687/1327) described their use for people with dementia, cognitive impairment, or memory issues. The majority (n=1109) contained information about users' gender, of which 89.09% (n=988) were females. Less than half (n=539) provided explicit information about the setting in which the device was used (Appendix 7). Most were used in care settings, including long-term care facilities (n=399), specialized memory care facilities (n=56), retirement homes (n=16), or other care facilities (n=49).

Qualitative Findings

Five themes were generated from the qualitative analysis: (1) prior expectations, (2) evolving perceptions, (3) meaningful activities, (4) impact of the robotic cat, and (5) practical aspects surrounding the use of the JfA cat. Table 4 shows the main themes, subthemes, and their prevalence in the data. It also provides information on exemplar codes and representative quotes in each subthemes. We will describe the themes in the following sections.

1. Prior Expectations

This theme describes the circumstances which prompted reviewers to acquire the JfA robotic cat for the older person or person with dementia, and reviewers' perceptions of this technology prior to its use. Some reviewers (n=223, 16.8%) commented that users had previous experience with or liked cats or other animals. However, users were now unable to own a live animal due to circumstantial or personal reasons (n=181, 3.6%), such as institutional restrictions in residential care facilities and reduced physical or cognitive capacities.

> *"Recently my 93 mother's dementia progressed to the point that she required assisted living in a nursing home. She was devastated that she could not take her two cats with her. She misses them more than anything" – Reviewer 108*

Other reviewers indicated that they were prompted to purchase the JfA cat due to concerns about loneliness and isolation (102/1327, 7.69%), especially for intended users who lived alone or in residential facilities. The impact of COVID-19 measures was discussed in more recent reviews, where reviewers shared that visitation and activity restrictions exacerbated feelings of isolation. As such, expectations were focused on the users' likes of animals, and hopes that it might provide comfort, companionship, and improve their overall quality of life.

> *"When my family was faced with having to admit my 91-year-old Granny to a memory care facility it was devastating for us to think of her in there all alone and sad…" – Reviewer 8*

> *"Due to the pandemic and imposed isolation and restrictions, all enrichment activities such as visiting music, games, exercises, therapy animals were ceased. Residents were no longer allowed to eat with other residents. We hoped the therapy cat would provide some comfort" – Reviewer 13*

Table 4: Main themes, subthemes and exemplar codes

Main themes	Subthemes	Prevalence n (%)	Examples of exemplar quotes *(code)*
Prior expectations	Circumstances	390 (29.4%)	When my 89-year-old mother was sent to a nursing home after a hospital stay, she lost her residence of 25 years, and worst of all, she lost her beloved orange tabby *(can't have a live cat)*
	Expectations	182 (13.7%)	I was sceptical when I first heard that a mechanical cat like this could provide comfort and relief from anxiety for an elderly person suffering dementia *(uncertainty and scepticism)*
Perceptions	Appearance	364 (27.4%)	You can feel the bumps on the body through the fur *(not lifelike)*
	Interactivity	418 (31.5%)	It's ingeniously designed, with the movements coming at a seemingly random cycle, just like a real animal. The meowing is the only weakness, it doesn't really sound like a cat, but the purring is spot on" *(positive comment about interactivity)*
	Expectations met	415 (31.3%)	It did way more than I thought it could. Seemed like I found new things it could do for 3 days before I found everything *(exceeded expectations)*
	Ambivalence and/or rejection	114 (8.6%)	I bought this for my grandma, and she was very upset by it. She's in her late 80's and has slight dementia but she still got offended by this kitty. I took the cat home with me since she was so upset. I wasn't trying to insult her *(rejection)*
Meaningful activities	Companionship	270 (20.3%)	Now Brutus (name for the JfA cat) is helping my grandma not to feel completely alone *(companionship)*
	Doing something (activities)	500 (37.7%)	She takes it everywhere she goes, it rides along in her basket in her walker *(taking it to places)*
	Facilitation and support	75 (5.7%)	she wants it to purr, but gets upset if it meows too much. So we put it on mute so it still moves it's head and eyes and arm and purrs but doesn't get annoying *(facilitation and support)*
	Treating the robot cat as if it were real	70 (5.3%)	We talked to Mom/Grandma and let her know we were going to try to get her cat fixed. She is very concerned that we are going to take her cat away, but we assured her that we would try very hard to not take it away from her *(attachment)*
	Topic of conversation	78 (5.9%)	Both cat and grandfather are now quite popular. With dementia, I am not sure if he knows the cat is

			not real. Needless to say this cat has helped to improve my grandfather's social interactions as many people come to check out the cat *(topic of conversation)*
Impacts	Positive impacts on users	1000 (75.4%)	Mom who has dementia & suffers from sundowner syndrome. Her cat's meowing & purring (an impressively large repertoire of vocalizations) and the many movements it makes in response to touch, motion & sound provide the perfect kind of distraction my Mom needs in those PM hours *(a welcome distraction)*
	Negative impacts (users)	20 (1.5%)	She cried the other day because she thought it died (someone turned it off), she picked it up and cried for hours *(negative impact on users)*
	Positive impacts (others)	111 (8.4%)	My Mum is in a residential care manor and one of the other residents saw the cat and her daughter bought her one. All the residents love them *(positive impacts on others)*
	Negative impacts on others/ caregivers	3 (0.2%)	When the care home residents saw the cat, there was a near riot because they all wanted to hold it and stroke it at the same time *(negative impact on others)*
Practicalities	Positive aspects	409 (30.8%)	We have had it for a few weeks now and have yet to replace the batteries. The cat goes into sleep mode when it is not touched for several minutes which saves the battery life. It is reactivated as soon as one of the sensors in the back or head are touched *(battery life)*
	Negative aspects	118 (8.9%)	the product is ONE STAR in terms of reliability. My FIL loved it so much he broke it. We think he held the head too tightly, and ultimately the servos broke. The cat still meows and purrs, but it no longer rolls onto its back and the eyes no longer open *(not robust)*
	Suggestions for improvement	51 (3.8%)	One thing they missed though, is the movement a cat makes when you scratch under her chin... You know, head back so you can really get in there. And if they are reading this... they could make it a smart cat with an app and everything. It would be cool if you could talk to it or give it commands and it responds *(suggestions for improvement)*

A few reviewers (70/1327, 5.28%) reported skepticism about the usefulness of the robotic pet, and concerns about how users would perceive it or respond to it.

> *"I braced myself for a dismissive laugh, a 'what the hell did you get this for, what a waste of money' " – Reviewer 335*

> *" At first, I was hesitant because I was worried that she (my mother) would be insulted if I gave her a 'toy' " – Reviewer 146*

2. Perceptions

This theme describes perceptions about the appearance and interactive features of the JfA cat, and whether it has met reviewers' expectations. Perceptions about its appearance were mainly positive (312/1327, 23.51%), as reviewers commented about its life-likeness, size, and weight as resembling a real cat. Reviewers (357/1327, 26.90%) also commented about the device's realistic movements and vocalizations, especially its purring. Some pointed out that their JfA cat looked similar to users' previous cats. The robotic cat has sensors to respond to light and touch, however, its vocal and movement responses are nonprogrammable and are unpredictable. Some reviewers perceived its unpredictability as behaviors that resembled a live cat.

> *"At intervals, this cat flicks its ears, raises a paw to its face as if it's washing, turns it head when touched, blinks its eyes, and partially closes its eyes; and purrs and meows when it's head and back are petted. It also rolls back to expose its belly, and what is funny about the cat, is that the moments are unpredictable, and spontaneous just as if it were real" – Reviewer 394*

However, a few reviewers were negative in their comments (105/1327, 7.91%). The robotic cat was thought to be hard to the touch, which reduced its cuddliness and realism. The meowing sound of the cat was perceived as sounding like a person imitating its meow, and some movements were perceived to be mechanical looking and sounding. Although most reviewers said that not being life-like did not influence the interaction that users had with the technology, others commented that users' acceptance of the device was negatively impacted.

> *"She (my mother) doesn't seem to notice the battery pack which is quite hard but likes to pet it (JfA cat) and keeps it on her bed at night" – Reviewer 588*

> *"The facial and ear movements do make some mechanical noise, but they're not that loud and don't detract from it. The one thing that I could do without is that occasionally the front half twists and rolls back, then after a few minutes it comes back up. That's when you hear the loud motor really kick in and I find it to be an unnatural movement" – Reviewer 215*

> *"While she (my mother) seemed to like the cat at first, she noticed the jerky movements and mechanical sounds it makes when it turns its head and she didn't like this. Three weeks after giving it to her she says that it's a beautiful cat, but that there's something wrong with it" – Reviewer 262*

Perceptions of the JfA cat sometimes evolved with its use. Although most reviewers who discussed about their expectations of the robotic cat perceived it to have met or exceeded their prior expectations and fitted the needs of users (182/1327, 13.72%), some considered that the JfA cat may not be suitable for everyone. Similarly, a few users were ambivalent or had negative perceptions, and rejected the technology (72/1327, 5.43%).

> *"We didn't know if (my father) would like it, scoff at it, or soon get bored with it. His eyes lit up the moment it (JfA cat) was taken out of the box" – Reviewer 171*

> *"My elderly aunt found the cat "creepy" and wanted no part of it. I can see how some elderly people would like this mechanical replica, but she didn't like it" – Reviewer 161*

3. Meaningful Activities

This theme describes the engagement in meaningful activities with the JfA cat. Use of the JfA cat provided opportunities to supervise or provide care for older people and people with dementia (500/1327, 37.68%). Activities included holding, petting or brushing it, talking to it, keeping it on their laps, sleeping with it, and taking it to places. Some activities, such as naming the cat after their previous pet or loved ones, also provided an avenue for users to reminisce about past experiences. The robot's interactivity also appeared to be perceived as behaviors of reciprocity, which facilitated users to continue engaging with it.

> *"She (my mother) no longer speaks and appears somewhat catatonic. We were looking for ways to 'reach' her since talking to her and trying other activities were fruitless. We gave her this cat and got a glimpse into our mom again! The purring, meowing and movements awakened my mom and she came alive" – Reviewer 763*

> *"He (my dad) stroked her head, tail and back. He wanted to know her name. We told him she needed him to pick one for her. She became Fluffy! She meowed... He meowed back and laughed …" – Reviewer 167*

In some instances, the JfA cat was perceived to replace a lack of activity or participation, or replace undesirable or restless behaviors. Reviewers also commented that it provided companionship, and some users developed an attachment toward it.

> *"She (my mother) has stopped looking for her kids at night and she is focused on taking care of her cat" – Reviewer 1060*

> *"She (my mother) will hang onto it (JfA cat) for dear life and not want to give it back to us. She has it with her at all times except at meals and during structured activities" – Reviewer 763*

The JfA cat also provided users with a topic of conversation with others, including family members, friends, care providers, and residents within care facilities. Some passers-by would stop to interact with the user, talking about the JfA cat. This suggests that the robotic pet provided different opportunities for interactions.

> *"She (my mother) had great difficulty speaking but would ask for "baby" every morning, would meow back at the cat and carry on an indecipherable conversation everyday" – Reviewer 641*

> *"I was delighted that not only did she (my mother) find it wonderful, but she also had the experience that all the dementia patients in her facility, including the nurses, are doting and cooing at the kitty cat. I was pleased that it brought her comfort and joy from the attention she got as well as the kitty itself" – Reviewer 651*

Users varied as to whether they considered the JfA cat to be real. Reviewers (74/1327, 5.58%) mentioned that users were aware that this was not a live cat, but still enjoyed the device. While some commented about explicit attempts to introduce or remind users that the JfA cat is a robotic device, others suggested that users should treat it as a real cat. Some users who were not aware that the JfA cat was a robotic device treated it as if it were a live animal (70/1327, 5.28%) and tried to feed it with food and water, which dirtied it. Such perceptions also caused anxiety among some users, who became concerned that it would not eat or drink, or that it would escape. The device's vocalizations caused concerns among some users (70/1327, 5.28%), who became worried that the cat was upset. Some also exhibited distress when the robotic cat was not moving.

> *"It's unclear whether she (my mother) believes it (JfA cat) is real or not - but we avoid clarifying that it isn't, and all try to act interact with it in front of her as though it is real, and of course we helped her pick a name!" – Reviewer 594*

> *"Dad was nervous his cat would escape and get lost or that no one had given her food or water and she'd die. Mom had to stop him from bring Fluffy water (i.e., dumping it over her)" – Reviewer 167*

4. Impact of the robotic cat

This theme describes how the JfA robotic cat impacted the primary user and the caregiver. Most reviewers (874/1327, 65.86%) reported that users exhibited positive emotions. These included expressions of love and affection toward the robotic cat, expressions of joy, and improved mood. Several reviewers (228/1327, 17.18%) also commented that use of this technology was calming, provided comfort, and gave users a sense of purpose.

> *"She [my mother] now has a reason to get out of bed in the morning and is back to her old self again" – Reviewer 554*

> *"I would say this week has been his calmest, happiest, most relaxed, enjoyable week in possibly three or more years! Because of this life-like, mechanical companion designed exactly for people like him" – Reviewer 167*

> *"She never slept through the night. Usually, I am up with her constantly, but we actually had to wake her this morning. She actually went to sleep with her cat cuddled in her arms" – Reviewer 160*

The reviewers and other caregivers were also impacted. Reviewers shared about positive emotions and physical relief that they, their family members, and care staff experienced from observing users' interactions with the robotic cat (161/1327, 12.13%). Amidst these feelings, some reviewers shared about a sense of conflict or dilemma in watching users interact with a robotic device.

> *"The amount of joy this has brought her - and me watching her interact with the cat - is priceless" – Reviewer 265*

> *"Now honestly for some in my family the idea that my mom is in love with a mechanical cat and believes it is real can be a distressing and shocking new reality. But to see her joy with this cat and to occasionally use it as a diversion when she sundowns or when she goes through an angry phase is priceless" – Reviewer 530*

The JfA cat was also reported to have a positive impact on other people (111/1327, 8.36%), such as users' neighbors, or other residents in their care facility, who also enjoyed the technology.

> *"She enjoys sharing it with all the other residents, and they agree that petting this purring cat is very soothing and relaxing" – Reviewer 146*

5. Practical Aspects of Its Use

This theme describes comments about the facilitation that was rendered to support users' interaction with the JfA cat, overall experiences of the technology, and technical aspects of its use. Some reviewers provided mediation and supported users who perceived it to be a real animal (75/1327, 5.65%). Actions included reassuring users that the JfA cat was well taken care of, keeping it on mute or turning it off at night when users fell asleep, preparing spare batteries and being ready to prepare to change them as needed, and regularly cleaning food stains off its mouth. A few mentioned the use of a waterproof bib on the JfA cat's neck, and creating artificial feeding stations. Some reviewers also commented that they purchased an additional robotic cat as a back-up device.

> *"It was purring a lot last night and I heard him telling the cat "shhhhh". I looked over and he's looking it in the eyes and shhhhing it. So I turned the cat off for a while" – Reviewer 722*

> *"I've got her (JfA cat) a collar and made her a tag and a feeding station (thank you hot glue and modge podge), so that he can care for her the way years of instinct and memories tell him he should" – Reviewer 167*

Overall, most reviewers (409/1327, 30.82%) reported positive experiences. This included comments about satisfaction, and comments that they would recommend this device to others.

> *"If you have someone in your life living with dementia or Alzheimer's, or something similar, please consider… this for that person. I haven't seen my grandmother that happy since before she became sick" – Reviewer 180*

Nevertheless, some reviewers (118/1327, 8.89%) shared negative experiences, which included comments about the technical aspects of its use. Experiences about the JfA cat's technical performance were mixed. While some reviewers shared that the technology was durable and lasted for over a year at the time of review (32/1327, 2.41%), others commented that it only lasted for a week to 8 months (48/1327, 3.62%). Others elaborated that the short lifespan of the device was sometimes attributed to users' behaviors, such as attempts to feed it or holding it too tightly, which hindered or damaged the device's mechanics. Such issues led to disappointment among some reviewers.

> *"Grandma holds it so tight that when the cat wants to put its paw up or roll on its back, she is preventing the movement. Now, it sounds like the motor has been damaged" – Reviewer 344*

> *"It's really sad that this cat did not last. My elderly mother is devastated…. Really, really, really disappointed" – Reviewer 207*

Some reviewers also raised concerns about difficulties cleaning the robotic cat and maintaining its cleanliness.

> *"Ours is showing wear around the cat's mouth as grandma keeps insisting on feeding it real food.... so I am cleaning it ALOT with dove soap, water and a washcloth" – Reviewer 265*

> *"It is difficult to clean Lucette's (name for the JfA cat) fur. Elderly people do tend to be like children and stroke their pets with sticky hands" – Reviewer 108*

Finally, some reviewers (51/1327, 3.84%) suggested how the JfA cat could be improved. These included improvements to its appearance, such as having more cushioning to make it softer to hold, having a more realistic “meowing” sound, and more interactive movements. Reviewers also commented that the device should be more durable and customizable, and suggested that volume controls or options to turn off the movement of the cat while keeping its sounds on should be made available.

Discussion

Principal Findings

This is the first study to use a novel web-based approach to explore the usability and impact of a low-cost robotic pet for older adults and people with dementia, based on perceptions and experiences of its use. Most of the review content was derived from consumer sites that were based in the United States, and most reviewers were family members of older adults and people with dementia. Overall, most reviewers had positive perceptions and experiences of using the JfA cat and found it to be beneficial and practical for older adults and people with dementia. Nevertheless, not all were satisfied with this technology.

Users’ previous experiences of pet ownership were frequently reported as a circumstantial reason for purchasing the JfA cat for the intended user. This finding aligns with previous findings that users’ like of animals influenced their acceptance of a robotic pet [43]. Therefore, it may be worth screening users’ likes and dislikes of animals as a predictor to gauge their acceptance of the robotic pets [44]. Reviewers also acknowledged that pragmatic deterrents, such as institutional regulations and a lack of capacity to care for a live animal, propelled them to seek robotic alternatives. This echoes the proposition that a recognition of the relative advantage of an innovation can facilitate its adoption [45].

Most perceptions about the JfA cat were positive, which suggests its design as a familiar animal was acceptable. In previous studies, familiarly designed robotic animals, such as the JustoCat and the NeCoRo cat, were also well received by older adults and people with dementia [46,47]. Likewise, other studies have highlighted preferences for familiarly designed pet robots [20,48,49]. These findings contrast with the notion that people are more likely to accept less familiarly designed robots because they would have fewer prior conceptions or expectations [50]. However, this hypothesis has not been widely evaluated, as few studies have investigated design preferences of older adults or people with dementia. Indeed, in most research studies, participants were typically given a single pet robot to engage with, which was selected based on the needs of the research rather than the preference of the participants. In line with a person-centered approach to care [51], older adults and people with dementia should be given the autonomy to choose their preferred robotic pet design. People with dementia, especially in the advanced disease stages, may not be able to articulate their preferences for pet design. However, they should still be given opportunities to participate in decisions relating to their care [52], to allow for the maintenance of self-identity, dignity [53], and personhood [54]. Moving forward, more considerations should be made to identify pet robot design preferences of individuals.

Use of the robotic cat offered older adults and people with dementia opportunities to participate in meaningful activities. Older adults and people with dementia participated in an array of activities with the JfA cat, such as talking to it and about it, cuddling, and stroking it. These findings resonate with results from studies which used other robotic pets [46,48,55,56], suggesting the potential of the JfA cat to elicit similar activities. Other activities identified included brushing the cat, sleeping with it, and taking it to places. Some reviewers supported these meaningful activities by getting a brush for users to brush the cat, and getting a cat bed and a personalized collar to allow for easier identification in care facilities. Such activities were not reported in previous studies and appeared to be unique to this study. This might be attributed to more opportunities for interaction with the cat over an extended period, made possible due to individuals owning their own robotic cat and not sharing it with others. Individual ownership may have provided users with the opportunity to take ownership of the robotic pet and be actively involved as care providers, in contrast to their traditional role as passive recipients of care [57]. Furthermore, the consistent and proximate presence of the JfA cat might have enabled such additional activities involving its use to be scaffolded naturally.

The relationship between engagement in meaningful activities and health outcomes has been established [58-62]. Similar to findings from previous studies [10-12,18], participating in activities with the JfA cat elicited positive emotions among users, and also provided comforting and calming effects. This is an important finding, because it highlights the potential of the JfA cat to elicit therapeutic benefits that are similar to costlier and more technologically sophisticated robotic pets. This raises an important question—In consideration of potential cost benefits, what degree of technological sophistication is required for a robotic pet to be therapeutic? Further research and randomized controlled trials should be conducted to evaluate and compare the effectiveness of low-cost robotic pets on the mental and social health of older adults and people with dementia, with other more technologically advanced robots.

The movements and vocalizations of the JfA cat appeared to be perceived positively by users as behaviors of reciprocity. Reciprocity, or the give and take that occurs between individuals, can influence the maintenance of social relationships [63,64]. This may explain why interactive robotic pets have been able to elicit more user engagement as compared with noninteractive or plush alternatives [65,66]. Interestingly, the lack of predictable responses to touch and movement was interpreted by some users as resemblant of a live cat's behavior, and was well received. Nevertheless, the JfA cat's interactive features also resulted in some negative impacts, particularly among those who perceived it as a live animal. When the robotic cat ran out of batteries, some users exhibited emotional distress as they perceived it to be dead. The meowing sounds worried or caused annoyance to some users, who sometimes perceived the robotic cat to have unmet needs. Similar issues have also been raised previously in relation to other robotic pets [13,48,67,68]. Furthermore, some users became concerned that the cat was not eating and attempted to feed it. These issues may be due to individual ownership of the robotic cat, where perceived responsibility for pet care may place a burden on people with cognitive impairment [69]. In such instances, reviewers provided mediation and support. This suggests that unattended, prolonged interactions with the robotic pet may have the potential to cause negative impacts. In turn, this raises the question as to what amount of robot–human interactions, especially for people with cognitive impairments, should be conducted completely without the support of caregivers. Findings from this study suggest some degree of facilitation and mediation by caregivers may still be necessary.

The JfA cat also positively impacted caregivers, providing them with a sense of relief and positive emotions, which included feelings of happiness and contentment. There is currently a lack of research that has focused on how robotic pets impact caregivers. More research is needed to increase understanding, especially since one of the key premises for developing social robots is to supplement and support the care of older people with dementia [66].

Finally, despite the overall positive perceptions and experiences, some reviewers reported negative opinions about the cat's design. This included comments about its "hardness" and lack of sophistication, such as audible mechanics during movements and unrealistic “meowing” sounds. These issues did not appear to influence most users’ interaction with the robotic cat, suggesting that reviewers may have a higher expectation than the end users in wanting the robotic cat to behave more realistically and autonomously. Nevertheless, these issues resulted in the rejection of this technology by a minority of users. Comments about the robustness of the technology were mixed, with some reviewers being dissatisfied with its durability. Some elaborated that users’ handling of the JfA cat, such as holding it too tightly or dropping it, affected its functioning. The relatively short longevity of the device has potential to cause negative impacts such as emotional distress, especially among users who have developed an attachment toward it [70]. The understanding of such issues are useful to inform future robot development to ensure technological robustness [18].

Limitations

Despite the valuable new knowledge that was generated through this study, there are limitations that should be acknowledged. Data that were used for this study were self-reported information that was gathered through publicly available sources. The anonymity of users makes it difficult to verify the authenticity of the content, and to verify the ages and diagnoses of the users of the robotic cat. Most reviewers were family members, and as such, their perceptions and experiences might differ from actual opinions of the primary end user (ie, older adults or people with dementia). Although most included reviews were shown as verified purchases, it is not possible to confirm the authenticity of review or distinguish potentially deceptive reviews. There could also be a bias in terms of the representation of data, as not all consumers will upload their reviews on consumer websites. Nevertheless, given the analysis of the large number of reviews from multiple websites across a 5-year period, as well as the richness of the data contained in these reviews, it may be reasonable to infer that the findings from this study represent real-world perceptions and experiences of using the JfA cat for older adults and people with dementia.

Conclusion

This study provides important knowledge about the usability and impact of a low-cost robotic pet for older adults and people with dementia based on perceptions and experiences of its use. It analyzed user-driven content to access a unique perspective toward an understanding of this phenomenon. We found that circumstantial reasons, such as inability to care for a pet, have prompted the use of the robotic cat, and that familiarly designed robotic pets can be accepted by older adults and people with dementia. Although the JfA cat is less technologically advanced than other robotic pets, its interactive features were generally well received. Use of the JfA cat facilitated participation in meaningful occupations, as it provided older adults and people with dementia opportunities to participate in various activities. These activities elicited positive psychosocial impacts on both users and caregivers. Nevertheless, facilitation by caregivers may be necessary to monitor for and mitigate potential negative impacts. Although perceptions and experiences were mainly positive, negative aspects of the JfA cat’s design and interactivity were raised. Experiences of its durability were also mixed, which highlights the need to improve the technical robustness of this device.

These insights are vital in helping researchers, robot developers, and clinicians to understand the viability of using low-cost robotic pets to benefit older adults and people with dementia. Future research should consider evaluating design preferences for nonfamiliarly versus familiarly designed robotic pets. It will also be valuable to conduct a randomized controlled trial to compare the impacts of low-cost robotic pets with other more technologically advanced robotic pets, to understand any similarities or differences of their impacts on the mental and social health of older adults and people with dementia. A process evaluation may also be conducted to identify factors that may explain any outcome variations. This has the potential to influence equal access to technology if their impacts on the psychosocial health of users are comparable.

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Authors' Contribution

WQK conceptualized the research, developed the review questions and review design, and collected the data. WQK, SW, and PH coded and analyzed the data. Preliminary results were discussed with RMD. WQK initiated the first draft of the manuscript. All authors read the draft and provided critical feedback. All authors approved the final version of the manuscript.

Conflict of Interest

None declared.

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Chapter Summary

This paper evaluated user-generated data on consumer websites to explore the usability and impact of a low-cost pet robot (JfA cat), based on reviewers' experiences and perceptions of its use with older adults and PLWD. A total of 1,327 reviews meeting the pre-defined inclusion criteria were included in the qualitative content analysis. Most were family members who described their use with older people and PLWD. First, reviewers described situations such as institutionalisation and concerns about social isolation, which led reviewers to purchase the pet robot to support the psychosocial well-being of older people and PLWD. Second, while many reviewers had positive perceptions of the robotic pet's features, some dissented their appearance and interactivity. Third, using the pet robot provided older adults and PLWD with the opportunity to engage in a range of activities. Some regarded it as a live animal, or experienced anxiety or distress during the care of the pet robot. Next, most reviewers described positive psychosocial impacts on older adults and PLWD and the ripple effect on their caregivers and others. Finally, the practical aspects of using the pet robot, such as facilitation, durability and hygiene, were described.

Overall, these findings add to the evidence from Chapter 2, suggesting that low-cost pet robots have the potential to improve the psychosocial health of older adults and PLWD. Similar to previous research, this study found that not all older adults and PLWD benefitted from pet robots and some experienced distress as a result of pet robot interactions.

Chapter 4: Barriers and facilitators to the implementation of social robots for older adults and people with dementia: A scoping review protocol

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Prologue

This chapter presents paper four, a protocol which outlines the methodology that was established a priori to guide the conduct of a scoping review which examined the barriers and facilitators to the implementation of social robots for older adults and people living with dementia. The prospective specification allows the review methods to be critically appraised by independent peer reviewers before the review is conducted and reduces bias when undertaking the review.

Chapter 4: Barriers and facilitators to the implementation of social robots for older adults and people with dementia: A scoping review protocol (Paper 3)

Abstract

Background: Psychosocial health issues such as depression and social isolation are an important cause of morbidity and premature mortality for older adults and people with dementia. Social robots are promising technological innovations to deliver effective psychosocial interventions to promote psychosocial wellbeing. Studies have reported positive findings regarding this technology on the psychosocial health of older adults and people with dementia. However, despite positive findings of the effects of social robots for older adults and people with dementia, little is known about factors affecting their implementation in practice.

Methods: This study follows Arksey and O'Malley's approach and methodological enhancement by Levac et al (2010). Relevant articles will be identified by searching electronic databases: MEDLINE, EMBASE, PsycINFO, Scopus, Web of Science, Compendex and PubMed. A two-phase screening process will be undertaken by two independent reviewers to determine articles' inclusion. Findings will be summarized and reported thematically based on domains in the Consolidated Framework of Implementation Research (CFIR) and presented narratively. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR) will guide the reporting of findings.

Discussion: Reporting the protocol in advance of conducting the review will ensure a rigorous and transparent methodological approach is undertaken. The outcomes of the review include identifying variants in terminologies used to describe implementation, identifying the scope of the literature regarding the barriers and facilitators affecting the implementation of social robots, and identify research gaps to guide further empirical research in this field. This evidence synthesis constitutes part of a bigger project aimed to develop implementation guidelines for social robotics for older adults with dementia. Since the methodological process consists of reviewing and collecting data from publicly available data, this study does not require approval from a research ethics board.

Scoping Review Registration: Our protocol is registered with the Open Science Framework (https://osf.io/2x3y9/) as an open access article, under the Creative Commons Attribution Non Commercial (CC BY-NC-4.0) license, which allows others to distribute, remix, adapt and build on this work on a non-commercial basis, and license their derivative work using different terms, on the basis that the original basis is properly cited and the use is non-commercial (http://creativecommons.org/licenses/by-nc/4.0/).

Background

Psychosocial health issues among older adults, such as depression and social isolation are an important cause of morbidity and premature mortality for older adults(1, 2). In particular, older adults with dementia are at a higher risk of developing these issues(3). Even though people with dementia may want to remain socially connected and be involved in activities that are personally meaningful(4), disease related impairments such as impaired cognition and emotional control can reduce their capacities and confidence. The stigma surrounding dementia and age discrimination amplifies the isolating effects of disease related impairments and can have disempowering, dehumanizing and marginalizing effects on people with dementia(5). Consequently, they are predisposed to heightened risk of depression and a further decline in cognition and function(6). As the world's population is ageing rapidly, these issues are expected to be amplified. It is therefore important to look into effective interventions to promote psychosocial wellbeing of older adults, including people with dementia. Technological innovations have been viewed as solutions to deliver effective psychosocial interventions(7), and one such example would be the use of social robots. Social robots are defined as 'useful robots with social intelligence and skills to allow interaction with people in a socially acceptable manner(8). According to Góngora and colleagues(9), there are four classifications of social robots: pet robots, humanoid robots, telepresence robots and socially assistive robots.

The effectiveness of social robots on the psychosocial health of older adults has been evaluated in the literature. A recent systematic review of 11 randomised controlled studies, of which 80% of the 1042 participants had dementia or mild cognitive impairment, was conducted by Pu et al(10). Social robots were found to improve social engagement between participants and staff, and positively affect physiological indicators of participants through improved sleep, improved oxygenation and improved cardiac status, as well as reduced use of psychotropic drugs for people with severe dementia. Likewise, a scoping review was conducted to map the key benefits of PARO, a robotic seal, for older people with dementia in care settings based on 29 included studies(11). The findings were congruent to the findings from the systematic review. The first benefit was reduced negative emotions and behavioural symptoms in people with dementia, which includes decreased agitation, less use of psychotropic medications, reduction in wandering behaviour, reduced staff stress and caregiver burn out. Secondly, it helped to improve mood, as caregivers highlighted that users had brighter facial expressions, improved quality of sleep and reduced use of pain medication. Thirdly, it helped to improve visual and verbal social engagement, and was used to facilitate conversations between care home residents and staff. The findings from both reviews elucidate evidence on positive trends on the effects of social robots on the psychosocial health of older adults, including people with dementia.

After the effectiveness of interventions have been evaluated, the next phase is to examine their implementation in a real-world setting(12), where conditions for implementing an intervention differ from a research setting. Contexts for research (i.e. clinical) trials are dependent on research supported resources, have specified timeframe, and are transient in nature since interventions are usually discontinued after a trial ends(13). In contrast, factors that influence implementation in real-world practice, such as competing demands on the care provider, may not be reflected in a research trial(14). Despite positive findings with regards to the effects of social robots for older adults, little is known about how to ensure that these interventions are implemented in practice. Papadopoulos and colleagues conducted a systematic review of twelve articles to identify enablers and barriers to the implementation of socially assistive humanoid robots (SAHR) in health and social care(15). The authors found that facilitators include participants' enjoyment, intuitiveness and ease of use of the SAHR, personalisation of SAHR services to users' needs, as well as familiarity towards the SAHR. On the other hand, barriers to implementation were limited capabilities of the robot, as well as negative preconceptions about stigma and dehumanisation of care. The authors reported these determinants were identified through single articles due to heterogeneity in study designs, therefore their findings may not be generalisable. It is also worth noting that the construct of 'implementation' was not included in the search strategy. Instead, a broader and less specific construct relating to the 'context of implementation' (i.e. health and social settings) was used. This may have limited the specificity of searches, and some pertinent studies might have been missed out. Furthermore, the term 'implementation' was not included in the titles or abstracts of any of the included articles. Rather, terms such as 'service evaluation', 'usability', 'social acceptance', 'acceptability', and 'feasibility' were used. This suggests variations in terminologies used to describe implementation in existing studies.

Rationale

The recent systematic review by Papadopoulos et al (15) has provided important insights relating to the implementation of SAHRs. Our review differs in that it encompasses a broader scope to allow inquiry into the implementation of all variants of social robots. Given the variations in terminologies that has been used to describe implementation, this broader scope of evidence synthesis is necessary to establish the breadth of evidence base and to identify knowledge lapses in this field. In addition, our review places a greater focus on the conceptual aspects of implementation. This will be reflected through our search strategy and the use of the Consolidated Framework of Implementation Research (CFIR) to frame our findings. A scoping review is an ideal method for evidence synthesis to meet these goals, since it allows for broad exploration of literature(16, 17). Moving forward, the findings from this review would facilitate a better understanding of factors that are affecting the implementation of social robots for older adults in real-world practice, and to identify research gaps.

Objectives

The aim of this review is to facilitate a better understanding of factors that are affecting the implementation of social robots for older adults and people with dementia in real-world practice. The research questions for this review are as follows:

1. What are the terminologies that have been used to describe implementation in relation to social robots?
2. What are the barriers and facilitators affecting the implementation of social robots for older adults, including people with dementia?

Methods

Conceptual framework

According to Nilsen (2015), implementation is a multidimensional phenomenon, where implementation barriers and facilitators can be influenced by an interplay of multi-level factors ranging from individual to organisational factors(18). The Consolidated Framework for Implementation Research (CFIR) is a determinant framework in implementation science that was developed to guide the systematic assessment of multi-level contexts to identify determinants (i.e. factors) that can influence intervention implementation(19). The constructs in CFIR are derived from the synthesis of theories on dissemination, innovation, organisational change, implementation, knowledge translation and research uptake, and have received consensus from experts in this field(19). It comprises of 39 constructs grouped within five major domains - intervention, outer setting, inner setting, characteristics of individuals and implementation process - all of which interact to influence intervention implementation and implementation effectiveness. This framework has been previously applied to wide ranging fields of study, including eHealth technology(20), and provides a comprehensive approach to the investigation on barriers and facilitators that can affect implementation. Therefore, results of the extracted articles will be synthesized and integrated using the CFIR. Use of this framework will allow barriers and facilitators affecting implementation of interventions to be identified and presented in a structured manner. It will also enable findings from this review to be more readily comparable to other implementation studies and allow gaps in research to be identified.

Protocol Development

This study follows the Arksey and O'Malley's (2005) framework for scoping reviews along with methodological enhancement by Levac et al (2010). The five stages within this framework are 1) identifying the research question, 2) identifying relevant studies, 3) selecting studies, 4) charting the data, and 5) collating, summarising and reporting the results. The study protocol was registered with the Open Science Framework on 16 May 2020 (https://osf.io/2x3y9/), under the Creative Commons Attribution Non Commercial (CC BY-NC-4.0) license. This means that others may distribute, remix, adapt and build on this work on a non-commercial basis, and license their derivative work using different terms, on the basis that the original basis is properly cited and the use is non-commercial (http://creativecommons.org/licenses/by-nc/4.0/). The structure and content of this protocol follows the Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) checklist (21) (Appendix 8). The Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-P) was not used as many items in the checklist are not applicable to a scoping review.

Stage 1: Identifying the research question

The main research question is defined as: "What are the barriers and facilitators that affect the implementation of social robots for older adults, including people with dementia?". To allow for a broad exploration of research that has been conducted in this field, no limits will be applied to the context of implementation (i.e., study settings).

Stage 2: Identifying relevant studies

Search strategy

Relevant published studies or literature will be identified by searching the following electronic databases and search systems: MEDLINE via Ovid, EMBASE via Ovid, PsycINFO via Ovid, Web of Science Core Collection (via Web of Science), Scopus, Compendex and PubMed. Reference lists of selected studies will be hand searched to ensure that any additional literature that may be of relevance will be identified. To ensure that all relevant information is captured, grey literature sources (E.g.: Web of Science Conference Proceedings, Google Scholar) will also be searched to identify studies, reports and conference abstracts of relevance. Several terminologies have been used across the literature to describe the term or concept of implementation(22). Therefore, to improve the specificity of searches (23), the taxonomy of implementation outcomes that was developed by Procter and colleagues(24) will be used to guide the systematic search for articles relating to implementation. This taxonomy consists of eight constructs, which includes: acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration and sustainability. Some of these concepts have been used in studies to describe implementation of SAHRs(15). Therefore, use of these concepts as part of the search strategy will likely yield relevant results and ensure thoroughness of the searches. The concepts in the taxonomy are to guide the literature search strategy, so that the search and selection of articles may be consistent, broad and unbiased. To improve the sensitivity of searches(23), the search strategy will not include terms such as 'facilitators and barriers', 'factors' or 'determinants, because the authors anticipated that such terms are often not mentioned in the title and/or abstract. Instead, barriers and facilitators to implementation may only be discussed in the body of the text. Hence, this information will only be assessed through reading the full texts at a later phase of screening to ensure that no potentially relevant articles are omitted. This will enable a more thorough overview of all research that implemented social robots for older people and people with dementia. These search strategies were developed in consultation with a research librarian to optimise the specificity and sensitivity of the searches, who will also provide support throughout the search process. No forward citation tracing will be conducted; however, the reference list of relevant reviews and included studies will be hand searched to identify other potentially relevant studies. A sample search strategy that has been developed in consultation with a research librarian can be found in Appendix 9.

Stage 3: Study selection

The titles and abstracts resulting from the search strategy focused on the barriers and/or facilitators that affect the implementation of social robots will be included for review. Articles will be imported into EndNote and be deduplicated. To determine eligibility, a two-phase screening process will be undertaken by two independent reviewers. Firstly, titles and abstracts of identified articles will be screened for eligibility by each reviewer as per the following inclusion criteria: (1) use of social robot(s) as an intervention, (2) involve older adults and/or people with dementia, (3) published in English language, and (4) provide information regarding factors affecting the implementation of social robots, based on any of the constructs listed in the taxonomy of implementation outcomes. This approach of evidence selection reduces the potential for evidence selection bias(25). All types of empirical research studies encompassing any types of methods and study designs will be included. No search limits will be applied to the year of publication, and all publications will be searched from inception. Correspondingly, (1) non-empirical studies such as review articles, commentaries or expert opinions, (2) studies that do not involve older adults and/or people with dementia, (3) published in non-English language and (4) do not contain any terms relating to implementation, will be excluded. Next, the full texts of relevant papers will be screened. At the end of each screening process, the reviewers will compare their decisions. Any non-consensus or ambiguity regarding eligibility for inclusion will be discussed and resolved among both reviewers and with a third independent reviewer if necessary.

Stage 4: Charting the data

A standardised charting sheet will be developed using Microsoft Excel to allow reviewers to chart the data to confirm the studies' relevance and to extract their characteristics. Charting refers to the technique of sifting, mapping out and sorting of materials based on their key characteristics(26). Study characteristics to be extracted will include information such as authors' name, year of publication, study design, country, participants' demographics, study setting, construct or term used to describe implementation, key relevant results relating to the aim of the research question (i.e. barriers and facilitators affecting implementation). This charting sheet will be reviewed and pre-tested by both reviewers to ensure consistency in data extraction and that all the necessary information is captured from each study. Each reviewer will then independently extract data from the included studies, and comparisons will be made afterwards. Any incongruence will be discussed and resolved among both reviewers and with a third independent reviewer if necessary. Finally, the data will be combined into a single Microsoft Excel spreadsheet.

Stage 5: Collating, summarising and reporting the result

In this stage, findings will be collated, summarized and reported. First, terms that were used to describe implementation will be mapped onto Proctor's taxonomy of implementation outcomes. Terms that are not described in the taxonomy will be identified as independent terms. The frequency in which these terms were used will be presented. Next, the types of social robots used will be categorised into three operational groups based on their functions: (1) socially assistive robots, (2) pet robots, and (3) telepresence robots (Appendix 10). Next, to synthesise the extracted data on barriers and facilitators, directed content analysis (27) will be applied deductively using the CFIR (28, 29). Based on the extracted data, data synthesis will be conducted separately for older adults and people with dementia. Barriers and facilitators will be mapped onto one of the 39 constructs in the CFIR, based on a pre-established codebook of definitions that has been adapted to fit this study (Appendix 11). Although a deductive approach to analysis is planned, open (inductive) coding may be applied to barriers and facilitators do not fit any of the existing CFIR constructs to generate new constructs and categories. This synthesis will be verified by a second reviewer. Any disagreements will be discussed and resolved among both reviewers and with a third reviewer, as necessary. All data will be organised thematically according to the five domains in the CFIR to map and present implementation barriers and facilitators in a structured manner. This will show areas that have been under researched and may require further investigation. The findings of the study will then be presented narratively (30, 31), using the PRISMA-ScR checklist (21). Gaps in literature will be discussed, and areas for further research will be identified. A PRISMA flow chart will be used to present the methodological process in detail.

Discussion

The advance reporting of the scoping review protocol can ensure a rigorous and transparent methodological and conceptual approach (32). This study will be the first scoping review to conduct a broad exploration of the literature to systematically identify barriers and facilitators affecting the implementation of all variants of social robots for older adults, including people with dementia, using a conceptual framework. The findings from this scoping review will help to identify the scope of the literature regarding the barriers and facilitators in relation to the implementation of social robots, for older adults, including people with dementia, provide synthesised findings of the results, discuss the implementation terminology used in the literature and identify research gaps to guide further empirical research in this field. This evidence synthesis constitutes part of a bigger project aimed to develop implementation guidelines for social robotics for older adults with dementia.

Even though this review will follow a rigorous method, we anticipate limitations to this review. Firstly, since only publications in English are included, the comprehensiveness of the findings in this review may be limited. Secondly, since this is a scoping review, quality assessment and grading of included studies will not be conducted. Hence, it cannot determine whether the included studies provide robust and generalisable findings.

Declarations

Ethics Approval and Consent to Participate

Since the methodological process consists of reviewing and collecting data from publicly available materials, this study does not require approval from a research ethics board.

Consent for publication

Not applicable

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Competing Interests

The authors report no competing interests.

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Authors' contributions

WQK conceptualised the review approach, developed the review questions and the review design, and initiated the first draft of this manuscript. SAF contributed to the development of the research question, SAF, ET and DC and had meaningful contributions to the drafting and editing of the manuscript.

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Chapter Summary

This chapter described the protocol for the scoping review in chapter 5 (paper four) to explore the barriers and facilitators to the implementation of social robots for older adults and PLWD. This protocol was developed based on guidelines outlined by Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) and was registered on the Open Science Framework on 23 May 2020 (https://osf.io/2x3y9/).

Chapter 5: Barriers and facilitators to the implementation of social robots for older adults and people with dementia: A scoping review

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Prologue

This chapter presents paper four, a scoping review which systematically examined and synthesised research evidence to explore the barriers and facilitators affecting the implementation of social robots for older people, including PLWD. The Consolidated Framework of Implementation Research, an implementation determinant framework, was used to guide evidence synthesis to ensure a comprehensive investigation of the barriers and facilitators that occur at different levels.

Abstract
Background

Psychosocial issues, such as social isolation and loneliness among older adults and people with dementia, continue to pose challenges with a rapidly aging population worldwide. Social robots are a rapidly emerging field of technology, developed to help address the psychosocial needs of this population. Although studies have reported positive findings regarding their psychosocial benefits, their implementation in real-world practice remains a challenge. Nevertheless, little is known about the factors affecting their implementation. The purpose of this review is to provide a systematic overview of the barriers and facilitators affecting the implementation of social robots for older adults and people with dementia.

Method

The Arksey and O'Malley approach with methodological enhancement by Levac et al (2010) was used to guide the conduct of this review. Seven electronic databases were searched. In addition, hand searching and backward citation tracing was conducted. Three independent reviewers were involved in the screening and data charting process. Findings were synthesised and categorised into the five domains outlined in the Consolidated Framework of Implementation Research (CFIR).

Results

A total of 53 studies were included in the final review. Most of the included studies were based in participants' homes and in care facilities. Barriers and facilitators were mapped onto 18 constructs in the five domains of the CFIR. The most frequently cited barriers were mapped to the constructs within the domain of "Intervention characteristics", where issues such as the complexity of using the technology and technical obstacles impeded implementation. Most facilitators were mapped onto the domain "Patient needs and resources". Overall, existing research are disproportionately focused on the internal validity (i.e. characteristics) of social robots, and there is significantly less research investigating their external validity, such as organisational or wider contextual factors that can affect their implementation in real-world practice.

Conclusion

This review has identified and synthesised the breadth of evidence on the barriers and facilitators to the implementation of social robots for older adults and people with dementia. Future research should pay more attention to investigating the contextual factors, using an implementation framework, to identify barriers and facilitators to guide the implementation of social robots.

Keywords: social robots, implementation, barriers, facilitators, scoping review, consolidated framework for implementation research, dementia, older people

Introduction

Populations are aging worldwide (1). It is estimated that 5 – 8% of the world's older population live with dementia (2). Since the prevalence of dementia increases with age (3), it is one of the biggest challenges of a rapidly aging population. Previous research has identified several psychosocial challenges associated with aging and onset of dementia including social isolation, loneliness and a loss of autonomy (4, 5). These challenges have continued to place constraints on healthcare costs and caregiving demands (6), which can influence the sustainability of care. Social robots are a rapidly emerging field of technology to facilitate social networks between people, and to interact with people in a meaningful way (7-9). They provide a multitude of services such as affective therapy, cognitive training and companionship (10) and may be categorised into three operational groups based on their functions: (i) socially assistive robots, (ii) pet robots (or robopets), and (iii) telepresence robots. Socially assistive robots have several functions to assist users with tasks (11), pet robots are intended as viable substitutes to live animals (12) and function as pet therapy to provide physiological and emotional benefits for users (13). Finally, telepresence robots contain a video conferencing system mounted on a mobile robotic base, and have a primary function to provide social interaction between humans (14). As such, social robots are considered as a promising technological solution to mitigate some of the challenges associated with rapidly ageing populations by supporting psychosocial needs and assisting with care. A growing body of research focused on developing and evaluating social robots for older people and people with dementia reflects this interest. Their impact and effectiveness have been investigated and synthesized in several reviews (13, 15-17).

Although the overall evidence is not definitive due to insufficient of high-quality studies and smaller sample sizes, synthesised evidence has repeatedly demonstrated strong face validity of their positive impacts in several psychosocial domains, including reduced loneliness, improved social engagement, mood and quality of life (13, 15-17). Despite their promise to positively impact the psychosocial health of older adults and people with dementia, their implementation in real-practice remains a challenge (18, 19). For example, while 80% of nursing homes in Denmark have implemented Paro, a pet robot (20), only one dementia care facility has implemented Paro in Ireland (21). For social robots, the challenges to implementation may be attributed to multi-level factors affecting implementation in actual practice, such as competing demands on the care provider (15), that may not be present or investigated in a research trial due to existence of research supported resources (22). Additionally, the traditional stepwise approach of research (i.e. investigating implementation only after confirmatory findings of efficacy and effectiveness) has been argued to contribute to the time lag between research discovery and their uptake in real practice (23-25). To improve the speed of knowledge creation and to improve the clinical relevance of social robots in real-world practice, it is important to pursue knowledge on the implementation of social robots alongside investigation into their effectiveness (26, 27). Nevertheless, little is known about factors affecting their implementation in practice. A scoping review conducted by Hung et al (15) found that infection concerns, cost and work load, stigma and ethical issues were key barriers that influenced the adoption of Paro in care settings. In another recent systematic review, Papadopoulos et al (28) found that facilitators supporting the implementation of socially assistive robots in health and social care settings include the social robots' usability and personalisation, users' enjoyment and familiarity with the technology, while barriers relate to technical issues, limited capabilities of the robots, and users' negative preconceptions. In both two reviews, an implementation framework was not used to guide the search and evidence syntheses, which highlights the possibility that some factors affecting implementation may have been overlooked. Furthermore, there is a variety of terminologies that have been used to describe implementation, which can pose challenges in evidence synthesis (29). For instance, the term 'implementation' was not used in Papadopoulos et al's (28) search strategy; instead, other terms such as 'service evaluation' and 'acceptability' were used. This issue of terminology variation has also been articulated in another review investigating determinants of implementing e-Health for caregivers of people with dementia, where authors reported that only one out of 46 included articles used the term "implementation" in the title of their publications (30). There has been no other previous research that has provided a broad overview of the available evidence in this field. Therefore, the objectives of this review were to 1) identify the terminologies that have been used to describe implementation in relation to social robots, and 2) broadly examine existing evidence on barriers and facilitators affecting the implementation of social robots for older adults and people with dementia, and to collate and map the types of available evidence to identify potential research gaps. To address these objectives, a scoping review methodology was identified to be the most appropriate (31).

Conceptual framework

The Consolidated Framework for Implementation Research (CFIR) was developed by Damschroder and colleagues, based on the integration of 19 different implementation theories, to enable a systematic exploration of multi-level contextual factors that can influence the implementation of an innovation or intervention (32). There are 39 constructs across the five key domains in the CFIR that are reported to influence implementation:

1. Intervention characteristics, which refers to the key attributes of the intervention
2. Outer setting, which refers to external influences on implementation
3. Inner setting, which refers to features of the implementing organisation
4. Characteristics of individuals involved in implementation
5. Implementation process, which refers to the strategies employed in implementation

The CFIR provides a comprehensive approach to the investigation of multi-level barriers and facilitators that can influence implementation. Therefore, employing this framework will enable the identified barriers and facilitators to be presented in a structured and systematic manner. It will also allow findings to be easily compared to other implementation studies to identify research gaps.

Methods

Protocol and registration

The Arksey and O'Malley framework (31) for scoping reviews with methodological enhancements by Levac et al (33), and the Preferred Reporting Items for Systematic Reviews and Meta-analysis Extension for Scoping Reviews (PRSIMA-ScR) (34) (Appendix 12) was used to guide the development, conduct and reporting of this review. The protocol was registered on the Open Science Framework (https://osf.io/2x3y9/), and the methods were described in detail in a published protocol (35).

Stage 1: Research question

The main research question governing this review was: "what is the existing evidence on the barriers and facilitators that affect the implementation of social robots for older people, including people with dementia?"

Stage 2: Identifying relevant studies

A total of seven electronic databases were searched in May 2020, and updated in November 2020: MEDLINE via Ovid, EMBASE, PsycINFO via Ovid, Scopus, Web of Science, Compendex and PubMed. A search strategy was developed in consultation with an expert research librarian using the key terms "older adults", "people with dementia", "social robots" and "implementation". Various terminologies have been used across the literature to describe the concept of implementation. Therefore, we drew on an existing taxonomy of implementation outcomes by Proctor et al (36) to define the constructs of interest and implementation search terms in this review. They include acceptability, adoption, appropriateness, costs, feasibility, fidelity, penetration and sustainability. A full search strategy for Medline is provided in Appendix 13. We anticipated that the terms "barriers" and "facilitators" may only be discussed in the full-text of articles, potentially described using other terms. As such, these terms were excluded from the search strategy to enable a more thorough search of all research in the field. Consequently, this information was assessed through reading the full texts at a later phase of screening to ensure that no potentially relevant articles were omitted. To identify other potentially relevant studies, the reference list of reviews that were excluded from this study were manually searched to identify other potentially relevant studies (Horsley et al, 2011).

Stage 3: Selection of studies

All search records were imported into Endnote and deduplicated for screening. A two-phased screening process was undertaken by three reviewers (WK, SF, BB). WK screened all articles, while SF and BB each conducted screening of 50% of all articles independently in each phase. All reviewers met to discuss the results and conflicts after each stage of screening. Firstly, titles and abstracts resulting from the search strategy were selected if they met the following inclusion criteria: (i) used a social robot for more than one session, (ii) involve older adults and/or people with dementia, (iii) contains any terms relevant to any constructs related to implementation, based on Proctor's taxonomy, (iv) published in English language and (v) contains information about barriers and facilitators that influenced implementation. Correspondingly, the exclusion criteria were: (i) non-interventional papers, such as review articles or guidelines, (ii) did not use a social robot, or only used the social robot for a single session, (iii) did not contain any terms relating to implementation and (iv) non-English language publications. Next, full text of relevant papers were then assessed for eligibility for inclusion using the same criteria.

Stage 4: Data charting

A standardised charting form was developed using Microsoft Excel to identify key characteristics of each study, as well as barriers and facilitators to the implementation of social robots. Data that were charted included: authors, publication year, country in which the study was conducted, aims and objectives, study design, study setting, name and type social robot used, intervention characteristics, and barriers and facilitators that influenced implementation. Terms that were used to describe implementation in relation to social robots were charted from the title and abstract of studies. The charting sheet was pre-tested by all reviewers to ensure consistency in data extraction. Three reviewers were involved in data charting – WK independently charted all included articles, while SF and BB each charted 50% of the included articles. All reviewers consulted after the data charting to resolve any inconsistencies.

Stage 5: Collating, summarising, and reporting the results

WK deductively coded the extracted data by mapping determinants (i.e. barriers or facilitators) onto the 39 constructs in CFIR (Additional File 3). Coded data that were mapped onto each construct were listed and presented in a tabular form and grouped into subcategories. The synthesised results were then organised and presented categorically, based on the five domains in the CFIR. Terms used to describe implementation were mapped onto Proctor's taxonomy of implementation outcomes, and those that are not described in the taxonomy were identified as independent terms. The frequency in which these terms were used were presented.

Results

The search of databases yielded a total of 1065 publications and an additional 51 from hand searching. After title/abstract screening, 138 articles remained for full-text screening. A total of 85 publications were excluded after full-text screening (details provided in Appendix 14), and 53 publications that met the eligibility criteria were included in the final review (PRISMA flowchart in Figure 1). Of these, 18 were published conference papers, and 35 were journal publications.

Study Characteristics

The included publications employed three types of research methods: 15 quantitative (n=15), 19 qualitative (n=19) and 19 mixed-method or multi-method (n=19). Studies were conducted in 19 different countries. Most were conducted within 13 countries in Europe (n=37), including Austria, Belgium, Denmark, Finland, France, Greece, Germany, Hungary, Ireland, Italy, the Netherlands, Sweden, and Poland. Others were conducted in Australia (n=9), the United Kingdom (n=7), the United States (n=5), New Zealand (n=3), Japan (n=2) and Mexico (n=1). The majority were conducted in participants' homes (n=26) and long-term care facilities (n=23). Most studies involved older adults (n=31), and people with mild cognitive impairment or dementia (n=24). Some studies also included other stakeholders such as care professionals or management staff (n=16) and family members (n=12). Table 1 shows a summary of the characteristics of included studies.

Figure 1: PRISMA Flow Diagram

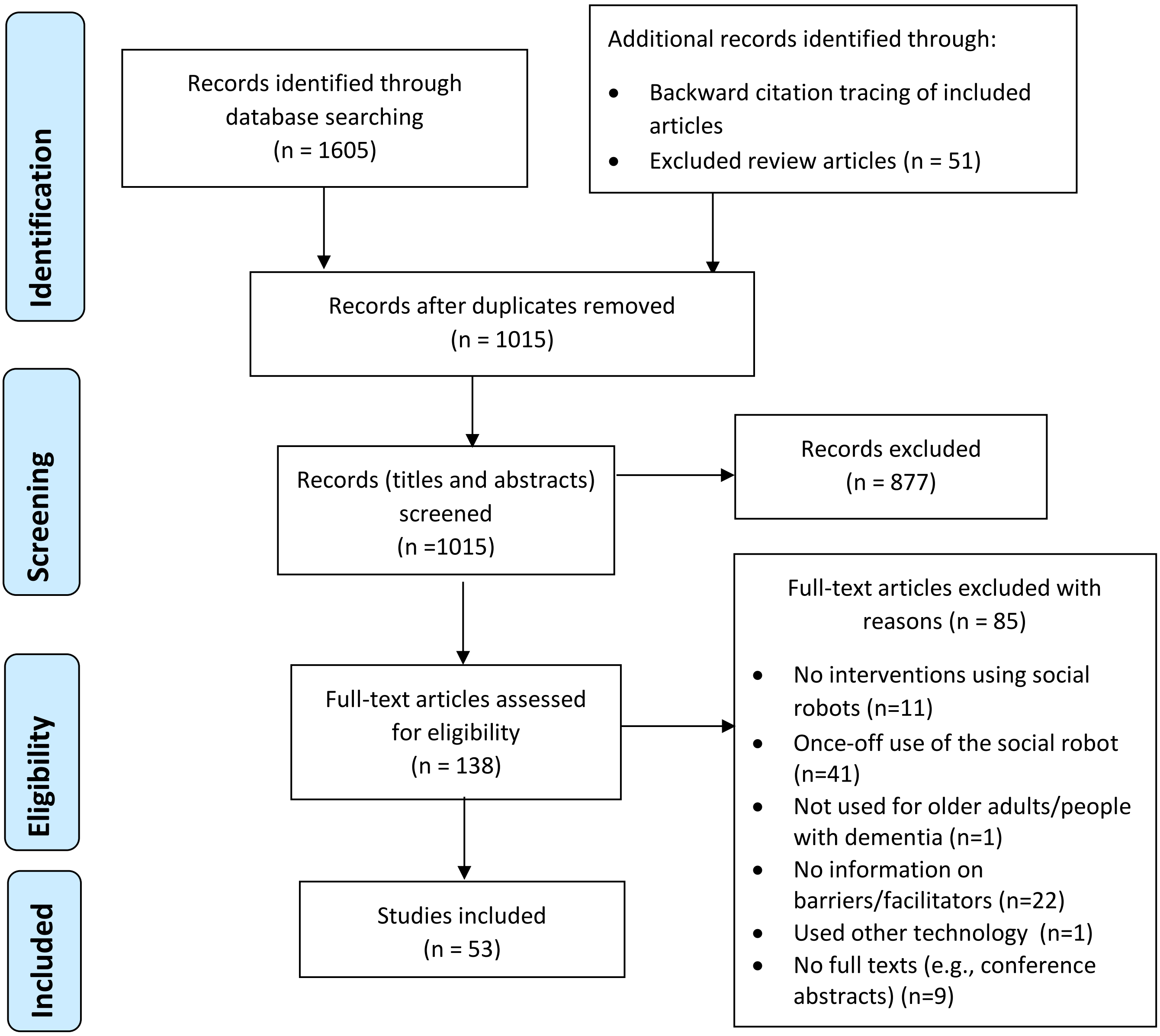

Table 1: Characteristics of included studies

Author	Country	Publication type	Methodology	Study design	Study participants	Study setting
Aaltonen et al, 2017	Finland	Conference paper	Qualitative	Qualitative interviews, observations	Older person, care staff, family members	Participants' homes
Bajones et al, 2018	Austria, Greece, Sweden	Journal paper	Multi-method	Field trial	Older people (living alone, fallen in the last 2 years, and impairments in mobility,	Participants' homes
Bajones et al, 2019	Austria, Greece, Sweden	Journal paper	Multi-method	Field trial	Older people (living alone)	Participants' homes
Barrett et al, 2019	Ireland	Journal paper	Quantitative	Single group, pre-post pilot study	People with dementia	Nursing home
Bemelmens et al, 2016	Netherlands	Journal paper	Multi-method	Feasibility study	People with dementia, care staff, family members	Care institution for psychogeriatric care
Blond, 2019	Denmark, Finland	Journal paper	Qualitative	Ethnographic study	Older adults, care staff, management staff	Elderly care center
Bradwell et al, 2020	UK	Conference paper	Qualitative	Longitudinal study	Older people	Supported living facility
Broadbent et al, 2014	New Zealand	Conference paper	Quantitative	Repeated measures randomised cross-over trial	Older people	Participants' homes
Caleb-Solly et al, 2018	UK, Netherlands	Journal paper	Quantitative	Usability and user experience evaluation	Older people	Assisted living studio, residential care, and participants' homes

Carros et al, 2020	Germany	Conference paper	Qualitative	Pre and post interviews	Older people, caregivers and manager	Care home
Chang et al, 2013	USA	Conference paper	Multi-method	Observations and interview	Older people, care staff	Retirement community (long- and short-term care)
Chang et al, 2015	USA	Conference paper	Multi-method	Field study	Older people (majority had dementia), staff, visitors	Nursing home
Cruz-Sandoval et al, 2018	Mexico	Conference paper	Quantitative	Observational	Older people with dementia	Geriatric residence
de Graaf et al, 2015	UK	Journal paper	Qualitative	Exploratory in-depth study using video recording and interviews	Older people	Participants' homes
Demange et al, 2018	France	Journal paper	Quantitative	Quasi-experimental (pre-post)	older people with dementia	Hospital
D'Onofrio et al, 2019	Italy	Conference paper	Quantitative	Pre-post	Older people with dementia	Hospital
D'Onofrio et al, 2019	Italy, Ireland and UK	Journal paper	Quantitative	Pre-post	People with dementia	Community setting, nursing home and hospital
Fattal et al, 2020	France	Journal paper	Quantitative	Pre-post	Older people	Hospital
Fiorini et al, 2020	Italy	Conference paper	Quantitative	Pre-post	Older people	Participants' homes

Gross et al, 2012	Netherlands Belgium	Conference paper	Qualitative	Field trial	Older people with mild cognitive impairment, their partner	Smart home (Test home)
Gross et al, 2015	Germany	Conference paper	Multi-method	Case study	Older people	Participants' homes
Gross et al, 2019	Germany	Conference paper	Multi-method	Case study	Older people	Participants' homes
Hebesberger et al, 2017	Austria	Journal paper	Mixed method	Concurrent multistrand research design	Older people with dementia, care staff and management staff	Hospital
Hudson et al, 2020	USA	Journal paper	Qualitative	Descriptive qualitative	Older people	Participants' homes
Huisman and Kort, 2019	Netherlands	Journal paper	Mixed method	Evaluation study	Older adults, care staff and board members	Geriatric care facilities
Kelly et al, 2020	USA	Journal paper	Quantitative	Feasibility study	Older people with dementia	Hospital (acute care)
Khosla et al, 2017	Australia	Journal paper	Quantitative	Cross-sectional	Older people with dementia	Residential aged care facilities
Khosla et al, 2019 (Australia)	Australia	Journal paper	Mixed method	Observational	People with dementia. their family members	Participants' homes
Klamer et al, 2010	UK	Conference paper	Qualitative	Case study	Older people	Participants' homes
Kolstad et al, 2020	Japan	Journal paper	Qualitative	Semi structured interviews	Older people, nursing staff and site managers	Two nursing homes and one elderly day care centre

Kouroupetroglou et al, 2017	Italy, Ireland	Conference paper	Quantitative	Questionnaire	People with dementia	Hospital and nursing home
Melkas et al, 2020	Finland	Journal paper	Qualitative	Field study	Older people, care staff	2 care homes and a geriatric rehabilitation hospital
Moyle et al, 2013	Australia	Conference paper	Qualitative	Case study	Older people with dementia	Nursing home
Moyle et al, 2014	Australia	Journal paper	Mixed method	Semi structured interviews and observational data	Older people with dementia, care staff, family members	Long term care facilities
Moyle et al, 2016	Australia	Journal paper	Qualitative	Case study	Older people with dementia	Nursing home
Moyle et al, 2019	Australia	Journal paper	Qualitative	Descriptive qualitative	Family members of older people who live in residential care	Residential care facilities
Moyle et al, 2019	Australia	Journal paper	Qualitative	Descriptive qualitative	Older people with dementia	Long term care facility
Moyle et al, 2019	Australia	Journal paper	Qualitative	Descriptive qualitative	People with dementia, family members	Long term care facility
Niemala et al, 2017	Finland	Conference paper	Qualitative	Pre-post interviews, user observations, logged use of robot, videotaping	Older people	Long term residential home
Niemala et al, 2019	Finland	Journal paper	Multi-method	Field trial	Older people, care staff, family members	Residential care facilities

Orejana et al, 2015	New Zealand	Conference paper	Multi-method	Case study	Older people	Participants' homes
Peri et al, 2016	New Zealand	Journal paper	Quantitative	Controlled non-randomised comparison study (Observational)	Older people, care staff, visitors	Retirement complex (Residential care ward)
Piasek and Wieczororwska-Tobis, 2018	Poland	Journal paper	Quantitative	Pre-post	Older people with mild cognitive impairment, their family member	Laboratory setting and participants' homes
Pike et al, 2020	UK	Journal paper	Qualitative	Multiple case study	Older people with dementia, family members	Participants' homes
Portugal et al, 2019	Netherlands	Journal paper	Multi-method	Observation and post- questionnaire	Older people, care staff, visitors	Care center
Pu et al, 2020	Australia	Journal paper	Qualitative	Descriptive qualitative	Older people with dementia	Residential aged care facility
Randall et al, 2019	USA	Journal paper	Multi-method	Pre-post focus groups, survey	Older people	Participants' homes
Sabelli et al, 2011	Japan	Conference paper	Qualitative	Ethnographic study	Older people, care staff	Elderly care center
Schroeter et al, 2013	Netherlands Belgium	Journal paper	Multi-method	Semi-structured interviews, observation, diary, questionnaire	Older people with mild cognitive impairment, their partner	Smart home (Test home)
Torta et al, 2014	Austria	Journal paper	Multi-method	Questionnaire and semi-structured interviews	Older people	Test setting (In a Senior centre)

van Maris et al, 2020	UK	Journal paper	Multi-method	Questionnaire and interviews	Older people	Retirement villages
Wu et al, 2014	France	Journal paper	Multi-method	Questionnaire and semi-structured interviews	Older people (cognitively healthy and those with mild cognitive impairment)	Test setting (In the Gerontechnology living lab in a hospital)
Zsiga et al, 2018	Hungary	Journal paper	Quantitative	Field test	Older people	Participants' homes

Social robots and Intervention Characteristics

A total of 28 different types of social robots were implemented. This includes 18 types of socially assistive robots (n=33), three types of telepresence robots (n=8) and five types of pet robots (n=18). Paro was the most commonly deployed social robot, and was featured in 11 studies. The intervention duration ranged widely from 2 days to 4 years. Most implemented the social robot over a one-month to three-month period (n=23). In terms of intervention frequency, the majority of studies (n=19) implemented social robots on a full-time basis, where participants could access the social robot at any time of the day. A summary of this information can be found in Table 2.

Table 2: Social robot(s) and intervention characteristics

	No. of studies (n)
Social robots used	
Pet robots	*18*
Paro	11 (22, 60, 73-81)
CuDDler	1 (82)
Qooboo	1 (77)
Joy for all cat	3 (45, 83, 84)
Joy for all dog	2 (45, 83)
Telepresence robots	*8*
VGo	1 (85)
Giraff	3 (78, 85, 86)
Double	4 (87-90)
Socially assistive robots	*33*
Betty / Matilda	2 (91, 92)
Cafero	2 (93, 94)
CompanionAble robot	2 (95, 96)
Eva	1 (97)
Guide	1 (94)
Hobbit PT2	1 (98, 99)
iRobiQ	2 (93, 100)
Kompai mobile robot	3 (101-103)
MARIO	4 (104-107)
MAX (SCITOS G3)	1 (108)
Nao / Zora	3 (109-111)
Pepper	4 (77, 112-114)
Robovie 2	1 (115)
Silbot-2	1 (116)
STRANDS robot	1 (117)
SYMPARNTER	1 (118)
Tiago	1 (119)
Violet’s Nabaztag	2 (120, 121)

Study Duration	
Less than one week	6 (76, 95, 96, 105, 108, 122)
One to four weeks	14 (73, 75, 81, 98, 99, 102, 104, 107, 110, 113, 114, 117, 118, 121)
More than four to 12 weeks	23 (22, 60, 74, 79, 80, 82-87, 89-91, 93, 94, 97, 101, 103, 111, 112, 119, 120)
More than 12 weeks	6 (19, 92, 100, 109, 115, 116)
No clear information	4 (77, 78, 88, 105)
Intervention Frequency	
Full-time (or full day)	20 (81, 83, 87, 88, 93, 95, 96, 98-100, 103, 108, 117-122)
Weekly intervention (ranging from 1-5 times weekly)	18 (22, 60, 73-75, 79, 80, 82, 89, 91, 97, 102, 104, 105, 107, 109, 112-114)
Others	2 (19, 111)
No clear information	13 (76-78, 84-86, 90, 92, 101, 105, 110, 115, 116)

Terms used to describe implementation of social robots

A total of 13 different terms have been used to describe implementation in relation to social robots (Table 3). Only 15 studies included the term “implement” or “implementation” in their title and/or abstract. Although the term “implementation” was identified in nearly half of the included studies, there appears to be a conceptual overlap on the use of this term. Although some authors (n=8) used this term to describe the process of using social robots within a given context (45, 60, 73, 74, 80, 81, 110, 116), others (n=7) used it to describe the execution of technical or systems of the social robot (95, 96, 106, 108, 112, 118, 122). Out of the eight constructs in Proctor’s taxonomy, we identified terms that could be mapped onto five. Overall, “acceptability” or “acceptance” were most frequently used terms (n=25). Other terms that were used included use, usefulness, integration, usability and deployment.

Table 3: Terms used to describe implementation

Terms used	No of studies (n)
Proctor's taxonomy	
acceptability, acceptance	25 (75, 76, 84, 88, 92, 93, 95, 97, 98, 100-107, 111, 113, 114, 117-121)
adoption, adopt	6 (83, 89, 90, 102, 105, 115)
feasibility	8 (73, 76, 82, 85-87, 93, 113)
sustainability	1 (92)
cost	1 (22)
penetration	no data
fidelity	no data
appropriateness	no data
Other terms	
implementation, implement	15 (45, 60, 73, 74, 80, 81, 95, 96, 106, 108, 110, 112, 116, 118, 122)
use, usage	25 (22, 45, 60, 73, 78-84, 87-91, 94, 96, 102, 106, 109, 110, 118, 119, 121)
usefulness, useful	8 (74, 81, 92, 93, 102, 103, 105, 113)
integrate, integration	5 (77, 83, 110, 113, 117)
usability	4 (88, 98, 101, 113)
deploy, deployment	4 (112, 115, 117, 122)
utilisation, utilise	2 (77, 94)
employ	1 (98)

Barriers and Facilitators to Implementation

A summary of barriers and facilitators coded to the CFIR, excluding constructs with no supporting data, are presented in Table 3. Overall, the barriers and facilitators were mapped onto 18 constructs across all five domains. There was no data that could be mapped onto the 21 other CFIR constructs.

Domain 1: Innovation Characteristics

1.1 Relative Advantage

Telepresence robots were considered to be more disadvantageous than using the telephone or skype as they were more expensive (86) and had less audibility to cater to those with a hearing impairment (87, 89, 90). Relative advantages included an increased sense of presence due to their video element (85-87, 89, 90) and mobility aspect (85). They were also reported to be more conducive for use with people with dementia (85, 86). Pet robots were compared to live animals, where their maintenance-free nature was seen as an advantage (22, 83). Socially assistive robots were perceived to be more beneficial than a tablet solution due to their proactivity (95), and potential economic profitability as compared to having human staff (117).

Table 4: Summary of barriers and facilitators

CFIR construct	Barrier(s)	Facilitator(s)
Domain 1. Innovation Characteristics		
1.1 Relative advantage	• Relative cost as compared to other technology (86) • Less audibility (87, 89, 90)	• Sense of presence (85-87, 89, 90) • Mobility aspect (85). • More conducive for people with dementia (85, 86) • Maintenance-free (22, 83) • Proactivity (95) • Economic advantage (117)
1.2 Adaptability	• Vocalisations(81) • Functions(93) • User interface or interaction (92, 101, 104, 105) • Physical inaccessibility (85, 94, 100, 104, 110, 112, 115, 117, 122)	• Physical accessibility (85, 104) • Customisability of interactivity or functions (91, 112)
1.3 Complexity	• Pre-programmed instructions (99, 101) • Complicated functions (81, 89, 90, 96, 99, 100, 102, 104) • Compose or program activities (109) • Multimodal interaction features (89, 90, 104, 107)	• Ease of use (75, 83, 85, 90, 98, 99, 102, 104, 108-110, 117, 121, 122)
1.4 Design quality and packaging	• Audio and speech issues (82, 85, 89, 90, 92, 98, 99, 101-105, 111, 112, 115, 116, 122), • Hardware problems (86, 116, 118) • Unreliable functions (82, 93, 96, 98, 99, 101, 103, 106, 116-118, 121, 122), • Unpredictable intentions (98, 99, 116, 120) • Other technical difficulties (100, 109, 112, 113, 116) • Physical attributes (18, 22, 81, 93, 107, 110) • Design (22, 81, 82, 122)	• Acceptable and/or pleasant appearance (80, 91-93, 102, 104, 107, 110, 111, 113) • Interactivity and proactivity (96, 98, 100, 104, 108, 115, 118), • Robustness (45, 103, 108)
1.5 Cost	• High acquisition and maintenance cost (22, 45, 78, 81, 100, 102, 108)	

Domain 2: Outer setting		
2.1 Patient needs and resources	• Unfamiliar with technology (85, 102, 120) • Cognitive impairment (60, 74, 85, 102, 104, 105, 107) • Independence in managing daily tasks (83, 100, 102) • Limited usefulness of the robot (81, 93, 98, 104, 108, 114, 120, 121) • Doubts about sustained benefits (102, 108, 111). • Intrusiveness or privacy (81, 93, 101, 102, 108, 120) • Negative affect (82, 91, 98, 102, 105, 112, 117, 121) • Negative perceptions or stigma (45, 75, 76, 82, 84, 88, 98, 102, 113, 120, 122)	• Support and familiarisation (102, 108, 112, 119) • Emotional support (75, 80, 81, 83, 96, 104, 108, 115, 118) • Companionship (45, 80, 81, 83, 93, 100) • Improvement to daily life (92, 98, 118, 122) • Entertainment (91-93, 97, 104) • Reminiscence (82, 93, 104) • Reminders (91, 113, 118) • Phased introduction and training (101) • Prolonged use (86, 101, 112, 120).
2.2 External policy/incentives	• Align care work with national care policy (89, 90)	
Domain 3: Inner Setting		
3.1 Compatibility	• Institutional regulations: privacy, space and safety privacy (87, 89, 115) • Confused/frightened residents (117) • Background noises (89, 104, 105) • Concern about misuse of technology (87, 89, 90) • Lack of support from co-workers (109) • Delineate professional boundary (87, 89, 90) • Ethical concerns (73, 79, 82, 110) • Hygiene (22, 45, 73, 79) • Interfere with routine • Physical environment (98)	• Supported work of care professionals(90, 110, 112, 115, 117) • Integration into care routine (73, 74, 89, 112, 115) • Positioning of social robots(83, 120, 121) • Adaptation of physical environment (98, 104)
3.2 Relative priority	• Existing care work/processes took precedence (77, 89, 110) • Workplace tension (110)	
3.3 Leadership engagement		• Leadership involvement and commitment (109)

3.4 Available resources	• Poor network connectivity (85-90, 99, 109, 110, 122) • Lack of manpower, time or training (73, 77, 78, 86, 110) • Computer incompatibility (85)	• Improved network infrastructure(109) • Time and support for care professionals (109).
3.5 Access to knowledge and information	• Access to support in rural areas (100)	• Dedicated helpdesk within care facility (109) • Individualised intervention instructions/manual (73, 109, 116)
Domain 4: Characteristics of Individuals		
4.1 Knowledge and beliefs	• Initial ambivalence/negative attitudes (22, 73, 77, 85, 110, 112, 117, 122) • Fear of damaging robot (100, 117) • Privacy concern (87, 89, 90) • Fear of job replacement (112, 117) • Negative perceptions, which stemmed from technical challenges/ perceived lack of usefulness (85, 89, 109, 117)	• Evolved attitude after witnessing positive impacts on older adults/people with dementia (22, 45, 73, 74, 77, 78, 84-86, 89, 95, 110, 112, 122) • Understanding that robots cannot replace their jobs (112) • Motivation to support robot interactions (73, 109, 115) • Alignment to organisation visions (109)
4.2 Self-efficacy	• Unequipped to program and compose activities (109)	• Gain experience over time (109)
Domain 5: Implementation Process		
5.1 Planning	• Assign robot with a clearly indicated role (115)	
5.2 Engaging		• Public exposure facilitated engagement and change in perceptions (74, 86, 117)
5.3 Key stakeholders	• Negative attitudes of care professionals (78)	• Care professionals' enthusiasm (77) • Active engagement with care professionals (115) • Mediation of robot interactions (60, 74, 97, 107, 112, 116)
5.4 External change agents	• Lack of sustainability(112)	• Support robot interactions (74, 85, 90, 98, 104) • Provide technical support(99, 100, 116)

1.2 Adaptability

The inability to adapt the functions of social robots to cater to participants' preferences and abilities impeded their use. This included the inability to adjust vocalisations (81), personalise functions (93), and customise user interfaces or modes of robot interaction (92, 101, 104, 105). Other barriers relate to issues of physical inaccessibility (85, 94, 100, 104, 110, 112, 115, 117, 122). Correspondingly, facilitators included the physical accessibility (85, 104) and customisability of the robots' interactivity or functions (91, 112).

1.3 Complexity

The complexity of operating social robots primarily related to the use of socially assistive robots, which included complicated pre-programmed instructions (99, 101) and functions (81, 89, 90, 96, 99, 100, 102, 104), or difficulty composing or programming activities (109). For telepresence robots, navigation difficulties occurred during remote driving (78, 89, 90). For some participants, particularly people with dementia, the multiple modes of visual, auditory and tactile interaction with social robots were confusing and challenging (89, 90, 104, 107). Facilitators relating to their ease of use were reported in 14 studies (75, 83, 85, 90, 98, 99, 102, 104, 108-110, 117, 121, 122), of which some attributed this to the involvement of users in the design process (104) and prolonged technology use (111).

1.4 Design quality and packaging

Technical issues were widely reported as barriers, particularly in relation to socially assistive robots. These included audio and speech issues (82, 85, 89, 90, 92, 98, 99, 101-105, 111, 112, 115, 116, 122), hardware problems (86, 116, 118), overheating (78, 86, 98), unreliability of functions (82, 93, 96, 98, 99, 101, 103, 106, 116-118, 121, 122), unclear or unpredictable actions (98, 99, 116, 120) and other technical issues (100, 109, 112, 113, 116). The frequent need to recharge batteries was also cited as a barrier (81). Next, barriers relating to their physical attributes, such as weight (18, 22), size (93, 110) unpleasant vocalisations (18, 81, 107) and unsatisfactory levels of interactivity (18, 81), were raised. Finally, unfamiliar designs (22, 81) and the "machine-like" (82, 122) or "toy-like" (82) appearances of social robots were also cited as issues. Facilitators were related to overall acceptable or pleasant appearances and design (60, 74, 80, 91-93, 102, 104, 107, 110, 111, 113). Other facilitators included the interactivity and proactivity of social robots (96, 98, 100, 104, 108, 115, 118), and their overall robustness (45, 103, 108).

1.5 Cost

Multiple stakeholders raised concerns about high acquisition costs (22, 45, 78, 81, 102, 108), and maintenance costs of social robots, especially when used in rural areas or out of their country of manufacture (78, 100).

Domain 2: Outer Setting

2.1 Patient Needs and Resources

The demographics of participants influenced their needs. Older people who were less familiar with technology were more hesitant to use social robots (85, 102, 120). People with dementia, especially those with more cognitive impairment, required more ongoing support (60, 74, 85, 102, 104, 105, 107). Correspondingly, familiarisation and support to use the technology was perceived to be a necessary facilitator (102, 108, 112, 119). Next, the inability of social robots to meet participants' needs also impeded their use. Older adults who were living at home and were independent in managing daily tasks felt that the technology was unnecessary (83, 100, 102), had limited usefulness (81, 93, 98, 104, 108, 114, 120, 121), and had doubts about their benefits with sustained use (102, 108, 111). Issues that were raised by both older adults and people with dementia include privacy concerns (81, 93, 101, 102, 108, 120), negative affect which stemmed from technical issues (82, 91, 98, 102, 105, 112, 117, 121), and negative perceptions or stigma (45, 75, 76, 82, 84, 88, 98, 102, 113, 120, 122). Correspondingly, when functions of the robots aligned with participants' needs and were perceived to be relevant, their use was facilitated. The needs that these robots fulfilled included emotional support (75, 80, 81, 83, 96, 104, 108, 115, 118), companionship (45, 80, 81, 83, 93, 100), perceived improvements to daily life (92, 98, 118, 122), entertainment (91-93, 97, 104), reminiscence (82, 93, 104) and non-intrusive reminders (91, 113, 118). Phased introduction and training (101) and familiarisation also facilitated a greater acceptance of (86) and adaptation to the technology (101, 112, 120).

2.2 External Policy and Incentive

Only two studies (n=2) reported on external policy as a facilitator, where care professionals perceived that use of the technology aligned their care work with the wider national care policy (89, 90).

Domain 3: Inner Setting

3.1 Compatibility

In care facilities, barriers included institutional regulations which limited the mobility of social robots due to issues of privacy (87, 89), safety and space allocation (115). The unexpected appearances of the robot confused some residents (117), and background noises also influenced participants' interaction with the technology (89, 104, 105). Next, challenges integrating social robots into work process included concerns about potential misuse of the technology (87, 89, 90), lack of support from co-workers (109), uncertainty on how to delineate a professional boundary (87, 89, 90), ethical (73, 79, 82, 110), and hygiene concerns (22, 45, 73, 79). Correspondingly, they were compatible with work processes when their use supported the work of care workers (90, 110, 112, 115, 117), could be integrated into daily care routine (73, 74, 89, 112, 115). For studies conducted in participants' homes, incompatibility occurred when social robots interfered with daily routine (112, 120), or when environment inaccessibility impeded the robots' mobility (98, 118, 120). Facilitators included an integrated routine of use (83, 120, 121), and environment accessibility (98, 104).

3.2 Relative Priority

Barriers relating to relative priority was reported in three studies (n=3), where care professionals felt that social robots caused additional work, and that existing work took precedence (77, 89, 110). Their use also led to workplace tension, where those who did not prioritise use of the technology dissented those who used it (110).

3.3 Leadership Engagement

Only one study (n=1) reported on leadership engagement as a facilitator, where organisational leaders demonstrated active involvement and commitment towards implementation effort. Support services and meetings were planned for care professionals to exchange knowledge and experiences (109).

3.5 Available Resources

More resource-related barriers than facilitators were identified. In care facilities, barriers included poor network connectivity (85-87, 89, 90, 99, 109, 110, 122), and lack of manpower, time or training (73, 77, 78, 86, 110). Only one study reported on facilitators, where the network infrastructure was boosted, and time and support were provided to support use of the technology (109). For studies that were conducted in participants' homes, or involved family members who lived at home, resource barriers include a lack of Wi-Fi infrastructure (88) and computer incompatibility (85) to connect with the robot at the care facility.

3.6 Access to Knowledge and Information

Access to technical support was reported as a barrier for participants who lived in rural areas (100). Three studies reported access to knowledge and information within care facilities through a dedicated helpdesk (109), a manual and individualised interventions instructions (73, 116), which supported implementation.

Domain 4: Characteristics of Individuals

4.1 Knowledge and beliefs

Some care workers and family members were ambivalent or had negative attitudes towards social robots (22, 73, 77, 85, 110, 112, 117, 122), hesitated their use for fear of damaging them (100, 117), and had concerns about privacy (87, 89, 90) and job replacement by robots (112, 117). While some negative perceptions persisted after experiencing their use, due to technical challenges or perceived lack of usefulness (85, 89, 109, 117), other attitudes evolved positively after witnessing their positive impacts (22, 45, 73, 74, 77, 78, 84-86, 89, 95, 110, 112, 122), and having a renewed understanding that robots cannot replace their jobs (112). As such, they were motivated and willing to support robot interactions (73, 109, 115). Perceptions at the managerial level were only reported in one study (n=1), which reported positive views that the technology aligned with the organisation's vision (109).

4.2 Self efficacy

Only one study (n=1) reported that care workers felt unequipped to compose group activities using social robots. Nevertheless, they gained experience to work around the capabilities of the technology over time (109).

Domain 5: Implementation Process

5.1 Planning

In one study (n=1), the plan to assign a social robot with a clear role to make it more approachable facilitated the implementation process (115).

5.2 Engaging

The public exposure of social robots facilitated engagement by multiple stakeholders (117), who developed positive perceptions of the value of the technology from observing robot interactions (74, 86).

5.1 Key Stakeholders

Negative attitudes of care professionals was reported as a key barrier to implementation (78), while staff enthusiasm was facilitated their use (77). Only one study (n=1) reported active involvement of care professionals in the implementation process, which facilitated their proactivity and enthusiasm (115). Staff-mediated robot interactions, such as using active strategies to mediate the limitations of robot interactions (74, 97, 107, 112, 116) and changing composition of group sessions (60) led to more successful robot interactions.

5.4 External Change Agents

Eight studies (n=8) identified family members, researchers and robot developers to be external change agents, who facilitated the implementation process by supporting participants' interactions with social robots (74, 85, 90, 98, 104) and providing technical support (99, 100, 116). However, the ethical challenge of lack of sustainability of social robot intervention after the end of the study was reported in one study (112).

Discussion

This review synthesises available evidence on the barriers and facilitators to the implementation of social robots for older people and people with dementia. Most included studies were conducted in long term care facilities and in participants' homes, and the majority used socially assistive robots and pet robots. The most frequently cited barriers were mapped onto constructs within the domain "Intervention characteristics", while most facilitators were mapped onto the domain "Patients needs and resources".

Terminology

Overall, less than a third of the articles included the term "implementation" in their title and/or abstracts. There appears to be no clear conceptual definition of the term "implementation". This could be attributed to different disciplinary research focus and/or discipline-specific vocabulary, since included papers were derived from different academic fields: health and social sciences, engineering and computer science. In health and social science contexts, implementation refers to "the constellation of processes intended to get an intervention into use within an organisation" (123). However, in computer science, it is used to describe the process of executing technical applications (124). Given that social robotics is a transdisciplinary field, it is important for researchers to be aware of discipline-specific terms. Moving forward, a concept analysis should be done to understand interdisciplinary concepts used to describe implementation in relation to social robots. Terms in Proctor's taxonomy were identified in titles and/or abstracts of most included papers. This highlights the practicability of using the taxonomy to develop a sensitive search strategy to identify studies that investigated intervention implementation.

Barriers

Barriers to implementation were primarily related to the characteristics of social robots (i.e. "Intervention characteristics" domain), such as complexity, physical accessibility and cost. In particular, technical failures were raised as issues in more than half of the included studies. It may be worth noting that most of these barriers were related to the use of socially assistive robots. This may be attributed to the range of functions available on such robots (as compared to telepresence or pet robots), which can proportionately increase the complexity of their operation. Although another possible explanation for barriers in this domain are that many of the social robots that were used were prototypes, it is also important to note that such issues were also raised in relation to the use of commercially available social robots such as Zora, Pepper and Giraff. Such challenges are not novel to social robots, as similar issues have been well-documented even amongst studies which used less novel or daily technology to conduct interventions (125-128). These issues had repercussions on other implementation domains, as they resulted in negative perceptions by multi-level key stakeholders, including older people and people with dementia, family members and care professionals. This finding is in alignment with findings by Rozental et al (129), which found that such technical problems evoked negative psychological effect among users.

People with cognitive impairment required more support to use social robots, and those with less experience with technology had lower self-efficacy. This finding corresponded with existing research (18, 130-132). Next, the mismatch between the social robots' function and users' needs was also reported as an obstacle. Such barriers were primarily reported in studies which investigated the use of social robots for cognitively older adults who were living at home, suggesting that their needs and expectations of social robots differ from people with dementia or are living in care facilities, who may use technology differently. A recent scoping review by Abdi and colleagues (133) found that the needs of community-dwelling older adults ranged widely from mobility needs and interpersonal needs to self-management needs. As such, they may require social robots to have more functionalities that are tailored to their needs (81, 134). In contrast, the needs of people with dementia and those in care setting differed. They included having stimulating day time activities and company (135). Understanding of the needs of intended population is a therefore fundamental contextual consideration for implementing social robots.

Although one of the key bases for the development of social robots is to support and aid caregiving in individuals' homes and care settings (136), which is expected to be increasingly strained due to a rapidly aging population (130, 137), there is ironically a lack of studies which has investigated how social robots can be successfully integrated into care organisations (i.e. "Inner setting" domain). There were significantly more barriers than facilitators identified in this CFIR domain. These barriers, including incompatibility of the intervention to institutional regulations or work processes and the lack of time, manpower and training to support implementation efforts, corresponding with existing literature (138, 139). Therefore, dedicated resources should be allocated to supported the implementation of social robots, especially during the initial implementation phase (140) to allow care organisations and care professionals to familiarise and adapt to their use (141). Next, even though organisational theories have highlighted the influence of other external factors on implementation such as external policies or incentives (142, 143), this was only reported in two studies. There is also a lack of studies that reported perspectives of other stakeholders, such as management staff and policy makers, which highlights research gaps in these areas. Finally, findings relating to the CFIR domain of "Implementation process" were scarce as there were few studies that undertook process evaluations.

Facilitators

Most of the identified facilitators correspond with the identified barriers. For instance, the characteristics of the social robots, such as their physical accessibility, ease of use, cost and technical robustness were identified as implementation facilitators. In addition, the match between social robots' functions and users' needs and their compatibility with work processes within care organisations were seen as enablers. We also found that despite initial ambivalence or scepticism, older adults and people with dementia developed positive perceptions after using social robots with functions that matches their needs or expectations. Similarly, when family members and care professionals experienced the positive impacts of the technology and developed a renewed understanding that they cannot replace their jobs, positive attitudes were reported. This confirms current research findings that direct experiences with a technology can elicit attitude change when the interactions evoke cognitive-affective discrepancies from baseline beliefs (144, 145). These positive perceptions had implications on other implementation domains. In the CFIR domain of "Implementation process", care professionals and family members who had had positive attitudes were more enthusiastic in supporting and facilitating robot interactions. The mediation of robot interactions by these stakeholders also helped to reconcile the limitations of the intervention characteristics, such as technical issues and the complexity of use. These facilitators also highlight the importance of avoiding evaluating implementation determinants in silos, and instead consider the interplay of multi-level contextual factors that influence implementation (146, 147).

Future research and practical implications

Overall, more barriers than facilitators were identified. Data from this review could only be mapped onto 18 out of 39 constructs in the CFIR. Data were mostly coded to the CFIR domain of "intervention characteristics", and there is significantly less research emphasis on other CFIR domains. This is also exemplified through the lack of data that could be mapped onto 21 other CFIR constructs. This indicates that existing research have been focused on the internal validity of the intervention, and that future research focus must be directed towards identifying other contextual factors that can influence the external validity of social robots in real-world practice. Very few of the included studies have undertaken process evaluation, and none have used an implementation framework to ensure a systematic approach to consider all factors that can affect implementation. Given the complexity of implementing social robots, process evaluations can provide valuable insights that may explain why the intervention has (or has not) been implemented as intended in real-world practice (148), and how different contextual factors may have influenced overall intervention outcomes (149). Future research should also consider applying an appropriate theoretical framework to guide a thorough investigation of implementation determinants, which can then enable corresponding strategies to be identified and tested in real-world practice. Waltz and colleagues (2019) developed a tool (150) for mapping barriers identified on each CFIR domain to the Expert Recommendations for Implementing Change (ERIC), which contains a comprehensive collection of implementation strategies (151). For instance, to address a barrier relating to "compatibility", one recommended strategy listed in CFIR-ERIC mapping tool is to conduct local consensus discussions, where different key stakeholders should engage in active discussions about whether social robots are appropriate to address needs within their context. Finally, aside from focusing on barriers, it is also pivotal to leverage on facilitators to guide the successful implementation of social robots in the real-world setting.

Strengths and limitations

There are a number of strengths underpinning this work. First, the methodological framework that was used was transparent and rigorous. We searched multiple databases, including grey literature and engineering databases. The application of an implementation science framework (i.e., the CFIR) enabled results to be presented in a comprehensive and systematic manner. Nevertheless, there are limitations of this review. In our review protocol, we reported a plan to extract terms used to describe implementation from the full text of included articles. However, due to the large number of articles that were included in this review, we had to deviate from the protocol to only chart terms that were included in the title and/or abstract of included papers. Articles that were published in other languages were not included in this review. Hence, relevant studies might be missed. In addition, the review aggregated barriers and facilitators related to the implementation of social robots in participants' home and long-term care settings, and thus the findings mainly apply to these settings. Several different social robots (i.e., interventions) were included in this review. The heterogeneity of the interventions and study settings could be a fundamental limitation, as these variable factors can affect implementation differently. Nevertheless, implementation barriers and facilitators that were identified in this study revolved around similar themes.

Conclusion

This review has identified and synthesised terms used to describe implementation in relation to social robots, and the breadth of evidence on the barriers and facilitators to the implementation of social robots for older adults and people with dementia. There is a lack of clear conceptual clarity regarding the term "implementation". A concept analysis may be warranted to explore this topic in depth. Although social robots show promise for improving the psychosocial health of older adults and people with dementia, there has been little attention paid to their implementation in the real-world setting. Most existing research were focused on evaluating the characteristics of social robots, and there has been significantly less research which investigated other multi-level contextual factors, such as organisational or wider contextual factors, that can influence their implementation in real-world practice. Further research in these domains, using an implementation framework, is necessitated.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

Supporting data and materials used in this paper can be accessed online through various public databases. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WK conceptualised the review approach, developed the review questions and review design with advice from ET and DC, and conducted the literature search. WK, BB and SAF undertook the screening, study selection and data charting process. WK undertook screening of the reference lists and backward citation tracing. Data synthesis was led by WK with consultation with ET. WK initiated the draft of the manuscript. ET and DC had meaningful contributions to its drafting and editing. All authors read and approved the final manuscript.

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Chapter Summary

This chapter presents a review of extant studies to explore the barriers and facilitators (i.e., determinants) affecting the implementation of social robots, including pet robots, for older adults and PLWD. Since the focus of this study was to broadly examine and scope the evidence base, a scoping review methodology was deemed to be most suitable. Seven databases were searched using a comprehensive search strategy that was developed in consultation with a research librarian. Backward citation tracking and hand searching were also conducted. Following a two-step screening process by independent reviewers, 53 articles were included. Most studies were conducted in participants' homes or long-term care facilities, and PARO was most frequently investigated.

Findings were categorised into constructs within five domains of the Consolidated Framework of Implementation Research (CFIR). In the first domain 'intervention characteristics', barriers and facilitators related to the relative advantage of social robots, their adaptability for use with older adults and PLWD, complexity, high costs, and design attributes. In the second domain 'outer setting', determinants related to the fit between robots' functions and users' needs, and national care policies. In the third domain 'inner setting', determinants related to the alignment of the robots with care organisations' workflows, their perceived priority by care providers, and the availability of resources and information. In the fourth domain 'characteristics of individuals', care providers' knowledge, beliefs and self-efficacy influenced implementation. Finally, in the domain 'implementation process', determinants related to the planning and engagement of key stakeholders and external change agents. While barriers and facilitators often manifest at multiple levels, this review demonstrated that most existing studies primarily focused on investigating intervention-related barriers and facilitators (i.e., characteristics of the social robots, including pet robots). There has been significantly less focus on examining other contextual influences, and none of the included papers had explicitly investigated the multi-level determinants of implementation.

These findings informed the development of the succeeding qualitative study (Chapters 6 and 7), which was specifically focused on understanding determinants that influence the implementation of pet robots. Attention was paid to addressing critical knowledge gaps that were identified in this review, such as internal and external contextual factors.

Chapter 6: Exploring Barriers and Facilitators to the Implementation of Pet Robots for People With Dementia in Nursing Homes: A Qualitative Research Protocol

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Prologue

This chapter presents paper five, a qualitative research protocol paper which outlines the methodology for the descriptive qualitative study. The purpose of the study is to explore barriers and facilitators to the implementation of pet robots for nursing home residents with dementia.

Chapter 6: Exploring barriers and facilitators to the implementation of pet robots for people with dementia in nursing homes: A qualitative research protocol (paper five)

Abstract

Background

People living with dementia, especially those who live in nursing homes, are susceptible to social isolation and activity disengagement. Pet robots are technology-based substitutes to animal assisted therapy that have demonstrated positive impacts on people with dementia in long term care settings, such as reducing agitation, improving mood and increasing social engagement. Nevertheless, knowledge about the issues influencing their implementation is lacking, as there is a scarcity of research that have explicitly investigated the barriers and facilitators influencing their implementation in real-world practice.

Objective

The objective of this study is to understand the multi-level barriers and facilitators to the implementation of pet robots for people with dementia in nursing homes, from the perspectives of key stakeholders.

Methods

A qualitative study employing a descriptive qualitative approach will be used. The Consolidated Framework of Implementation Research will be used to guide the research process. Multi-level stakeholders, including people with dementia, healthcare professionals and organisational decision makers in nursing homes, will be recruited for one-to-one interviews. Data will be analysed through framework analysis, using a combination of both deductive (based on the constructs and domains in the CFIR) and inductive approaches.

Discussion

To the best of our knowledge, this will be the first study to explore multi-level determinants to the implementation of pet robots in nursing homes for people living with dementia. Findings will be used to inform the identification of strategies that may be used to guide the implementation of pet robots for people with dementia in nursing homes.

Keywords: qualitative study, qualitative description, dementia, nursing homes, pet robots, social robots, animal assisted therapy, implementation research

Background

Dementia is a growing health concern. Worldwide, 50 million people live with dementia (Alzheimer's Disease International, 2016), and these numbers continue to rise with a rapidly ageing population (World Health Organization, 2020). It is estimated that between 47.8% to 73% of the people who live in nursing homes have dementia (Centers for Disease Control and Prevention, 2021; Hoffmann et al., 2014; Prince et al., 2014). Although residential care is important to ensure necessary care provision, people living with dementia (PLWD) who reside in nursing homes are especially susceptible to reduced social health as compared to those who live in the community. Olsen et al. (2016) found that PLWD who live in nursing homes had a significantly lower quality of life, less social contact and higher use of psychotropic medication. Through qualitative interviews, PLWD have also described life in residential care as a 'life of isolation, uncertainty and fear'(Clare et al., 2008), and reported a lack of social contact and engagement in pleasurable activities (Cahill & Diaz-Ponce, 2011). Social interactions and participation in activities are therefore considered to be important in enhancing the quality of life of PLWD in residential care facilities (Moyle et al., 2015; Moyle et al., 2011).

In the last three decades, there has been growing interest in the use of pet therapy or animal-assisted therapy to benefit the psychosocial health of PLWD who live in nursing homes (Bernabei et al., 2013; Virues-Ortega et al., 2012). Such interventions have shown benefits for people with dementia by providing companionship to reduce loneliness, improving engagement and eliciting relaxation (Banks & Banks, 2002; Le Roux & Kemp, 2009). Nevertheless, the use of live animals have raised concerns about adverse effects such as transmission of zoonotic diseases and compromised animal welfare (Lai et al., 2019). Pet robots are considered to be viable technology-based substitutes to animal-assisted therapy. The research and use of pet robots in dementia care began about two decades ago. A prominent example includes PARO, a robotic baby harp seal. PARO was developed in Japan and has been in use since 2003 with older people and PLWD (Paro Robots, 2014). To date, it remains the most researched pet robot. Since then, several other pet robots, such as the NeCoRO cat, JustoCat, CuDDler (robotic bear) and AIBO (robotic dog), have been developed and tested. Correspondingly, numerous studies have been conducted to evaluate the effectiveness of pet robots for PLWD. In a recent mixed method systematic review, Abbott et al. (2019) synthesised evidence from 27 articles based on 19 studies, to evaluate the impact of pet robots on residents in care homes. Over half of the included studies investigated pet robot use specifically for PLWD. Based on the quantitative synthesis, although the use of pet robots led to reduced agitation, the effects were not statistically significant. Nevertheless, the qualitative findings showed that pet robots stimulated engagement amongst nursing home residents, provided opportunities for social interactions, and improved overall mood, and quality of life. In another systematic review of 13 articles from 11 randomised controlled trials, researchers found that the use of social robots, including the pet robot PARO, led to reduced agitation, anxiety, loneliness and medication use among older people including PLWD who live in long term care settings (Pu et al., 2018). These effects did not reach statistical significance, which could be attributed to the marked heterogeneity of the interventions and small sample sizes.

Despite the need for more definitive evidence, pet robots have continued to demonstrate promise in improving the psychosocial health of PLWD. This could explain why they are still being used in dementia care in several countries (Shibata, 2012). However, the overall implementation and uptake of technological innovations in dementia care has remained slow or unequal (Meiland et al., 2017; Vernooij-Dassen & Moniz-Cook, 2014). Implementation can be defined as a 'constellation of processes intended to get an intervention into use within an organisation' (Nilsen & Bernhardsson, 2019). A recent scoping review was conducted to broadly examine the literature on factors affecting the implementation of social robots including pet robots, for older adults and PLWD (Koh et al., 2021). The authors found that much of the research have been largely focused on studying the internal validity of pet robots (i.e., effectiveness), and there has been significantly less research emphasis on their external validity, such as contextual factors (e.g., organisational climate) that can influence their implementation in real-world practice (Koh et al., 2021). There has also been a scarcity of studies which explored the perceptions of multi-level key stakeholders, such as healthcare professionals and organisational decision makers (Koh et al., 2021), who hold important roles in influencing the implementation of pet robots in care settings. A thorough understanding of their perspectives is pivotal to bridge the knowledge gap between research and clinical practice. Hence, the purpose of this study is to gather rich descriptions about how different stakeholders perceive factors influencing the implementation of pet robots in nursing homes in real-world practice.

Theoretical Framework

The use of an implementation framework has been recommended to guide the broad exploration of determinants that can affect implementation. The Consolidated Framework for Implementation Research (CFIR) is a determinant framework that was derived from synthesising 19 different theories on dissemination, innovation, organisational change, implementation, knowledge translation and research uptake (Damschroder et al., 2009). There are 39 constructs within the CFIR domains that are grouped under five key domains:

1. Characteristics of the intervention
2. Outer setting, which refers to influences that are external to the implementing organisation (e.g., political context in which the organisation resides)
3. Inner setting, which refers to the features of the implementing organisation
4. Characteristics of individuals involved in the implementation (e.g., healthcare professionals, organisational decision makers, and PLWD)
5. Implementation process, which refers to the plans and strategies that are used to put an intervention into practice

The CFIR represents a comprehensive approach to understand factors influencing the implementation of interventions (Damschroder et al., 2009). Its breadth compels researchers to broadly explore the phenomena in a holistic manner. As such, it is a suitable framework for this study, and it will be used to guide the conceptualisation, data collection and data analysis process.

Objectives

This objective of this study is to explore the multi-level barriers and facilitators influencing implementation of pet robots in nursing homes for PLWD, from the perspectives of key stakeholders.

Methodology

Qualitative description (QD), as described by Sandelowski (2000, 2010) is chosen as the most suitable qualitative approach, as the principles that underpin this approach is well aligned with the purpose of this research. From a philosophical stance, QD has been aligned with a pragmatic paradigm (Neergaard et al., 2009), as researchers make decisions about the conduct of the research based on its objectives (Ormston et al., 2014) to contribute to change in real-world practice (Chafe, 2017). In this approach, the researcher strives to stay close to the 'surface of the data and events' (Sandelowski, 2000, p. 336), gather rich descriptions of the views of participants and describe the phenomena from the viewpoints of participants. This approach also allows for flexibility in commitment towards the use of framework or theory (Sandelowski, 2010). As such, it allows for the CFIR to be used as a framework to guide the conceptualisation, conduct and reporting of this study using terminology that is consistent with literature (Colquhoun et al., 2014).

Sampling and Recruitment

Sample

Three groups of key stakeholders, including healthcare professionals, organisational decision makers and PLWD, will be included in this study.

1. Healthcare professionals

Healthcare professionals, including nurses, care assistants and allied health professionals (such as occupational therapists, physiotherapists and therapy assistants), are involved in providing direct care for PLWD. Hence, they can offer perspectives of barriers and facilitators related to direct care provision. Healthcare professionals who meet the following criteria will be included:

- Provide direct care provision for PLWD in nursing homes
- Can speak and understand English

2. Organisational decision makers in nursing homes

Organisational decision makers, such as team leaders, managers and directors, may be considered as indirect care providers who provide care services that do not require interaction between provider and the PLWD. It is necessary to involve this group of key stakeholders, as they can offer perspectives on barriers and facilitators manifesting from a managerial point of view. Organisational decision makers who meet the following criteria will be included:

- Has experience as a manager or leader in a nursing home, or has managed or led a team of care workers or organisational processes within facility
- Can speak and understand English

3. People living with dementia (PLWD)

Since PLWD are the end users of pet robots, it is important to include this group of participants as key stakeholders. Ideally, PLWD should be recruited from nursing homes to gather context specific information in relation to the research objective. However, due to COVID-19, and restrictions to physical access to nursing homes, it is not possible to physically access this group of participants since they are considered to be one of the most vulnerable populations with higher risks of morbidities and mortalities (Banerjee, 2020). As PLWD who live in nursing homes usually have more advanced dementia than community-dwelling PwD (Helvik et al., 2015), face-to-face interviews are especially important to maintain a physical presence and for rapport building (Digby et al., 2016). These principles are more difficult to uphold during online interviews. As such, conducting online interviews with PLWD from nursing homes may not be feasible. Hence, community-dwelling PLWD will be recruited for this study instead. Although this group of participants may not be able to provide context specific (i.e., nursing home) information, their experience-based perspective (lived experience of dementia) will still be invaluable in contributing to the understanding of the phenomena of interest. The inclusion criteria are as follows:

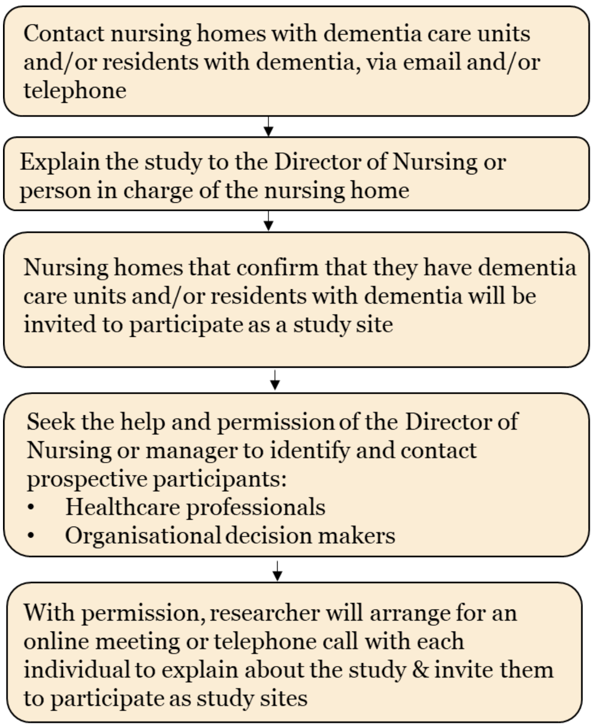
- 65 years old and above
- Can speak and understand English
- Have a formal diagnosis of dementia
- Not residing in an institutional facility (such as a nursing home)
- Has the capacity to consent independently, or has a legal appointed decision maker to assist with the decision making process for consent, as outlined in the Assisted Decision Capacity Act 2015 (182)

Recruitment Strategy

1. Nursing homes

Nursing homes will be used as a platform to recruit healthcare professionals and organisational decision makers. An overview of the recruitment process from nursing home can be found in Figure 1. According to the Health Service Executive, there are 578 nursing homes in Ireland, of which 44 are located in Galway (Health Service Executive, 2017). At least 33 of these nursing homes provide care for residents with dementia. The researcher will contact the nursing homes individually to explain about the study. Nursing homes that confirm that they have residents with dementia, and/or have a dementia-specific care unit, will be invited to participate as study sites. Permission will be sought from the Director of nursing or manager of the nursing home to identify and contact care staff who are involved in direct and indirect care provision for residents with dementia. With permission, the researcher will arrange for an online meeting or telephone call with each individual, based on their preference, to explain about this research and invite them to participate in this study.

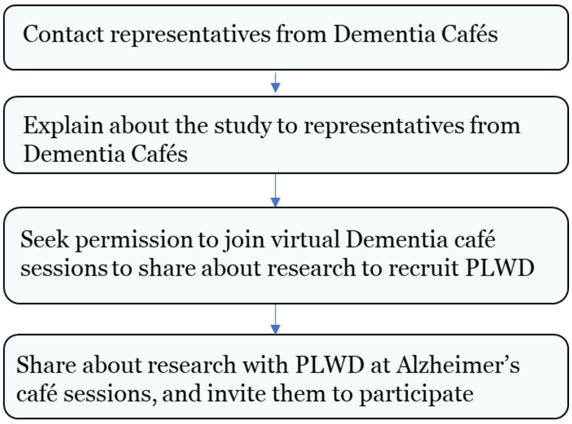
Figure 1: Recruiting care professionals and organisational leaders from nursing homes



2. Services for PLWD

The researcher will recruit PLWD primarily through TeamUp for Dementia Research (TUDR), a service that connects PLWD who are interested in participating in dementia research to researchers (The Alzheimer Society of Ireland, 2021b). The process of recruitment will follow procedures outlined by TUDR. The researcher will also recruit PLWD from Dementia cafes, if an insufficient number of participants can be recruited via TUDR. Dementia cafes are a community resource for people with dementia and their caregivers, and provide them with opportunities to meet others who live with dementia (Dementia Pathways, 2021). An overview of the recruitment process from Dementia cafes can be found in Figure 2. Since the start of the COVID-19 pandemic, cafes have been conducted virtually. To recruit PLWD from the cafes, researcher will first contact representatives from individual Dementia Café to explain about this study, and ask for permission to participate in the virtual meet up sessions to share about this research and invite them to participate in the study.

Figure 2: Recruiting PLWD from Dementia Cafes



Sampling strategy

Purposive sampling, based on the inclusion criteria as outlined in the sections above, will be employed. Those who meet the inclusion criteria will be invited to participate in the study. Snowball sampling will also be used as a secondary sampling technique. Participants will be asked if they have any colleagues or friends who would be eligible and interested to take part in this study. If so, they can contact the researcher to discuss participation. This will enable data to be collected from participants in similar settings or have similar roles (Merriam & Tisdell, 2015; Palinkas et al., 2015).

Patient and Public Involvement (PPI)

According to the National Institute for Health and Care Institute (2021), patient and public involvement (PPI) encompasses carrying out research with patients and members of the public, rather than conducting research to or for them. The researcher has received input from the European Working Group of People with Dementia (EWGPWD) on conducting interviews with PLWD. The researcher has also involved a member from the Dementia Research Advisory Team (The Alzheimer Society of Ireland, 2021a) as an advisor to this research, to understand how to best inform and communicate with participants with dementia in an understandable and accessible manner. This will enhance recruitment (Hassan et al., 2017) and improve the quality of experience for participants with dementia. The research advisor will also be involved in the interpretation of data collected from PLWD to enhance the validity of findings (Stevenson & Taylor, 2017).

Sample Size

It is difficult to determine a priori sample size required for a qualitative study. However, there is a practical imperative to provide an estimate before the study for review by the research ethics committee, and to predict resources that may be required. For this study, the initial sample will comprise of 30 participants (i.e., 10 healthcare professionals, 10 organisational decision makers and 10 PLWD).

The proposed sample size was determined using the numerical guideline and conceptual model approaches outlined by Sim et al. (2018). The numerical approach to sample size determination refers to sample size suggestions based on guidelines based on previous empirical studies. Previous authors who adopted a similar theory-based approach recommended an initial sample size of 10 participants (Francis et al., 2010). Next, the conceptual approach provides suggestions on estimating sample size requirements based on its informational power, which can be influenced by the specificity of the research objective, use of a theoretical framework, specificity of the sample, and quality of the interview dialogue (Malterud et al., 2016). With reference to these considerations — this study has a specific objective, and will be guided by the CFIR. However, since participants include different groups of stakeholders, the sample may not be considered to be specific. In relation to the quality of dialogue—although the researcher is an experienced occupational therapist who has worked closely with people with dementia and multidisciplinary team members, and has conducted therapeutic interviews with PLWD—therapeutic interviewing differs from qualitative interviewing (Patton, 2015). As a researcher in training, it may take her some time to familiarise and build rapport with participants and to build interview skills (Malterud et al., 2016). Overall, based on considerations from both approaches, the proposed initial sample size is thought to be appropriate. Nevertheless, this decision will be an iterative process, subjected to change based on informational power from the data being collected and analysed (Glenton et al., 2018; Malterud et al., 2016).

Data Collection

Data collection is expected to start in August 2021 and expected to be completed within a 5-month period, by December 2021. Due to social distancing and health regulations from COVID-19, data collection will take place virtually. Individual semi-structured interviews with be conducted with each participant via Zoom, or via the telephone. Zoom is a teleconferencing platform that allows both the researcher and participants to observe each other's facial expressions and nonverbal gestures during an interview (Saarijärvi & Bratt, 2021). As compared to other teleconferences such as Skype, Zoom has been described to be more intuitive and as a highly suitable platform for conducting online interviews (Archibald et al., 2019; Gray et al., 2020). However, this method requires both the researcher and participants to have a stable internet connection, camera and microphone (Saarijärvi & Bratt, 2021). In addition, not everyone may feel comfortable with using teleconferencing platforms. As such, the researcher will also offer participants the option to participate in the interview via telephone (Cachia & Millward, 2011; Drabble et al., 2016). Interviews with PLWD will last for 30–45 minutes, and interviews with nursing home staff will last for 45–60 minutes. Depending on public health guidelines during the data collection period, participants may be offered an option to participate in physical interviews if preferred.

Prior to the start of an interview, participants will be introduced to pet robots through a short video that shows the functions of some pet robots. After that, they will be asked to complete a demographics form and participate in a semi-structured interview. The interview guides were developed based on the CFIR domains (https://cfirguide.org/constructs/). The interview guides will be piloted prior to data collection. All interviews will be audio recorded. Field notes will be taken during and after each interview to note down observations that cannot be captured via audio recordings, such as participants' gestures or facial expressions (Phillippi & Lauderdale, 2018). The researcher will also maintain a reflexive journal to reflect on the overall data collection process (Probst, 2015).

Data Analysis

The process of data collection and analysis will occur concurrently. A qualitative data analysis software, NVivo 12, will be used for data management. Data will be analysed using the framework method (Gale et al., 2013; Ritchie & Spencer, 1994). This method follows a systematic and clearly defined process that can be replicated, thereby providing transparency (Gale et al., 2013). After each interview, data will be transcribed. The researcher will first immerse and familiarise herself with the data. The next step is the identification of an analytical framework, which involves the development of codes and categories. A combination of deductive and inductive approaches will be used. The constructs and domains listed in the CFIR will be used as a priori codes and categories for an analytical framework. Any barriers or facilitators that do not align with the a priori codes will be assigned with open codes for inductive analysis, to ensure that all data are considered (Ward et al., 2013). After coding the first few transcripts, codes will be grouped into categories to form a working analytical framework. After that, this analytical framework will be applied to subsequent transcripts (Gale et al., 2013). Next, data from each manuscript will be summarised by category and charted into the framework matrix to allow for constant comparison through a review of data across the matrix (Gale et al., 2013). Finally, the last step will be 'mapping and interpretation', where data will be interpreted by identifying characteristics and differences between data to explain barriers and facilitators affecting the implementation of pet robots for PLWD in nursing homes (Gale et al., 2013).

Ethical Considerations

This study has been approved by the Research Ethics Committee in the National University of Ireland Galway (Ref no.: 2020.10.014). The study will be conducted in full compliance with the approved protocol. It is not anticipated that participants involved in this study will be at any risk of harm. Special considerations will be made for PLWD to safeguard their interests. The process of consent seeking will follow guidance as outlined by the position paper by Alzheimer's Society Ireland (2021) on the Assisted Decision Making (Capacity) Act 2015. An ethical protocol will be followed to ensure that additional safeguards will be in place to guide the management of distress during data collection. If participants demonstrate or report of any form of distress, the session will be terminated. The session will be deferred to another date and time in agreement with the participant. If he/she would like to withdraw from the study, data collection for the participation will be terminated. All participants have the right to opt out of the study at any stage without any prejudice or consequence. During interviews, participants may disclose information (e.g., issues that pose a serious risk or danger to the participant) that may be unethical for the researcher to keep confidential. Hence, at the outset of the study, they will be informed that there are limits to the researcher's ability to keep the information confidential. When the researcher is informed about a clear risk/danger to the PLWD, the researcher will be obliged to disclose this information to their caregivers and/or the Research Ethics Committee.

Confidentiality and Data Storage

To maintain research data confidentiality, all participants will be assigned with a study code number to ensure the anonymity of participants during data analysis and for publication of the research at the end of the study. This will ensure that the data that is collected cannot be linked to an individual's identifier (personal information). In addition, for the publication of the study – findings will be presented in a global manner using the study code number to ensure that individuals cannot be identified. All research data will be stored within the research office at the National University of Ireland. All softcopy and hard copy data, including audio-recordings, will be stored securely with access for a maximum of seven years. This is in line with the requirements for research data storage by the National University of Ireland Galway. Only the researcher will be able to access the information. These steps will minimise the risk to participants from the breach of confidentiality.

Rigor

Rigor as outlined below will be maintained to ensure and to clearly demonstrate the credibility, transferability, dependability and confirmability of this research (Lincoln & Guba, 1985). A clear research method and participant selection criteria, such as delineating sample size considerations, interview procedure and interview guides before commencing the study, will ensure transparency and minimise the researcher's subjective biases. The use of an interview guide and prompting questions can reduce the potential for interview bias (Salazar, 1990). To ensure confirmability, a clear research record will be kept as a transparent trail to document decisions (Maher et al., 2018; Noble & Smith, 2015). Use of the NVivo 12 software to support data analysis will further support the confirmability and dependability of this study, since it can store raw data and keep a record of the analysis process to enable an audit of the research trail when required (Bonello & Meehan, 2019). Finally, the Standards for Reporting Qualitative Research (SRQR) checklist (Appendix 15) will be used to guide the reporting of the study findings (O'Brien et al., 2014).

Discussion

This study is preceded by a scoping review, which demonstrated that existing knowledge about multi-level stakeholders' perspectives on about the barriers and facilitators affecting the implementation of pet robots are scarce. To the best of our knowledge, this is will be the first study to thoroughly and explicitly explore multi-level barriers and facilitators that can affect the implementation of pet robots for PwD in nursing homes. This understanding is a necessary first step to understand how research on pet robots can be translated into practice, as findings will be used to inform the identification of strategies that may be used to guide their implementation. This study is a part of a larger project to develop recommendations for the implementation of pet robots for PwD in nursing homes. Findings will be submitted for publication in an open-access, peer-reviewed journal. We also expect to share our findings with other healthcare professionals, researchers and members of the public via national and international scientific conferences and newsletters.

Declarations

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Conflict of Interest

The authors declare that they have no competing interests

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Chapter Summary

This paper described the protocol for a descriptive qualitative study to understand the barriers and facilitators to implementing pet robots in nursing homes for residents with dementia. The next chapter details findings from the qualitative study (Chapter 7).

Chapter 7: Determinants of implementing pet robots in nursing homes for dementia care

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Prologue

This chapter presents paper six, a descriptive qualitative study to explore the determinants of implementing pet robots for residents with dementia in nursing homes. The Consolidated Framework of Implementation Research (CFIR) was used to guide the study conceptualisation, data collection and data analysis.

Abstract
Background:

Pet robots have been employed as viable substitutes to pet therapy in nursing homes. Despite their potential to enhance the psychosocial health of residents with dementia, there is a lack of studies that have investigated determinants of implementing pet robots in real-world practice. This study aims to explore the determinants of implementing pet robots for dementia care in nursing homes, from the perspectives of healthcare professionals and organisational leaders.

Methods:

A descriptive qualitative study, conceptualised and guided using the Consolidated Framework of Implementation Research (CFIR), was conducted. We conducted semi-structured interviews with healthcare professionals and organisational leaders from nursing homes. Data was transcribed and analysed using Framework Analysis, based on the CFIR as an a priori framework.

Results:

A total of 22 participants from eight nursing homes were included. Determinants mapped to constructs from all five CFIR domains. Determinants relating to the characteristics of pet robots include their design, realisticness and interactivity, affordability, cleanability, perceived evidence strength and comparative advantages to live pets. Determinants relating to external influences (outer setting) include national regulatory guidelines, funding and networks with other organisations. With regards to characteristics of nursing homes (inner setting), determinants include the relevance of pet robots in relation to the needs of residents with dementia, alignment with care processes, infection control mandates and their relative priority. In the domain 'characteristics of individuals', determinants were associated with individuals' beliefs on the role of technology, desires to enhance residents' quality of life, and differential attitudes on the use of robots. Finally, in the domain 'implementation process', assessments and care planning were identified as determinants.

Conclusions:

Overall, while sentiments around determinants within CFIR domains of pet robots' characteristics, outer setting and implementation process were similar, participants' opinions on the determinants within the 'inner setting' and 'characteristics of individuals' were more varied. This could be due to different organisational structures, disciplinary differences and personal experiences of using pet robots. Many determinants in different domains were interrelated. Findings provide a springboard for identifying and designing implementation strategies to guide the translation of pet robots from research into real-world practice.

Keywords: Dementia, implementation, barriers, facilitators, social robots, pet robots, robotic pets, nursing homes, long term care, residential care, care homes

Background
Pet robots are technology-based substitutes for animal-assisted therapy. Animal-assisted therapy have demonstrated positive benefits on the psychosocial wellbeing of people with dementia, such as reducing depression, providing companionship and addressing unmet needs [1]. However, using live animals can be challenging due to issues such as logistical difficulties or potential transmission of zoonotic diseases [2]. Correspondingly, pet robots are considered as alternative solutions to circumvent such challenges and have been used as non-pharmacological interventions to support the psychosocial health of people living with dementia [3]. There are several pet robots designed with varying levels of familiarity, realisticness and interactivity. Among the different robots, PARO is

the most well-researched. While PARO was designed realistically to resemble a seal, it was intentionally designed as an unfamiliar animal to enhance its acceptability, based on developers' notions that people would have fewer preconceptions or expectations of it [4]. Other examples of pet robots include the AIBO dog, Pleo (dinosaur) and the Joy for All (JfA) cat—some studies have suggested that older adults and people with dementia prefer familiarly designed pets such as cats and dogs [5]. Overall, current research suggests that realistically designed pet robots with fur-covering, such as PARO and the JfA cat, can evoke affective behaviours and are preferred by older adults and people with dementia [6, 7].

Three systematic reviews were conducted to evaluate the effectiveness and impacts of pet robots. While only one had a specific focus on using pet robots with people with dementia [8], most studies included in the other reviews focused on users who had mild cognitive impairment or dementia [9, 10]. Most studies included in all reviews were also focused on using PARO in long-term care. In terms of effectiveness and impacts, Leng and colleagues (2019) found a statistically significant reduction of behavioural and psychological symptoms of dementia (BPSD). Pu and colleagues (2019) had similar findings—using social robots including PARO decreased agitation, anxiety, medication use and loneliness. However, these effects did not reach statistical significance, possibly due to small samples and intervention heterogeneity. Similarly, while Abbott et al. (2019) did not find statistically significant reductions in agitation in their mixed method review, their qualitative synthesis demonstrated positive impacts of stimulating engagement, social interactions and mood amongst older adults and older people with dementia.

Although most included studies focused on the use of PARO, some researchers have argued that PARO has been overly researcher driven and technology driven, with insufficient consideration of real-world needs [11], which could explain low uptake in real-world practice [12]. For instance, a scoping review which synthesised the barriers to using PARO in care settings highlighted pragmatic issues such as cost [11]. The JfA cat represents a lower-cost alternative, and have been chosen by older adults in care homes as their preferred pet robot design among seven other alternatives [6, 13]. While the number of studies conducted to investigate the impacts of the JfA cat [14, 15] are significantly less than that of PARO, findings of their positive impacts on the psychosocial health of users resonate with previous studies. Hence, despite the need for more definitive evidence on the effectiveness and impact of pet robots, there is promising findings of benefits to the psychosocial health of nursing home residents with dementia.

The traditional research sequence often involves evaluating the efficacy and effectiveness of an intervention before knowledge of its implementation is being investigated [16, 17]. However, such step-wise approaches have been argued to have caused time lags between research discovery and uptake [16, 17]. As such, it is necessary to pursue knowledge on the implementation of pet robots alongside further investigation into their effectiveness, to improve the speed of knowledge creation in guiding the translation of pet robots from research into practice. This should entail a thorough understanding of implementation determinants [18]. A scoping review was conducted to synthesise findings from 53 studies, to identify barriers and facilitators to implementing social robots (including pet robots) for older adults and older people with dementia [19]. The review found that current research have been disproportionately focused on identifying determinants relating to the characteristics of robots, with a lack of studies investigating multilevel contextual determinants that can influence implementation, such as organisational workflows [19]. As such, the purpose of this study is to explore multilevel determinants to implementing pet robots in nursing homes for dementia care, from the perspectives of healthcare professionals and organisational leaders. The pet robots we focused on were PARO and the JfA cat, due to their realistic designs and the existing evidence-base suggesting their potential to positively impact the psychosocial health of nursing home residents with dementia.

To guide the comprehensive exploration of implementation determinants, we used the Consolidated Framework for Implementation Research (CFIR) as a guiding framework to undertake a comprehensive exploration of implementation determinants [20]. The CFIR is a meta-theoretical determinant framework that was conceptualised following a review and synthesis of theories of organisational change, dissemination, innovation, implementation, research uptake and knowledge translation [20]. Within this framework, 39 constructs that influence implementation are organised into five domains: 1) intervention characteristics, 2) inner setting, 3) outer setting, 4) individuals' characteristics and 5) implementation process (Table 1).

Table 1: CFIR Domains

CFIR Domain	Description
Intervention Characteristics (i.e., characteristics of pet robots)	Refers to key characteristics of pet robots, such as complexity, design quality and packaging and cost
Outer Setting	Refers to external influences on the implementing organisation, such as external policies and guidelines
Inner Setting	Refers to the features of the implementing organisation (i.e., nursing home), such as residents' needs and resources, readiness for implementation and implementation climate
Individuals' characteristics	Refers to the characteristics of individuals (e.g., healthcare professionals) who are involved in implementation
Process	Refers to strategies for implementing pet robots, such as planning and engaging stakeholders

Methods

Study design and setting

A descriptive qualitative study (21, 22) was conducted. In a qualitative descriptive approach, researchers aim to stay close to the 'surface of data and events' (23) to explore and describe the phenomena of interest from the participants' points of view. It also allows for flexibility in using a theoretical framework to guide the process of inquiry (23). As such, this was chosen as the most suitable approach for our study. This study received approval from the National University of Ireland Galway research ethics committee (REF. 2020.10.014). Informed consent was obtained from all participants prior the study. Full details of the methods for this study are described in detail in a published protocol (24) and any deviations are clearly detailed below.

Sampling and Recruitment

Purposive sampling was used to identify and recruit healthcare professionals (HCPs) with experience of providing care to residents with dementia, and organisational leaders (OLs) with experience of managing or leading a nursing home that provided care for residents with dementia. Sample size determination for this study was based on considerations from Sim and colleagues' (25) outline of the numerical guideline and the conceptual model approaches. The former refers to suggestions based on recommendations from previous empirical studies, and the latter refers to sample size estimation based on information power (26) – this has been posited as a useful alternative to 'data saturation determination' (27). Previous authors who used a theory based approach to qualitative inquiry have recommended an initial sample size of 10 participants (28). Some considerations about information power included the non-specificity of the study objectives (due to heterogeneity of stakeholder groups) and quality of dialogue with participants, based on the lead researcher's (WQK) experience with qualitative interviewing (29). Based on these considerations, we anticipated an initial sample of at least 10 participants per stakeholder group. This decision was an iterative process, subjected to change based on informational power from the qualitative data was collected and analysed (26, 30). To recruit study sites for participant recruitment, we leveraged on data from the Irish national open data portal and identified 33 nursing homes in a county in the west of Ireland that provided care for residents with dementia. WQK systematically contacted the nursing homes to explain about the study and invite them to participate. Eligible participants (Table 2) from nursing homes that agreed to participate were invited to join the study. Although we planned to recruit 2-3 HCPs and 2-3 OLs from four nursing homes in the West of Ireland, we had to extend recruitment to include additional nursing homes, due to difficulty recruiting sufficient participants from each organisation.

Twenty two participants from eight nursing homes participated in this study. Of seven invited organisations, six agreed to participate. Of 19 invited participants, all but one agreed to be interviewed. Three participants from two additional homes were recruited through snowball sampling. Table 3 shows the characteristics of the nursing homes. We anticipated that nursing homes would not have pet robots. However, two had the JfA cats, and one had both the JfA dog and cat. None had experience using PARO, except for one participant who used it during a trial approximately ten years ago. Participants comprised of 10 OLs and 12 HCPs (due to the heterogeneity of HCPs being included). A summary of their demographics can be found in Table 4.

Deviation from protocol

We also intended to recruit community-dwelling people with dementia, however this was not possible - this may be because participation would require them to think ahead about care provision in nursing homes, a future that may be difficult for them to contemplate, or due to challenges with executive cognitive functioning which may influence their ability to consider prospectively (31). Furthermore, the study involved questions relating to organisational contexts within nursing homes, which may be difficult for community-dwelling people with dementia to discuss. Therefore in deviation from our protocol, we could not include community-dwelling people with dementia. However, to ensure that their viewpoints on implementing pet robots in nursing homes were considered, we consulted with an advisor with dementia from the Dementia Research Advisory Team (32) during the study conceptualisation and data collection as a part of Patient and Public Involvement (PPI) – this refers to the partnership with patients and the public in research, rather than 'doing research for them' (33). The Dementia Research Advisory Team is comprised of people living with dementia and their carers who collaborate or provide advice in dementia research in Ireland (32). A summary of the agenda for the PPI consultation sessions can be found in Appendix 20.

Data collection

Data collection took place between August to November 2021. Participants were first introduced to the pet robots through a 5-minute video, where the lead researcher (WQK) demonstrated their features and functions (Appendix 21). In-depth, semi-structured interviews were conducted by WQK subsequently, and each interview lasted between 31 to 54 minutes. The interview guide (Appendix 22). used to guide data collection was developed using domains and constructs in the CFIR (20) and findings from our preceding scoping review (19). For instance, we placed emphasis on understanding organisation-related factors, which were identified as knowledge gaps that were not explicitly investigated in previous studies. These questions were piloted prior to data collection. All interviews were audio recorded. Due to the ongoing Covid-19 pandemic, we planned to conduct interviews primarily via Zoom or via the telephone, to minimise the risk of infection transmission through physical meetings. However, the option of physical (in-person) interviews was also offered to participants if preferred. The latter option depended on prevailing public health guidelines, which determined the practicability and safety of physical access into nursing homes. Fourteen interviews were conducted in-person at each participant's nursing home, and 8 were conducted through videoconferencing via Zoom.

Data analysis

Framework analysis was used to analyse the data (34, 35), using a combination of deductive and inductive approaches. First, all audio recordings were transcribed verbatim and uploaded onto NVivo12. The first ten transcripts were transcribed by WQK and the remaining transcripts were transcribed with professional transcription services. In step two, WQK and AF familiarised themselves with the data by listening and immersing in the interview transcripts and audio-recordings, keeping notes of any initial impressions, thoughts and ideas in relation to the CFIR, to remain attuned to emerging data whilst using CFIR as a starting point. Based on the initial notes from the first five interviews, we developed subcodes within the constructs and domains in the CFIR, and this constituted our preliminary framework. The third step involved identifying a framework that could be applied to the rest of the data through an iterative process of piloting our preliminary framework, to ensure that we remained attuned to emerging data. WQK and AF independently coded one interview, met up regularly to discuss any difficulties in applying the framework, and revised the framework categories to ensure that we remained attuned to any emerging data. After piloting the preliminary framework on five interviews, we developed a framework (Appendix 24) for the fourth step of indexing. In this step, WQK applied the framework to the rest of the transcripts. Next, all indexed data were charted onto a framework matrix by summarising participants' interviews and arranging them by categories (i.e., CFIR constructs and subcodes). This facilitated analysis within and between each interview, and the preparation of data for mapping and interpretation. WQK reviewed the charted data to identify characteristics, differences and patterns in the data, and annotated impressions during this process. Attention was also paid to comparing the patterns of data between participants with and without experiences of using pet robots. The findings and interpretation were presented to AF and our PPI member, who were invited to provide feedback and suggest changes to the interpretation. These steps were not linear, and involved a reflective, analytical (iterative) process of moving forward and back between steps. For example, although the process of 'identifying a framework" (step 3) was intended to precede "indexing" (step 4), the development of our framework was an ongoing process in our study to accommodate new subcodes that were created to capture the descriptions of data that did not fit in the existing framework during indexing. In addition, descriptions of some subcodes were revised. During the 'mapping and interpretation' process, we also moved back and forth to refer to the original transcripts to better understand and confirm patterns of data. This ensured that the data analysis remained a thoughtful and reflective process rather than being mechanistic, especially during the 'indexing' stage (34). The Standards for Reporting Qualitative Research (36) was used to report the findings (Appendix 25).

Findings

Domain 1: Characteristics of Pet Robots

This domain describes determinants relating to the characteristics of robots, such as their design, cost and evidence. Participants described them as being realistic, which they felt was important for acceptability and to not be considered infantilising. While PARO's design as a seal was culturally unfamiliar, the JfA cat's design as a familiar animal was thought to be more relevant and impactful. Some felt that PARO's advanced interactive capacities were beneficial, however others doubted their essentiality, especially if they increased cost: *"Maybe people are just as happy if they feel it responds to them [HCP10]"*. Furthermore, some felt these features, such as PARO's voice recognition abilities, might be restricted in a nursing home environment where noise levels are often high. Their robustness was also of concern, as residents with dementia may not understand how to care for the robot as a technical device: *"when you give such a pet to somebody with dementia, they have no concept of not holding it too tight or restricting its movement. It's very likely that they will, so I would be concerned about their durability [HCP4]"*. While their fur-covering contributed to appeal, their cleanability was a concern. This led a nursing home to dispose of a JfA cat during Covid-19. Most participants were unanimous that PARO's cost was prohibitive, and that it would be unaffordable for their nursing homes. Organisations with the JfA cat learned about and acquired it through a central website for medical supplies, describing it as being more affordable.

Participants shared personal anecdotes of their experiences as supporting evidence for pet robots, which facilitated implementation: *"He's so much happier. I think everybody would probably say that they see such a difference [HCP5]"*. Whilst not all had experience of using pet robots, many compared them to dolls and plush toys, expressing that pet robots would have similar or more impacts on residents since there is an added element of interactivity: *"I've seen over the years, residents especially those with dementia, forming a bond with dolls and the teddies.. if the teddy talks or moves she'd (resident) be over the moon [OL2]"*. Compared to live animals, pet robots were thought to be more manageable for residents with dementia, since live animals may have more unpredictable behaviours. From an organisational perspective, pet robots also represented a more hygienic, safer and resource-efficient way forward:

"Live ducks and hens were introduced in a county home.. it was great for the patients to go out and take in the egg.. staff went on courses to look after these hens and ducks, that only introduced more work.. three residents went to pick up the hen eggs and they fell.. Whereas to me the robots there is no maintaining [HCP7]".

Nevertheless, a few preferred live animals, describing tangibility that cannot be replaced with robots: *"It's the living, breathing, the meows.. whereas this is not real [OL4]"*. Some doubted the impacts or sustained interest over time, as some residents became disinterested or lost interest in interventions such as doll therapy. Therefore, stronger supporting evidence was thought to be necessary to facilitate greater implementation. This should involve evaluating residents' responses, the proportion of receptive residents, and sustained interest over time.

Domain 2: Outer Setting

This domain focuses on determinants relating to external influences on implementation, such as external policies and networks with other organisations. Obtaining government funding for pet robots was described by most as difficult, especially for PARO. For public organisations, public funding such as donations, supported the purchase of resources for residents, including the JfA cat. Participants from privately run nursing homes described such sources of funding to be less accessible, as the public would often perceive such organisations as businesses that are focused on profitability, and are therefore less likely to donate funds to them: *“most private nursing homes have a bad name, they will say, well for you it’s a business right? [OL2]”*. The Health Information and Quality Authority (HIQA), a regulatory authority for health and social care standards, was described as having strong influence on care processes. Since pet robots were described as an additional form of activity for residents and could support person-centred care, participants felt that they were well aligned with HIQA’s guidelines and their endorsement of activity provision: *“They were very pro activity provision.. certainly when they discovered that we would have them they would be happy, because it’s person-centred [HCP5]”*. Nevertheless, some expressed concerns about meeting their infection control mandates, because their decisions could have a significant impact on the implementation of pet robots. For example, one participant expressed: *“if they said no that’s it, it’s gone [HCP7]”.* This was especially in light of Covid-19, where infection prevention and control was described by nearly all participants to be paramount. Another participant who had a pet robot within her nursing home shared that all staff were mindful that it was only used with one resident with dementia, and cannot be shared with other residents to prevent cross contamination: *“Even with our experience with the robot there, it’s just for (the resident). Nobody else is touching it and we’ve to be very conscious [OL9]”.*

With the exception of participants from one of the nursing homes that was a part of a wider group of nursing homes that shared information with each other, others often described minimal networking with other organisations. This was especially pertinent for private homes which typically worked in silo: *“unless they’re a part of a group, generally don’t have a tendency to talk to each other, but kind of they are a business on their own [OL4]”.* However, some expressed interest in knowing other organisations’ experiences with robots, which they felt would influence the implementation of pet robots in their own setting: *“Do they have it in the UK?. We have to probably learn from their experience and their mistakes or positive things [OL2]"*. Nevertheless, a participant from a private nursing home shared that she leveraged on the social media page of Nursing Homes Ireland (NHI), a representative body for nursing homes, which provided some form of networking, as their social media page involved the sharing of other nursing homes’ initiatives.

Domain 3: Inner Setting

This domain describes determinants relating to the features of nursing homes, such as residents’ needs and resources, the compatibility of robots with existing care processes and workflows, and the availability of resources.

Most participants shared similar sentiments regarding residents’ needs and resources, expressing that residents sometimes felt anxious, lonely, unsettled and were at risk of being passive recipients of care. Most residents had past experiences with animals, but lose access to their pet(s) upon admission. However, *“just because somebody comes into a nursing home does not mean that they stop liking cats or dogs [HCP4]”*. Correspondingly, many (with and without experience of using robots), echoed similar thoughts that implementation was, or would be facilitated, when robots addressed these needs. Like pets, many felt pet robots should be individualised, and should not be shared among residents. Participants who had used pet robots echoed similar sentiments, expressing that residents are often reluctant to share pet robots with other residents: *“she won’t let go (of the JfA cat) to anybody else, so they are trying to get more (robots) [HCP11]”*. Nevertheless, residents were described to have fluctuating interests, needs and reduced functional capacities, which could impact their abilities to engage with pet robots.

Residents' responses to robots had varying influence on staff caregiving. Some described their potential to support caregiving, since care provision would be easier when residents feel comfortable. Such sentiments were congruent with participants who had used pet robots: "you can see the difference it made to this lady because if not, she'll be constantly calling for carers [HCP10]". Some used robots to encourage residents to engage in routine care: "*We have difficulty giving him supplements. He doesn't want to take them. And we'll say well (name of robot) won't like it if you don't take your supplement [HCP9]".* In such sense, the use of pet robots were synergistic with care provision, which facilitated their routine use within the organisation. Participants from one nursing home also described circumstances where one of their residents became disengaged from care routine due to attachment to the pet robot*: "she was so glued to the (JfA) cat she would not eat... would want to feed it and all that… it had to be taken away from her [HCP9]".* Nevertheless, these participants shared that they managed this situation through formal and informal discussions, (e.g., during handover meetings), to communicate their thoughts and observations of using the pet robots, which helped them tailor their use with residents.

Participants from all nursing homes shared that individual assessments are conducted for all residents. Therefore, most expressed confidence in identifying residents who liked pets and may benefit from pet robots. Since the planning of activities for residents typically usually took place in advance, and pet robots were described as an extension to existing activities, some participants felt that it would not be difficult to integrate it into existing work processes. This was echoed by some participants who had used the JfA cat, who felt it aligned with workflow and resources:

"That's the beauty of that. You don't need extra people to administer that (pet robots).. a very important part of anything introduced into long-term care because it really has to be sustainable. No matter how strong people feel about something or how good something is, if there's a lot of manpower and time needed, it's hard to see that through [HCP5]".

Furthermore, since most residents spend time in a communal room, most nursing staff expressed that they could readily support residents to use pet robots in such communal spaces as a part of their routine work. However, some participants highlighted challenges or potential challenges of using pet robots in communal spaces, such as jealousy between residents, or having residents who dislike them: *"Some enjoyed the (JfA) cat, then there was one lady though… it annoyed her. We ended up having to sort of take the cat out of the room [HCP5]".*

Management support and a supportive learning climate was described as being important.. However, some organisational leaders and occupational therapists felt a lack of capacity to support implementation due to competing responsibilities. Others expressed the need for more information on how to use and manage pet robots. In terms of the relative priority for pet robots, some participants expressed that pet robots were especially relevant during Covid-19, since visitations to nursing homes were restricted. For example, one participant shared that pet robots were introduced into her nursing home during Covid-19, when volunteers could no longer bring in live animals for animal-assisted therapy. However, a few felt that spending financial resources on PARO, in consideration of its cost, should not be prioritised: *"I understand it's all technology, but there's so much more that could be bought with that kind of money, we could put that money towards getting a seven seater car to get them out [HCP3]*". Others shared similar sentiments, citing many existing interventions, or a smaller proportion of residents with dementia among their resident population to benefit from robots.

Domain 4: Characteristics of Individuals

This domain describes determinants related to individuals involved in the implementation, such as self-efficacy, knowledge and beliefs. Most participants reported that pet robots had a place in dementia care within nursing homes, and believed that technology will be increasingly used to support caregiving. They believed that residents' needs are evolving, and newer generations of older adults would be more attuned to using pet robots:

"Years ago, it was mass and it was prayers. That's out the window. The teddy bear and the pet robot, this all does mean something to them (residents)" [HCP8].

Many participants shared beliefs that residents deserve quality of life, and all staff would be supportive of interventions that can benefit residents: *"At the end of the day it's all about supporting them. When you come into a nursing home, you're on your end of life journey, you're basically living in the end. If it (pet robot) makes that journey better, absolutely [OL3]".* Furthermore, staff derived satisfaction from residents' joy from interacting with the robots: "They love it… when you see them laughing and see them so happy. That means a lot, they're here to live, not here just to be here [HCP7]". One participant reported initial scepticism when doll therapy was first introduced within her organisation. After discussions and seeing the impact of dolls on residents, staff grew to be accepting of them. By the time pet robots were introduced, staff showed similar support. The participant also described shared principles of going with residents' reality in facilitating the adoption of pet robots as a part of routine dementia care:

"As time has gone by, we've come to realise that it's how that person sees that cuddly robot, that's what matters. We adjust to their reality now. If this gentleman thinks that it's a real dog we go with that, rather than trying to bring him into our reality [HCP5]".

On the other hand, a participant emphasised the need to use them with residents who could distinguish them as robots: *"you don't actually want somebody associating with it as if it was a real animal, it could cause further distress down the line if they feel 'well I've never seen it eating' [HCP10]". However, some expressed confidence in managing such situations, such as residents' attachment to pet robots: "You'd have some other thing up your sleeve.. You know them so well that you'd know how to deal with a situation.. would be second nature sort of thing [HCP8]".* Nevertheless, a few were uncertain or ambivalent of their place in nursing homes, felt they suited children or expressed preferences for live pets.

Domain 5: Implementation Process

This domain describes determinants related to strategies for implementing pet robots, such as planning and engaging stakeholders. Participants identified key stakeholders who are, or should be involved in the implementation of robots. This included activity coordinators, nurses, healthcare assistants, management staff, occupational therapists, residents and family members. Discussion and information sessions were described as necessary for stakeholder buy-in. The implementation process should include an assessment of residents' preferences for animals, interests, and risk of distress as a part of tailored, person centred care. As family members are typically involved in care planning for residents, participants felt it would not be difficult to involve them. In fact, participants shared that family members could support the implementation of pet robots by advising on how to tailor their use for residents. A functional assessment of residents' cognition, communication, sensory and motor skills was described by occupational therapists as being necessary:

"Whether somebody has sufficient fine and gross motor skills, whether they're mobile, can they verbalise their needs. You'd want to be careful that something that's 2.5KG (PARO) doesn't end up being a restraint inadvertently… In line with the service provided to residents and our duty of care, we'd probably feel better that it would be assessed [HCP10]".

This would guide justifications for use, expected outcomes, and usage indications*: "It's around the assessment for them and the prescription for the length of time. Because they can get overstimulated by a sensory modulation strategy as well and it can actually lead then to more agitation.. it's around knowing how best to use it [OL10]"*. Participants suggested that there should be a designated person-in-charge of the robots, responsible for ensuring that their cleaning, maintenance, storage and usage are upkept. Nevertheless, all staff should know how to use the robots, since different staff may be involved in the care of residents each day: *"it could potentially be a bit of a barrier if nobody really knows what's happening [HCP2]".* Participants who had used robots reported that staff would share observations and feedback with each other, discussing ways to manage situations. This need for ongoing review was also raised by other participants, who expressed that it is necessary to consider that residents' needs, ability and preferences may change over time, and this can affect the appropriateness of pet robots for residents over time: *"people's cognitive function can change over time. And the robot may not be appropriate, it might end up in the back of a press and never taken out again.. I think (a regular review) should be factored into the service of the nursing home" [OL1].*

Discussion and Implications

To the best of our knowledge, this is the first study to explore multilevel determinants to implementing pet robots in nursing homes for dementia care. Although we anticipated participants to not have prior experiences of using pet robots, some had used them in practice. The determinants described by both groups of participants were generally congruent, although there were some differences in the 'inner setting' and the 'characteristics of individuals' domains. The cost of pet robots, particularly in relation to PARO, was described as a barrier in relation to other contextual considerations. Participants appeared to conceptualise evidence on pet robots based on non-empirical evidence sources. Although participants (especially those without experiences of using pet robots) expressed desires to learn about other organisations' experiences, most nursing homes appeared to be working in silos. While the interactivity of pet robots are described as important for engaging residents, participants felt that the interactive features should be balanced with overall affordability. Sentiments on available resources, knowledge and information differed, likely due to different organisational processes, interdisciplinary differences or personal experiences of using pet robots. Despite professional differences, residents' wellbeing was described as a central priority for all participants. Nevertheless, participants had different beliefs about how pet robots should be used with residents. Overall, determinants within all five domains of the CFIR were interrelated - these interrelations will be further discussed below.

Cost was described as a highly salient determinant. Like several studies involving PARO (11), our participants cited cost as a significant barrier. They further elaborated on this in relation to several individual, organisational and external contextual considerations, such as residents' needs and resources, internal and external infection control mandates, funding and financial constraints. Furthermore, participants perceived insufficient evidence on its impacts on residents, especially for longer-term engagement. Nevertheless, their expectations of robots appeared to be mediated in relation to the JfA cat, likely due to markedly lower cost. Economic accessibility to the different pet robots therefore highlights a pertinent gap between research and real-world needs (12). While there is research evidence to support the use of pet robots especially PARO (9, 10), there is a lesser volume of empirical evidence to support the use of the JfA cat (14, 37). However the lack of knowledge on their empirical evidence did not appear to have a negative impact on participants' perceptions of their evidence strength, as they referred to evidence from other sources - such as personal experiences with pet robots, an understanding of residents' unmet needs, and the intervention or supplier source (website for medical supplies). These non-empirical evidence sources facilitated the adoption of the JfA cat as part of their routine work in nursing homes. While participants also expressed the desire for external evidence, such as access to findings from trials or experiences of other nursing homes, there appears to be minimal networking between organisations, which could explain differing levels of implementation. Participants' description of residents' unmet needs - such as loneliness, anxiety, and reduced functional capacities - resonated with synthesised findings on the self-reported needs and experiences of nursing home residents with dementia (38).

Like other studies, where PARO better supported residents' engagement compared to a (non-interactive) alternative (39) our participants also described the realisticness and interactive features of robots as important. However, some doubted the need for advanced interactive abilities, especially if this significantly increase costs. This resonates with a cost-effectiveness study showing that using plush toys were marginally greater value for money than PARO in improving agitation among residents with dementia in care homes (40). While interactive, lower-cost options such as the JfA pets and Tombot (robot dog) are emerging as potentially more cost-effective options for dementia care, there have been no previous studies comparing robots with different interactive abilities. Future studies are needed to address this gap.

Many participants expressed that robots had addressed, or had the potential to address residents' needs. Their considerations also entailed residents' previous occupational roles as pet owners and lovers. As many Irish older adults had experiences with pets, having a pet robot in the nursing home was somewhat synonymous with a 'typical Irish home', which was thought as a culturally relevant way of enhancing the familiarity of the environment for residents with dementia (41). To meet these needs, participants emphasised that residents' individuality should be respected by considering their design preferences and abilities. In other words, as with other interventions (42), residents should be given the opportunity to uphold their values by choosing a robot that best resonates with them. In terms of product development, developers should also place more emphasis on designing robots to meet these needs. Participants' description of residents' needs were often accompanied by mentions of HIQA's influence on organisational activity provision and person-centred care. Some mentioned about disincentives related to the non-compliance to HIQA's standards, suggesting that their mandate on infection prevention and control is an important implementation determinant.

Participants had differing sentiments on available resources, knowledge and information, which could be attributed to different organisational processes and structures, disciplinary skillsets and responsibilities. Many organisational leaders, nurses and activity coordinators described "slack resources" (43) within their workflow - such as dedicated time for activities and admission assessments - would enable/has enabled them to 'squeeze time' to incorporate pet robots into their work routine. However, opinions on the need for more information on the management and use of robots were varied. Some organisational leaders and OTs emphasised that more comprehensive assessment and re-assessments are needed to ascertain residents' suitability and need for pet robots, and to design or prescribe individualised intervention plans. Congruent with previous research (12, 44), some participants saw this as necessary to minimise risk of distress from issues such as capacity changes or overstimulation. Nevertheless, allied health professionals highlighted significant manpower and time constraints to support implementation, due to staff shortages . For instance, not all organisations in our study had occupational therapy services. This can inform implementation planning , such as strategic involvement of different stakeholders in different implementation phases, to best leverage different skillsets and resources (45). Participants agreed that intervention sustainability can be compromised if it demands additional manpower and time. Correspondingly, participants with experience of using robots described their support on caregiving for residents with dementia as facilitators. Ironically, there is a scarcity of studies evaluating the impact of pet robots on caregiving and care processes. Future studies on robots could consider conducting a process evaluation and include these as points of evaluation. Some participants including organisational leaders, perceived a low priority for implementing pet robots, citing reasons such as an existing number of interventions for residents, or a small proportion of residents with dementia. This suggests that apart from considering residents' needs, organisational needs and workflows should also be considered at the outset.

Despite professional differences, all participants described residents' wellbeing as a central priority. Therefore, although some staff were initially sceptical or ambivalent about using robots, their attitudes changed after observing their impacts on residents. This finding is supported in the literature (19), suggesting that real-world experiences of using pet robots and evidence from clinical and patient experiences, are necessary to facilitate their uptake. While a few emphasised the importance of ensuring residents' awareness that robots are not real, most reported comfort with using it with residents regardless of their ability to distinguish it from a live pet. While the ethical issue of 'deception' has been critiqued in the literature on pet robots (46), such concerns did not appear to manifest as strongly in practice. This suggests a gap between philosophical ideals and their application to clinical needs and practices. In fact, ethical arguments in the literature appear to be shifting towards acknowledging deception and weighing their impacts on users (47). This aligns with participants' explanation of entering residents' reality, where they supported residents' belief of robots as live animals, with intentions to support their care. This is similar to the concept of "therapeutic lying", which is underpinned by principles of empathy, compassion, knowing the person; and is performed to mitigate distress in people with dementia (48). Similar to existing ethical arguments (46), some participants who did not have experiences with pet robots had concerns that residents may have negative reactions or become attached. However, those with experiences has different views, and reported confidence in managing such situations through professional experiences and discussions with colleagues. This highlights the importance of joint discussion and actions by all key stakeholders to facilitate the adoption of robots in clinical practice.

Limitations

Like other qualitative studies, there is a likelihood of response bias, where participants may be reluctant to share barriers, especially about their own organisations. Although we aimed to be inclusive and remained responsive to emerging data during analysis, using the CFIR a priori may have led to the exclusion of other determinants. Although some participants had seen or used a pet robot, some had not and based their reporting on a video (i.e., not from actual experiences of use). Nevertheless, the determinants reported by participants with and without experiences were largely congruent, suggesting that anticipated determinants were similar to the actual ones. Determinants of implementation may vary across different countries, where organisations may be governed by different contextual factors. Yet, our study was built upon known domains of implementation, and our findings resonate with findings from international literature. As such, they provide a good general overview of the determinants of implementing pet robots for nursing homes for dementia care.

Conclusions

In this study, we explored and identified determinants that manifested within all five domains of the CFIR, from the perspectives of organisational leaders and healthcare professionals in nursing homes. The contribution of this study is twofold: it addresses a pertinent knowledge gap in the field of pet robots in the context of dementia care in nursing homes, where little attention has been paid to gain a comprehensive understanding of factors that can impede or enable the implementation of pet robots in real-world practice. Interrelations between determinants clearly highlight that determinants do not occur in silos, and a thorough understanding of multilevel factors should be considered when ascertaining the implementability of pet robots in nursing homes for dementia care. Incongruences between different determinants were also highlighted. For instance, while learning about other organisations' experiences of pet robots was described as supporting evidence to facilitate the use of pet robots with residents with dementia (CFIR Domain: Characteristics of pet robots), most nursing homes in the study described minimal networks with other organisations (CFIR Domain: Outer setting). Secondly, these findings are of practical utility for researchers and stakeholders from nursing homes, as they provide a springboard for identifying and designing contextually relevant implementation strategies to guide the translation of pet robots from research into real-world practice.

List of abbreviations

CFIR: Consolidated Framework of Implementation Research

HCP: Healthcare professionals

OL: Organisational leaders

PLWD: People living with dementia

Declarations

Ethical approval and Consent to Participate

All methods were performed in accordance with the relevant guidelines and regulations. This study was approved by the Research Ethics Committee in the National University of Ireland Galway (Ref no: 2020.10.014). Written and verbal informed consent was obtained from all participants prior to the study.

Consent for publication

Not applicable

Availability of data and materials

The framework that was developed and applied to the dataset is available as a supplementary file. The data generated and analysed in this study is not publicly available in order to maintain participant privacy and confidentiality. However, deidentified parts of the interview transcripts may be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WQK, ET and DC contributed to the conceptualisation of the study and design. WQK conducted the data collection. WQK conducted the data analysis with initial input from AF, and feedback from all authors. WQK wrote the first draft of the manuscript. ET and DC provided intellectual contributions on the manuscript drafts. All authors approved the final version of the manuscript and take responsibility for its content.

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Chapter Summary

This paper described a descriptive qualitative study which explored the determinants of implementing pet robots in nursing homes for routine dementia care. It built on findings from the preceding scoping review in paper four (Chapter 5), where the emphasis was on addressing critical knowledge gaps such as contextual influences on implementation. This study also placed emphasis on exploring the implementation of pet robots in nursing homes. The CFIR was used to guide the comprehensive exploration of multilevel implementation determinants.

Ten healthcare professionals and 12 organisational leaders from eight nursing homes were recruited for individual, semi-structured in-depth interviews. Findings were mapped onto various constructs within the five CFIR domains. In the first domain ‘intervention characteristics’, determinants related to the comparative advantages of pet robots, their design features, supporting evidence and costs. In the second domain ‘outer setting’, determinants included the alignment of pet robots to regulatory authorities’ guidelines and networks with other organisations. In the third domain ‘inner setting’, determinants included the congruence of robots with residents’ needs, work processes, and organisational priorities. In the fourth domain ‘characteristics of individuals’, determinants related to care providers’ knowledge and beliefs. In the fifth domain ‘implementation process’, the planning and assessment of residents’ suitability for pet robots were described as determinants. Although only one-third of the participants had the experience of using pet robots with residents with dementia, the sentiments between those with and without experiences were largely similar. This study provided deeper insights into the multilevel determinants of implementing pet robots, thereby addressing critical knowledge gaps outlined in the scoping review.

Overall, papers four (Chapter 5) and six (Chapter 7) provided a comprehensive understanding of multi-level implementation determinants. Findings from these provided a robust springboard for identifying strategies to support the implementation of pet robots for PLWD in long-term care facilities.

Chapter 8: Strategies for implementing pet robots in care homes and nursing homes for people living with dementia: Protocol for a modified Delphi process

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Prologue

This chapter presents paper seven, which outlines the protocol for a modified Delphi study that builds upon findings from the preceding studies (chapters five and seven). The purpose of this study was to identify, contextualise, and achieve expert consensus on the most relevant strategies for implementing pet robots in care homes and nursing homes for residents with dementia.

Abstract
Background

Pet robots are a type of technology-based innovation that have shown positive psychosocial benefits for people with dementia in residential facilities, such as improving mood, social interaction and reducing agitation. Nevertheless, little is known about how pet robots can be implemented in care homes and nursing homes for dementia care in real-world practice. The objectives of this study are to: 1) Identify contextualised implementation strategies for implementing pet robots into care homes and nursing homes for dementia care, and 2) achieve consensus on the most relevant strategies.

Method

This study is informed by a preceding scoping review and qualitative study, which used the Consolidated Framework of Implementation Research (CFIR) to identify multi-level determinants of implementation (i.e. barriers and facilitators). We will use the CFIR-ERIC matching tool to identify relevant implementation strategies from the Expert Recommendations for Implementing Change (ERIC) taxonomy to address these determinants. Data from the scoping review and qualitative study will be used to contextualise the generic ERIC strategies for our setting. After that, a group of key stakeholders will be consulted to further contextualise and refine these strategies. Next, a two-round modified Delphi process will be conducted. 54 international expert participants including healthcare professionals and organisational leaders from care homes and nursing homes, and academic researchers will be recruited through purposive sampling. During the first Delphi round, participants will be invited to rate the relevance of each implementation strategy on a 9-point Likert scale and provide comments or suggestions. Descriptive statistics will be used to identify whether consensus has been obtained. Inductive qualitative content analysis will be used to analyse and summarise textual responses for any new statements suggested by participants. Statements that d0 not reach consensus and new statements suggested in Round one will be taken to the next round, which will follow the same rating process.

Discussion

This study will identify strategies for implementing pet robots in care homes and nursing homes for residents with dementia, which will have practical utility for clinicians, organisations and researchers. It will also demonstrate the practical application (and adaptation) of the CFIR-ERIC tool to identify and contextualise ERIC strategies.

Trial Registration: Not applicable

Keywords: Implementation strategy mapping, implementation strategies, pet robots, social robots, implementation, care homes, nursing homes, consensus study, dementia

Contributions to the literature

- Pet robots are technological innovations to benefit the psychosocial health of people with dementia. However, little is known about how they can be implemented in real-world practice in care homes and nursing homes
- This study will use expert consensus to identify the most relevant strategies for guiding the implementation of pet robots in care homes and nursing homes for dementia care
- This study will demonstrate the practical application of theory, using the ERIC taxonomy of implementation strategies and the CFIR-ERIC tool, to guide the identification and systematic contextualisation of implementation strategies using empirical data

Introduction

Pet therapy, or animal-assisted therapy, have shown positive psychosocial benefits for people living with dementia (PLWD), such as improving mood, social interaction and reducing agitation (1). Nevertheless, the use of live animals can pose practical and logistical challenges, such as potential transmission of zoonotic diseases, or causing unintended injury to the animal or to the person living with dementia (1). Since the early 2000s, pet robots have emerged as technology-based substitutes for pet therapy. Early examples include Aibo, a robotic dog encased in a plastic shell and PARO, a realistically designed baby harp seal robot covered in a soft fur coat. PARO was developed to support the social and emotional needs of older people, including people with dementia. In the last decade, developers have continued to develop pet robots to encompass different design features. Examples include Pleo, a robot dinosaur, CuDDler, a robot bear, and the Joy for All (JfA) cat. Studies have shown that older adults and PLWD prefer realistically designed pet robots that are covered in soft fur coats, and have cited the JfA cat as their preferred design (2). Numerous empirical studies have been conducted to investigate the effectiveness and impacts of pet robots for PLWD in long term residential care, such as care homes and nursing homes (3-6). Synthesised findings suggest that the use of pet robots for PLWD resulted in reduced behavioural and psychological symptoms of dementia (BPSD), reduced agitation, improved mood and improved social engagement (3-5). While most effects have not been statistically significant due to small sample sizes and intervention heterogeneity, pet robots show promise as non-pharmacological solutions to improve the psychosocial health of PLWD (3-5). Despite numerous studies that have been conducted on their effectiveness and demonstrated their promise, the uptake of pet robots in real-world practice remain low (7-9). This is because traditionally, research follows a stepwise process, where the efficacy and effectiveness of an intervention has to be confirmed before its implementation is investigated (10, 11). However, this stepwise approach to research have promulgated marked time-lag between research discovery and uptake in real-world practice (10, 11). In other words, to improve the speed of knowledge creation and to improve the clinical relevance of pet robots in real-world practice, it is important to pursue knowledge on their implementation alongside investigation into their effectiveness (12, 13).

Determinants of implementation

To move pet robots into routine dementia care practice in care homes and nursing homes, it is important to first understand the determinants (i.e., barriers and facilitators) influencing their implementation. In a recent scoping review, we explored barriers and facilitators that influenced the implementation of social robots, including pet robots, for older adults and PLWD (4). Findings were synthesised using the Consolidated Framework of Implementation Research (CFIR), a framework that has guided the comprehensive exploration of implementation determinants. Within the CFIR, 39 constructs are grouped into five domains: 1) intervention characteristics, 2) outer setting (i.e., external influences on the implementing organisation), 3) inner setting (influences within the implementing organisation), 4) characteristics of individuals involved in implementation, and 5) implementation process. Barriers and facilitators from 53 included studies were mapped onto 18 CFIR constructs across five domains. Findings showed that existing studies have been largely focused on investigating the internal validity of social robots, and there has been a scarcity of studies that investigated contextual factors relating to their external validity. Consequently, we conducted a qualitative study, guided by the CFIR, to address gaps that were identified in the scoping review and to further understand barriers and facilitators to the implementation of pet robots in nursing homes for PLWD (14, 15). Barriers included a lack of customisability to suit residents' abilities and preferences, doubts about long-term use, prohibitive costs, lack of external funding, resources and knowledge, infection prevention mandates, and conflicting stakeholder views on the anthropomorphisation of pet robots (15). Facilitators included the realisticness and familiarity of pet robots, identification of residents' needs that can be met or were met using a pet robot, compatibility with prevailing regulatory guidelines and organisational care processes, intrinsic desires to improve residents' quality of life, and buy-in from stakeholders (15).

Implementation strategies

Following the identification of implementation determinants, implementation strategies that are feasible, effective and contextually-relevant that specifically target those determinants need to be identified to guide their implementation in practice. Implementation strategies are defined as "methods or the techniques used to enhance the adoption, implementation and sustainability of a clinical program or practice" (16). They can include single methods (i.e., discrete strategies) or a combination of methods (i.e., multifaceted strategies) that are chosen to enhance the implementation of an intervention. Powell and colleagues developed the Expert Recommendations for Implementing Change (ERIC), a taxonomy of 73 implementation strategies based on a review of implementation taxonomies, reviews and compilations, conceptual papers, empirical papers, and has been previously validated through a modified Delphi process involving clinicians and implementation scientists.

Mapping determinants to implementation strategies

There is little guidance in the implementation science literature about how to systematically select strategies to address implementation determinants (17). Therefore in practice, the selection of strategies does not always follow from determinants identified (17). To address this, Waltz and colleagues developed the CFIR-ERIC mapping tool, which was intended to map barriers that have been coded to CFIR constructs onto ERIC implementation strategies (18). However, as the CFIR constructs are often considered as determinants (i.e., barriers or facilitators), both identified barriers and facilitators may be mapped onto the tool, to generate potentially relevant strategies to address CFIR-coded barriers and strengthen CFIR-coded facilitators (19, 20). The outputs of this tool include implementation strategies in relation to the input on CFIR determinants, along with percentages, which reflect the proportion of experts that have endorsed the strategy as being appropriate to address each CFIR determinant (18). It has been previously used in empirical studies to guide the identification of implementation strategies (21-23), (www.cfirguide.org/choosing-strategies). This study aims to use our previous studies (14, 24) to identify relevant implementation strategies for identified implementation determinants, contextualise the strategies for our setting, and to obtain expert consensus on the most relevant strategies for implementing pet robots in care homes and nursing homes for PLWD.

Objective

The objectives of this study are to:

1) Identify and contextualise strategies for implementing pet robots into care homes and nursing homes for dementia care
2) Achieve consensus from a panel of international experts on the most relevant strategies for implementing pet robots in care homes and nursing homes for PLWD.

Method

The Delphi Technique

The Delphi technique is a research method that allows for the structuring of group communication, through a multistage process of sequential surveys or rounds (25), to allow "a group of individuals as a whole to deal with a complex problem" (26). It is used where the judgement of individuals (experts) can be combined to address a knowledge gap or lack of agreement (26). The modified Delphi is a variant of the classical Delphi (27), where the first qualitative round is omitted when statements for the survey can be derived from literature or previous research (28). This has been recommended for use (in place of the classical Delphi) to enhance study validity, since using an initial qualitative round to generate statements can subject the initial statements to biases (29, 30). For instance, the number of experts and their levels of expertise can influence the validity of the statements. Furthermore, initial qualitative responses that are gathered may create ambiguous and generic statements, which could lead to biases at the outset (29, 31). As such, using the modified Delphi technique can enhance the content and face validity of the survey (29).

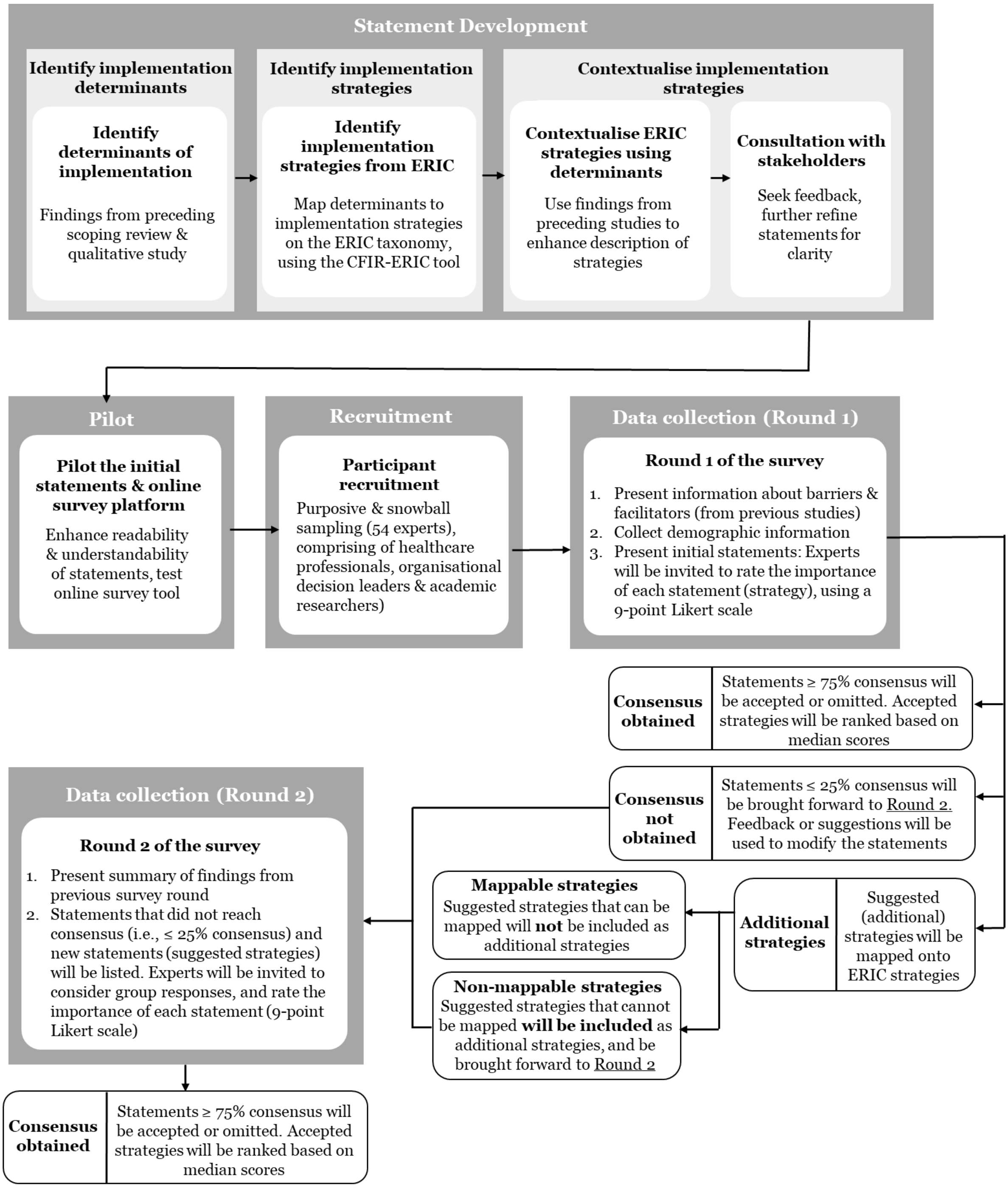
A two-round modified Delphi process was chosen as the most appropriate research method to address the research objective, as findings from the preceding qualitative study will inform the initial statements for the first survey round. The Conducting and REporting DELphi Studies (CREDES) guidelines (32) will be used to guide the design, conduct, and reporting for this study (Appendix 26). An overview of the study process can be found in Figure 1.

Statement Development

The determinants of implementation identified from our preceding scoping review (24) and qualitative study (14) and coded to CFIR will be used as a starting point. We will identify ERIC implementation strategies relevant to these determinants using the CFIR-ERIC mapping tool. This will allow a list of potentially relevant implementation strategies to be generated, along with a cumulative percentage to indicate the collective relevance of each strategy in addressing CFIR determinants. Whilst all the strategies in the ERIC taxonomy may be potentially relevant, not all should be considered as Delphi statements, as a longer list of statements have been associated with significantly lower response rates (26). To strategically balance the number of prospective statements with overall comprehensiveness, only implementation strategies with a cumulative percentage of over 100% will be selected.

The definitions (descriptions) of the ERIC implementation strategies are generic by design, as the authors intended for them to be broadly applicable (26). Accordingly, we will contextualise them for our setting by using the data from our preceding scoping review and qualitative study. The determinants identified in these studies will be used to describe each ERIC strategy. To minimise subjectivity in this process, this exercise will be verified by a second researcher. Meetings will be held to discuss any disagreements, until consensus has been met. Finally, to further contextualise the implementation strategies, we will purposively identify and consult with key stakeholders to discuss and refine the clarity and definition of each strategy. This will include at least one healthcare professional, one organisational leader from a care home/nursing home, one academic researcher, and one Patient and Public Involvement (PPI) member from the Dementia Research Advisory Team (33). These stakeholders will not be involved in the actual Delphi process. The identification and recruitment of these stakeholders will follow the same process as participant recruitment (outlined in the later section on recruitment).

Figure 1: Flowchart of study process



Finally, the statements and the Delphi process itself will be piloted to further refine and enhance the clarity of the statements and to address any potential issues related to the online survey platform (34). The final statements will constitute the initial statements for the first Delphi Round.

Participants (Expert Panel)

Baker and colleagues (2006) suggested that the knowledge and experience of individuals should be taken into account. Topic area knowledge relates to an individual's professional and/or academic qualification, which demonstrates that he or she has a level of predefined knowledge base in a topic or clinical area. Authors and co-authors' peer-reviewed publications are often considered as knowledge experts (35). Experience-based expertise refers to an individual's level of clinical or practical experience in relation to the research topic (35). As it is not possible to ascertain expertise solely based on the length of time spent in a field (35), other experience based criterion such as the nature of the individual's experience should also be considered. While some authors have argued for a homogenous sample of participants for Delphi studies (36), others assert the need for a heterogenous sample (37-39) to increase validity through incorporating diverse and varied perspectives (40). Based on these considerations, participants for this Delphi study will be selected for 1) topic-based knowledge expertise, as demonstrated through academic publications in relevant topic areas and 2) experience-based expertise, as demonstrated through practical experience. These will be outlined in the inclusion criteria below. The three main groups of participants will include: (i) healthcare professionals with experience of providing dementia care in care homes/nursing homes, (ii) organisational decision makers from care homes/nursing homes and (iii) academic researchers. Although PLWD are service users of pet robots, we did not include them as participants due to our focus on healthcare provider and organisational related contexts. For clarity purposes in this study, care homes and nursing homes are defined as institutions or facilities that provide long term residential care and support, and/or nursing care for residents (41). To support the external validity of the study findings, we aim to recruit participants from within Ireland and internationally.

(i) Care professionals

Care professionals such as nurses, healthcare assistants activity coordinators and allied health professionals (e.g. occupational therapists, physiotherapists and therapy assistants) can provide experience-based expertise about the implementation of pet robots for PLWD in care homes and nursing homes, as they influence the process of direct care provision. Healthcare professionals who meet the following criteria will be included:

- Have current or previous experience of providing care to PLWD in a care home or nursing home(s)
- Can read and understand English

(ii) Organisational decision makers (ODM)

Organisational decision makers, such as team leaders, managers and directors, may be considered as indirect care providers who provide care services that may not require interaction between provider and the PLWD. It is necessary to involve this group of key stakeholders, as they can offer experience-based perspectives on implementation strategies from a managerial point of view. Organisational decision makers who meet the following criteria will be included:

- Have current or previous experience as a manager/leader in a care home or nursing home that provides care for PLWD
- Can read and understand English

(iii) Academic researchers

Academic researchers with publications in the field of implementation science and in using technology and/or psychosocial interventions in dementia care in care homes or nursing homes, can contribute valuable topic-based knowledge expertise. As such, they are an important stakeholder group that should be included in the expert panel. Academic researchers who meet the following criteria will be included:

- First, second or last-author in at least one peer-reviewed publication in at least one of the following research fields within the last ten years: (i) implementation research in care/nursing home settings, (ii) psychosocial interventions for PLWD in care/nursing homes or (iii) using technology for dementia in care/nursing homes
- Can read and understand English

Recruitment

(i) Healthcare professionals and organisational decision makers

First, the lead researcher (WQK) will contact care homes/nursing homes in Ireland and in the United Kingdom (UK) that provide care for PLWD. Based on the list of homes identified on the Irish open data portal (42), the researcher will systematically identify ones that provide care for PLWD, using information from the Health Information and Quality Authority (HIQA) inspection reports. Organisations will be informed about this study, and invited to disseminate information about this study to staff. Care homes and nursing homes in the UK will be identified in collaboration with the Enabling Research in Care Homes (ENRICH), using the same process as outlined above. Second, the researcher will advertise the study through social media and by reaching out to healthcare professional bodies in the UK and Ireland, such as the Association of Occupational Therapists of Ireland and the National Activity Providers Association (UK), who will be invited to disseminate notices of this study to members. Those who express interest will be invited to contact the researcher for more information. Finally, the researcher will draw on her networks and connections to identify prospective participants.

(ii) Academic researchers

The first, second and/or last authors in peer-reviewed publications in implementation research, using technology and/or psychosocial interventions in dementia care in care homes/nursing homes will be identified and invited to participate. Next, an email will be sent to a representative from the INTERDEM (Early detection and timely INTERventions in DEMentia) network, a pan-European network of dementia researchers, who will be invited to disseminate information on this study to researchers in the network. Notices of this study will also be advertised through social media. Lastly, the researcher will also draw on her networks and connections, such as the DISTINCT (Dementia: Intersectoral Strategy for Training and Innovation Network for Current Technology) consortium. Similarly, those who express interest will be invited to contact the researcher for more information and invited to participate if eligible.

Sampling strategy

Purposeful sampling will be used to select experts for the study based on the expertise and experiences of individuals (39), as per the inclusion criteria. Snowball sampling will also be used as a secondary sampling technique. Participants will be asked if they have colleagues who would be eligible and interested, who can contact the researcher to discuss participation.

Sample size

There is no set standard for sample size of a modified Delphi panel. It has been suggested that the number of panelists could range from 10 to 18 panel members per area of expertise (43-45). Taking into consideration the median sample size based on these recommendations for a total of three groups of key stakeholders, the target sample size for this study is 42 participants (i.e., 14 panel members per area of expertise). Because the Delphi technique requires time and participants' commitment, a drop out is likely to happen (46, 47). Retention rates throughout the Delphi process from the first to the final round have not been reported consistently in the literature (47), and have ranged from 19.5% to 87.1% (34, 48-51). In consideration of the lower attrition margin of 20%, an initial sample of 54 participants will be recruited (i.e., 18 participants from each group). Measures will be taken to maximise the retention of participants, and this will be described in the later section.

Data collection and analysis

Data collection is expected to start in March 2022 and expected to be completed within a three month period by May 2022. Information about implementation determinants will be provided to participants, and two rounds of survey will be administered via an online platform (QuestionPro), and distributed to individual participants via email.

Round one

The first round of the survey will include three sections. In the first section, an executive summary of the determinants of implementing pet robots, based on the barriers and facilitators identified from preceding studies, will be presented. This is an important step for participants to have knowledge on the identified determinants of implementing pet robots before commencing the survey to identify relevant strategies. In the second section, demographic information will be collected. This will include information such as participants' gender and profession. Information about expertise will also be collected. For academic researchers, information about the number of years working in the field of implementation science and/or dementia research will be collected. For healthcare professionals and organisational decision makers, respective information about the number of years providing care for PLWD, and the number of years that they have held a management role in care home or nursing home(s) will be collected.

In the third section, participants will be presented with statements, and be invited to rate the importance of the implementation strategies. While there is no gold standard for selecting an appropriate scale for consensus processes to identify implementation strategies (52), nine-point scales have been recommended by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group to assess the importance of research evidence (53), and have been suggested to have more discriminatory power than other scales (54). As such, a nine-point Likert scale will be used. A score of 1 to 3 indicates limited importance; 4 to 6 indicates that a strategy is important but not critical; 7-9 indicates that it is important and critical. A comment box will also be included for each statement, where participants will be invited to provide optional explanations for their responses, and/or offer suggestions to revise its definition. At the end of the survey, participants will be given the option to suggest up to three additional strategy that they feel warrant inclusion. The survey will be fully anonymised to ensure that dominant participants do not unduly influence group consensus. Participants will be given up to three weeks to provide responses for each modified Delphi round. Email reminders will be sent at weekly intervals.

Data generated from the first round will be extracted for analysis on the Statistical Package for the Social Sciences (SPSS) version 21. Descriptive statistics will be used to identify whether consensus has been obtained. Inductive qualitative content analysis will be used to analyse and summarise textual responses (55). The distribution of participants' responses, including the median and interquartile range of responses (56), will be calculated to determine the level of consensus and the extent (ranked based on the median scores) to which experts found an implementation strategy important. Based on the results, statements that achieved 75% consensus (At least 44 out of 54 participants rating a statement with a score of 1 to 3, 4 to 6, or 7 to 9) will be accepted or omitted from the recommendations. This level of agreement is based on findings from a systematic review, which found that 75% consensus was deemed a most appropriate cut off point in previous Delphi studies (57).

The Kruskal–Wallis test will be used to test whether groups of experts differed significantly from each other in opinion about the implementation strategies. Items on which the groups differed will be further explored using the post hoc pairwise Mann–Whitney U test, to investigate which groups differed from each other. Statements not meeting 75% agreement will be brought forward to the next round. If feedback or suggestions are provided, they will be used to modify the statements. Additional strategies that are suggested by participants will be mapped onto the list of ERIC strategies – if the suggested strategy has already been included as an ERIC strategy, it will not be included as a new strategy. Conversely, if they have not been included as an ERIC strategy, it will be listed as a new strategy and brought forward to the next survey round.

Round Two

The second round of the survey will explore if further consensus can be reached for items for which there was no consensus obtained in the first round. In the first section, findings from the previous round will be presented. This includes the list of statements that did not meet consensus, and feedback of statistical data and comments to allow them the opportunity to reflect on the group response and reconsider their initial responses (58). In the second section, statements that did not meet consensus and new statements (suggested additional strategies) will be listed. Like the previous round, participants will invited to rate the relevance of the statements on the nine-point Likert scale. They will be given up to three weeks to provide responses. Similar to the previous round, email reminders to complete the survey will be sent weekly. Data analysis will follow the same process as described in Round 1. Statements will be included into or omitted from the list of recommended implementation strategies if a consensus of 75% has been achieved, ranked and reported according to median ratings.

Participant retention

To minimise attrition rates, it is important to keep participants fully engaged in the study (59). Different methods will be used to maximise the retention of participants. First, engagement barriers related to comprehension (34) will be minimised through the process of consulting with stakeholders to contextualise statements and by piloting the statements. Second, participants will also be provided with explicit expectations about the intended time commitments and tasks, which includes clear information at the outset of the study to ensure that each participants will know how much time they will be expected to contribute (including the expected duration of the study), what they will be asked to do (34, 60). Third, individualised emails will be used to remind and encourage participants to complete each round of the survey (34). In the emails, the researcher will also emphasise that their expertise and views were important, and provide an update of the number of experts that have completed the survey so far (34). These strategies have been reported to be helpful for maximising participant retention (34, 61, 62).

Rigour

Several strategies will be taken to ensure rigour, so that the use of the Delphi technique can be considered a reliable and credible source of evidence. First, instead of using a classical Delphi (where a qualitative first round is used to generate statements), statements for this study will be generated from the findings of two preceding research studies. A structured process and stakeholder consultation will be used to guide the selection and refinement of implementation strategies - this arguably enhances the reliability (63), content validity and face validity of the initial statements (29). Next, construct validity will be ensured through the process of Delphi iterations. As the researcher summarises group responses from each Delphi round and shares the summary with experts, it provides them with the opportunity to check and validate their responses (45, 64). Finally, the CREDES guidelines will be used to enhance rigour during conduct of the study, and guide the transparent reporting of findings (32).

Limitations

The potential limitations of this study should be acknowledged. First, our preceding qualitative study (to explore implementation determinants), was conducted with participants from nursing homes in Ireland, which may limit the generalisability of these determinants. Nevertheless, these findings were triangulated with findings from our scoping review, which synthesised findings from studies conducted in other countries. Next, while several data sources and expert opinions were sought to develop the ERIC taxonomy and CFIR-ERIC tool, which can guide the systematic selection of implementation strategies, the evidence base behind each strategy were not considered. To mitigate impact of this potential limitation and to support the utility of the ERIC strategies, we will employ a systematic process of contextualising them using findings from our previous studies and through stakeholder consultation. Finally, while we will employ PPI to contextualise implementation strategies, this study will not include PLWD as study participants although they may be able to provide valuable perspectives based on lived experiences of dementia. Future studies with more time and resources may consider adapting this study (65) to involve PLWD in consensus studies to refine or build on strategies that were identified in the current study.

Discussion

This study will address critical gaps in knowledge on how pet robots can be translated from research to clinical practice. This work will carefully consider and integrate multiple, rich sources of data (qualitative data, synthesised literature, stakeholder input, PPI input, and the modified Delphi technique), to identify the most relevant strategies to implement pet robots in clinical practice in care homes and nursing home settings. The process will also involve the practical application of theory by using the ERIC taxonomy of implementation strategies and the relatively new CFIR-ERIC tool, to guide the identification and systematic contextualisation of implementation strategies. We have also carefully considered the potential limitations, and made efforts to mitigate these within the time and resource constraints. Findings will have practical utility for academic researchers, clinicians and organisations, as they provide a practical starting point to support the implementation of pet robots in care homes and nursing homes for residents with dementia.

In line with principles of good dissemination (66), findings from this study will be disseminated with all key stakeholder groups through different platforms, including a peer-reviewed publication, national and international conference presentation(s), through social media, websites and newsletters for different audiences.

List of abbreviations

CFIR:	Consolidated Framework of Implementation Research
ENRICH:	Enabling Research in Care Homes
ERIC:	Expert Recommendations for Implementing Change
PLWD:	People living with dementia

Declarations

Ethical approval and Consent to Participate
This study received approval from the Research Ethics Board at the National University of Ireland Galway on 24 February 2022 (REC reference number: 2022.02.014)

Consent for publication
Not applicable

Availability of data and materials
Not applicable

Competing interests
The authors declare that they have no competing interests.

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Authors' contributions
WK conceptualised and designed the study, coordinated the ethics application and led the creation of the study protocol. ET provided guidance on the process of statement development, application of the conceptual framework and taxonomy. Both ET and DC provided guidance on the overall study design. WK wrote the first draft of the manuscript and processed all revisions to finalise the manuscript. DC, VH and ET contributed to the reviewing of all drafts. All authors approved the final version of the manuscript.

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Chapter Summary

This paper described the protocol for a modified Delphi study to guide the identification and contextualisation of implementation strategies. It also detailed the consensus-building process to establish expert consensus on the most relevant strategies for implementing pet robots in long-term care settings for PLWD.

Chapter 9: Strategies to implement pet robots in long-term residential facilities for dementia care: A modified Delphi study

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Prologue

This chapter presents paper eight, a modified Delphi study which aimed to establish expert consensus on the most relevant strategies to implement pet robots in long-term care settings for routine dementia care.

Abstract

Objectives

Pet robots are a technology-based substitute for live animals that have demonstrated psychosocial benefits for people living with dementia in long-term care. However, little research has been conducted to understand how pet robots should be implemented in routine care. This study aims to identify, contextualise and achieve consensus on strategies to implement pet robots as part of dementia care in long-term care facilities.

Design

A two-round modified Delphi study.

Settings and Participants

An international panel of 56 experts from 14 countries, involving care professionals, organisational leaders and researchers

Methods

A list of potentially relevant strategies was identified, contextualised and revised using empirical data and through stakeholder consultations. These strategies constituted statements for round one. Experts rated the relative importance of each statement on a nine-point scale, and free-text fields allowed them to provide justifications. Consensus was predefined as ⩾75% agreement. Statements not reaching agreement were brought forward to round two. Quantitative data were analysed using descriptive statistics, and textual data were analysed using inductive content analysis.

Results

Thirteen strategies reached consensus; 11 were established as critical: 1) assess readiness and identify barriers and facilitators, 2) purposely re-examine the implementation, 3) obtain and use residents' and their family's feedback, 4) involve residents and their family, 5) promote adaptability, 6) conduct ongoing training, 7) conduct educational meetings, 8) conduct local consensus discussions, 9) organise clinician implementation team meetings, 10) provide local technical assistance, 11) access new funding. Other strategies received differing extent of agreement. Reasons for variations included contextual differences, such as resource availability, organisational structures, and staff turnover.

Conclusions and Implications

This study identified the most relevant strategies that can be used by technology developers, care providers and researchers to implement pet robots in long-term care facilities for dementia care. Further development, specification and testing in real-world settings are needed.

Keywords: Implementation strategies, knowledge translation strategies, implementation science, implementation research, social robots

Introduction

Dementia affects approximately 55 million people worldwide, and this figure continues to rise alongside a rapidly ageing population [1]. Approximately 51.8% to 80% of residents in long-term care (LTC) facilities have dementia [2-4]. Residents with dementia have been described to be disengaged or minimally engaged in their daily lives [5]. They have also expressed the lack of (and need for) meaningful and individualised activities, desires to maintain previous life roles, and to experience freedom and choice [6]. Unmet needs reduce quality of life [7] and exacerbate behavioural and psychological symptoms of dementia (BPSD) such as aggression and apathy [8]. There is growing interest and evidence for non-pharmacological interventions to enhance the social health of people living with dementia (PLWD) [9]. Pet robots were developed nearly three decades ago to support the psychosocial health of PLWD. Numerous studies have demonstrated pet robots as a promising psychosocial intervention for PLWD in LTC, such as reducing agitation, improving mood and social interactions [10-14]. Despite over a decade of research to evaluate their impacts, there is a dearth of knowledge on the 'how' to translate them into practice. To support their uptake as a part of routine dementia care, it is vital to advance knowledge on their implementation to minimise the research and practice gap [15 16].

A scoping review explored the determinants of implementing social robots (including pet robots) for older adults and PLWD [17]. The review was guided using the Consolidated Framework of Implementation Research (CFIR), a determinant framework that guides the comprehensive exploration of 39 constructs within five domains that can influence the implementation of interventions [18]: *(1) intervention characteristics, (2) outer setting* (determinants external to the organisation), (3) *inner setting* (determinants related to characteristics of the organisation), *(4) characteristics of individuals* involved in implementation, and *(5) implementation process*. Among 53 included articles, 23 were conducted in LTC for older adults and PLWD. Implementation determinants were mapped onto 18 CFIR constructs. They included different preferences for robot designs, cost, (in)compatibility with work processes, time and manpower, and differing attitudes from family and care providers. Most studies were focused on understanding determinants relating to the intervention characteristics, with significantly less focus on other domains, such as organisational attributes or external influences. Consequently, a qualitative study was conducted to further explore the determinants of implementing pet robots in nursing homes for dementia care [19], where attention was paid to understanding gaps identified from the review. Determinants were mapped onto 28 CFIR constructs. Examples include costs, external funding and policies, resources, organisational or regulatory mandates, and conflicting stakeholder views.

This study aims to establish expert consensus on the most relevant (important) strategies for implementing pet robots in LTC facilities for dementia care, based on implementation determinants established from the preceding studies. We operationalised 'consensus' as the level and extent of agreement amongst experts [20].

Objectives

The study objectives are:

1) Identify and contextualise strategies for implementing pet robots for dementia care in long-term care
2) Achieve consensus from an international panel of experts on the most relevant strategies for implementing pet robots for dementia care in long-term care

Method

A two-round modified Delphi process was conducted. Methods are detailed in a published protocol [21] and briefly described here. The Expert Recommendations for Implementing Change (ERIC) and the CFIR-ERIC mapping tool were used to guide the study. ERIC comprises 73 implementations strategies [22] organised into nine conceptually distinct categories: develop stakeholder interrelationships, evaluative and iterative strategies, train and educate stakeholders, adapt and tailor to context, provide interactive assistance, engage residents and their family members, utilise financial strategies, support clinicians, and change infrastructure [23]. The CFIR-ERIC tool [24] is a tool to match CFIR determinants to implementation strategies in ERIC. The mapping process generates a list of potentially relevant strategies, ranked based on each's cumulative percentage generated by the tool's algorithm. The algorithm aggregates the proportion of participants (involved in the tool's development) who endorsed the strategy's applicability to address each CFIR determinant. A higher percentage indicates the strategy's potential relevance in addressing implementation determinants. The Guidance for Conducting and REporting Delphi studies (CREDES) guidelines [25] guided reporting (Appendix 28). This study received ethical approval from *(name of institution, blinded)* (Reference: 2022.02.014).

Expert panel (Participants)

Purposive and snowball sampling was used to recruit three key groups of experts with knowledge and/or experience-based expertise [26]: organisational leaders with leadership positions in LTC facilities and care professionals with experience providing care for residents with dementia were chosen for their context-specific, experience-based expertise [27]. These LTC facilities included nursing homes and care homes which provide personal and/or skilled care for residents. Researchers with expertise in psychosocial interventions, social robots and implementation research in LTC were included for their topic-based expertise [27]. Experts were identified from multiple avenues, including contact with LTC organisations, professional bodies, a trans-European research network, peer-reviewed publications, social media and personal connections. Our target sample size was 42 experts, based on recommendations from previous studies [21]. However, we aimed to minimally recruit 54 experts to account for at least 20% attrition. All eligible participants were invited to participate through individual emails, containing an invitation letter and an information sheet. Informed consent was obtained.

Statement development

Initial statements for the modified-Delphi were developed using empirical and conceptual data. Implementation determinants were identified from a preceding scoping review [17] and qualitative study [19] that were guided using the CFIR. These were mapped onto the ERIC taxonomy using the CFIR-ERIC tool. Strategies with a cumulative percentage of >100% were selected for potential inclusion. As each strategy's name and description were intended to be generic, they were contextualised using empirical data from preceding studies (i.e., tailored to the context of implementing pet robots for dementia care in LTC). This was led by WK, and verified by VH to minimise subjectivities. Disagreements were discussed and resolved. Next, key stakeholders (three care professionals, one organisational leader, and one academic researcher) were consulted through individual, informal meetings. An advisor (individual with dementia) from the Dementia Research Advisory Team was also consulted about implementation strategies from the 'engage residents and their family members' category. Strategies and their descriptions were presented - stakeholders commented on their readability and clarity, and suggested revisions. All were invited to pilot the survey, except for our advisor from the Dementia Research Advisory Team, since the survey was not adapted to ensure cognitive accessibility for PLWD. As only two were able to contribute to the pilot, another researcher and healthcare professional were invited for piloting. Feedback was sought regarding the survey layout and user experiences, and amendments were made accordingly.

Data collection and analysis

Round 1

Demographic information was collected. A summary of implementation determinants was provided before the list of 48 implementation strategies was presented. Participants were invited to rate the relative importance of each strategy on a nine-point Likert scale (1-3: little importance, 4-6: important, not critical, 7-9: important and critical). Free-text fields were available for justifications or suggestions to revise the description of each strategy. The survey remained open for three weeks, and up to three individualised reminder emails were sent.

Descriptive statistics were used to describe participants' demographic, percentage agreement and central tendency [20]. Consensus was pre-defined as ≥75% agreement on the relative importance of statements. Free-text comments for each statement were analysed separately using inductive qualitative content analysis, for the purpose of providing feedback in Round 2. WQK familiarised herself with the data by reading all responses and then developing low-inference codes for each statement. To further structure the data, responses were sorted into three categories based on whether they were (1) in support of the strategy, (2) not in support or expressed limitations, and (3) suggestions for revision. Statements that were not agreed upon were amended based on suggestions and brought forwarded to Round 2 for revoting. Newly suggested strategies were mapped onto the list of ERIC strategies – if the suggested strategy has already been included, the suggested strategy was not included. Otherwise, they were listed as additional strategies and included as new statements for Round 2. The Kruskal-Wallis test was conducted to identify statistically significant differences ($p \leq 0.05$) in responses between expert groups.

Round 2

A summary of the results in Round 1 was presented alongside each statement that did not reach agreement and new statements were presented for voting. Quantitative data analysis followed the process described in Round 1. The stability of consensus, defined as 'the consistency of responses between successive rounds" [28], was assessed. Responses were considered stable if there was <15% change between mean distributions [29,30]. The convergence of responses was evaluated based on changes to standard deviations between rounds [31]. To understand the variations in levels of agreement, textual data from both rounds were analysed as a whole using inductive qualitative content analysis [32]. WQK familiarised with the data by re-reading them to have a sense of the data as a whole, before assigning descriptive, open codes to the data. Data that were assigned to each code, were re-examined and organised into subcategories and categories.

Results

Statement development

Implementation determinants were identified from 28 CFIR constructs and mapped onto the CFIR-ERIC tool. Fifty-five strategies were selected and brought forward for contextualisation, resulting in three main changes. First, terms in the original strategies were amended to align with the context of our study. For instance, generic terms and jargon such as 'service formularies' and 'patients' were described by stakeholders as being difficult to understand or poorly termed. These were re-termed. Next, seven strategies were either removed or combined with other strategies based on stakeholders' suggestions, due to overlapping descriptions or irrelevance to our context. Finally, the list of implementation strategies was re-ordered. Instead of presenting the strategies in order of their potential relevance (i.e., cumulative percentage scores), which led to cognitive overload and recall difficulties for stakeholders during consultation sessions [20], the strategies were grouped based on their similarities and/or sequentially. Overall, 48 strategies constituted the initial statements for Round 1. Appendix 33 shows the original and contextualised strategies.

Round 1

Of 121 invited participants, 66 agreed to participate. Fifty-six completed Round 1 (response rate: 84.8%). The average completion time was 50 minutes. Table 1 summarises the experts' demographic information. Four experts belonged to more than one professional group.

Six strategies (12.5%) reached consensus, with participants rating all as important and critical. Table 2 shows a summary of the results. There was no statistically significant difference between the expert groups in their responses except for two strategies: 'use an implementation advisor' and 'tailor strategies'. Researchers rated the former as important and critical (median score: 7) while care professionals rated it as important but not critical (median score: 5) (p=0.029). The latter was also favoured more by researchers (median score: 8) than by organisational leaders (median score: 6) (p=0.028).

Free-text comments on the remaining 42 strategies were used to modify their descriptions (Appendix 34) Twenty-nine 'additional strategies' were proposed – twenty-one could be mapped onto the list of existing strategies, while three were generic comments and were therefore not included as new strategies. The remaining five were categorised into two additional strategies within the 'support clinicians' strategy group and carried forward to Round 2 along with the 42 revised strategies. Figure 1 summarises the study flow.

Round 2

Fifty-two experts completed Round 2 (response rate: 92.9%). Seven strategies reached consensus (15.9%). There was no statistically significant difference in the responses of different expert groups. Stability of consensus was assessed for the 42 strategies brought forward from Round 1. Thirty-four strategies achieved stability (81.0%). The standard deviations of 29 strategies (69.0%) decreased between rounds, suggesting a shift towards convergence of group opinions for most strategies [30]. However, the standard deviations of the remaining 13 strategies (31.0%) increased, suggesting a shift towards opinion divergence.

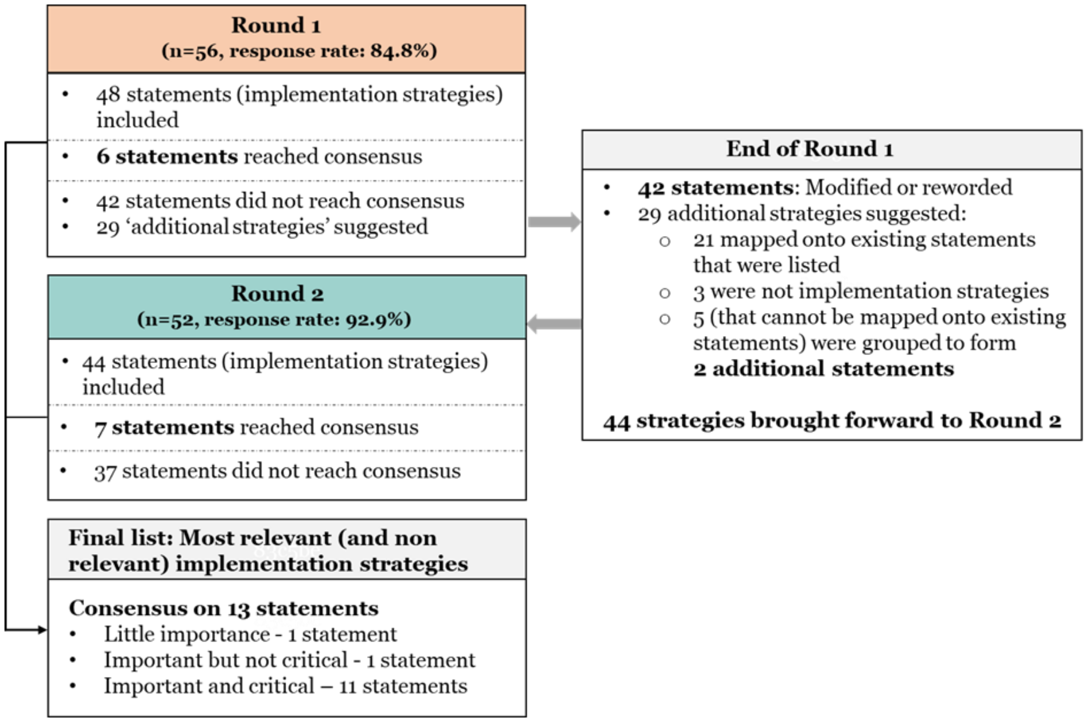
Table 1: Demographic Information

Characteristics	**No. of experts**	
	Round 1	**Round 2**
Roles		
Care Professionals	**22**	**21**
Activity Coordinator	7	5
Assistant Psychologist/Clinical Psychologist	2	3
Healthcare Assistant/Nursing Aide	3	1
Nurse	3	5
Occupational Therapist	5	5
Physiotherapist	1	1
Social Worker	1	1
Organisational Leaders	**17**	**15**
Activity Director	1	-
Assistant/Clinical Nurse Manager	1	2
Assistant/Care Home Manager	5	3
Clinical Lead for Care Home Liaison Service/Support Manager (Residential Aged Care)	2	2
Director/Head of Nursing, Care Homes and/or other services	7	7
Quality in Care Lead/Nursing Inspector	1	1
Academic Researchers	**24**	**22**
Assistant/Associate Professor/Professor	10	10
Doctoral Researcher/Research Assistant	6	5
Lecturer/Senior Lecturer	1	1
Post-Doctoral Researcher/Senior Scientist	4	3
Practice Development Consultant	0	1
Project Manager	1	1
Researcher-in-Residence	1	1
Care Professionals *(Years of experience)*		
Practising as a care professional		
Less than 1 year	1	
1 year to less than 3 years	4	-
3 years to less than 7 years	4	
7 years to over 9 years	13	
Working in a care home/nursing home context		
Less than 1 year	3	
1 year to less than 3 years	5	
3 years to less than 7 years	4	
7 years to over 9 years	10	

Table 1 Continued: Demographic Information

Organisational Leaders *(years of experience)*		
Working in a care home/nursing home context		
Less than 1 year	2	
1 year to less than 3 years	2	-
3 years to less than 7 years	2	
7 years to over 9 years	12	
Leadership/management in a care home/nursing home context		
Less than 1 year	1	
1 year to less than 3 years	2	-
3 years to less than 7 years	3	
7 years to over 9 years	11	
Academic Researchers - Research Expertise		
Implementation research	10	11
Psychosocial interventions*	14	10
Pet robots*	10	12
Other social robots*	8	9
Other technology-based interventions*	10	9
Dementia care*	16	16
**In care homes/nursing home contexts*		
Country		
Care home/nursing home		
Australia	2	1
Austria	1	-
Belgium	1	1
Ireland	7	7
The Netherlands	1	1
United Kingdom	22	22
United States	1	-
Research project(s)		
Australia	3	3
Austria	1	1
Canada	1	1
Denmark	1	1
Germany	2	1
Ireland	4	3
Malta	1	1
Norway	1	1
Sweden	2	2
Switzerland	1	1
Taiwan	1	1
The Netherlands	1	1
United Kingdom	5	5
United States	2	1
Experiences with pet robots in research and/or practice		
Have seen and/or used pet robots	46	-
Have not seen/or used pet robots	10	

Figure 1: Summary of results per round



Most relevant strategies for implementing pet robots

A summary of 13 strategies that achieved consensus and their relative importance is shown in Table 3. A detailed description of these strategies can be found at https://osf.io/7dywr. Twelve strategies were important and/or critical: 1) assess readiness and identify barriers and facilitators, 2) purposely re-examine the implementation, 3) obtain and use residents' and their family's feedback, 4) involve residents and their family, 5) promote adaptability, 6) conduct ongoing training, 7) conduct educational meetings, 8) conduct local consensus discussions, 9) organise clinician implementation team meetings, 10) provide local technical assistance, 11) access new funding, 12) develop resource sharing agreement. Experts expressed that strategy 'alter incentives/allowances structure' may lead to the inappropriate use of robots and had little importance: "*… all incentivising robots will get you is lots of people being forced to use robots who receive no benefit/are harmed by them*".

Variations in extent of agreement amongst experts

Strategies that did not reach consensus are grouped based on the level of agreement and summarised in Table 4. There was near consensus (70 to <75% agreement) on 10 strategies, moderate agreement (60 to <69%) on 10 strategies and low agreement (40 to <59%) on 17 strategies. To understand variations in experts' responses, 620 and 293 free-text comments were gathered from rounds one and two respectively, analysed and grouped into five categories.

Table 2: Summary of Results (Rounds 1 and 2)

	Round 1			***Round 2***			***Change between rounds***	
	Mean	*SD*	*Level of agreement*	*Mean*	*SD*	*Level of agreement*	*R1-R2 change in SD*	*Stability (<15% change in SD)*
Category 1: Develop Relationships between Internal and External Stakeholders								
1. Conduct Local Consensus Discussions	7.32	1.49	**78.60%***	-	-	-	-	-
2. Identify and Prepare Champions	7.04	1.61	73.20%	6.60	1.65	59.60%	-0.04	Stable
3. Inform Local Opinion Leaders	6.63	1.42	51.80%	6.08	1.48	55.80%	-0.06	Stable
4. Identify Early Adopters	6.68	1.56	58.90%	6.52	1.42	61.50%	0.14	Stable
5. Organise clinician implementation team meetings	7.27	1.43	**76.80%***	-	-	-	-	-
6. Capture and share local knowledge with other care homes/nursing homes	6.41	1.62	48.20%	6.48	1.53	53.80%	0.09	Stable
7. Build a Coalition	5.88	1.59	37.50%	5.71	1.42	59.60%	0.17	Stable
8. Use advisory boards and workgroups	6.04	1.84	46.40%	5.00	1.80	59.60%	0.03	Unstable
9. Involve governance	6.61	1.96	55.40%	6.35	1.92	61.50%	0.04	Stable
10. Visit Other Sites	5.59	1.69	28.60%	5.04	1.64	73.10%	0.05	Stable
11. Use an Implementation Advisor	5.61	1.92	32.10%	5.04	1.57	65.40%	0.35	Stable
12. Recruit, designate and train for leadership	6.41	1.60	53.60%	5.40	2.15	42.30%	-0.55	Unstable
13. Develop Academic Partnerships	5.77	1.90	37.50%	5.73	1.43	67.30%	0.47	Stable
14. Obtain formal commitments	4.91	1.68	14.30%	4.00	1.36	61.50%	0.32	Unstable
Category 2: Use Evaluative and Iterative Strategies								
15. Conduct local needs assessment	7.18	1.64	67.90%	6.85	1.76	73.10%	-0.12	Stable
16. Assess Readiness & Identify Barriers and Facilitators	7.64	1.45	**85.70%**	-	-	-	-	-
17. Tailor Strategies	7.11	1.69	62.50%	7.04	1.72	73.10%	-0.02	Stable
18. Develop a Formal Implementation Blueprint	6.73	1.70	53.60%	6.15	1.97	55.80%	-0.27	Stable
20. Stage Implementation Scale-up	6.80	1.43	60.70%	6.98	1.31	69.20%		Stable
19. Conduct Cyclical Small Tests of Changes	7.16	1.59	64.30%	7.12	1.26	73.10%	0.33	Stable

	Round 1			***Round 2***			***Change between rounds***	
	Mean	*SD*	*Level of agreement*	*Mean*	*SD*	*Level of agreement*	*Divergence/ convergence*	*Stability (<15% change in SD)*
21. Obtain and use residents' and family feedback	7.96	1.14	**87.50%***	-	-	-	-	-
22. Audit and Provide Feedback	7.13	1.45	69.60%	6.96	1.76	73.10%		Stable
24. Develop, test and introduce quality monitoring tools and system(s)	6.50	1.44	60.70%	5.98	1.85	73.10%		Stable
Category 3: Train and Educate Stakeholders								
25. Conduct Educational Meetings	6.86	1.50	64.30%	7.00	1.43	**75.00%***	0.07	Stable
26. Develop Educational Materials	6.70	1.36	60.70%	6.98	1.32	71.20%*	0.04	Stable
27. Distribute educational materials	6.41	1.55	53.60%	6.58	1.63	57.70%	-0.08	Stable
28. Conduct Ongoing Trainings	6.89	1.51	63.50%	7.37	1.42	**82.70%***	0.09	Stable
29. Make Training Dynamic	6.82	1.64	58.90%	7.02	1.24	69.20%	0.40	Stable
30. Use Train-the-trainer strategies	6.59	1.80	62.50%	6.79	1.38	73.10%	0.42	Stable
31. Create a Learning Collaborative	6.11	1.61	51.80%	5.63	1.98	50.00%	-0.37	Stable
32. Conduct educational visits	5.36	1.81	32.10%	4.56	1.67	61.50%	0.14	Unstable
33. Shadow Other Experts	5.66	1.71	30.40%	4.92	1.49	73.10%	0.22	Stable
34. Work with Educational Institutions	5.21	1.88	21.40%	4.58	1.66	65.40%	0.21	Stable
Category 4: Adapt and Tailor to Context								
35. Promote Adaptability	6.98	1.91	73.20%	7.56	1.09	**86.50%**	0.82	Stable
36. Use Data Experts	4.41	1.77	7.10%	3.52	1.32	51.90%	0.45	Unstable
Category 5: Provide Interactive Assistance								
37. Use a Facilitator	6.45	1.43	51.80%	5.92	1.63	51.90%	-0.21	Stable
38. Provide Local Technical Assistance	6.84	1.682	66.10%	7.06	1.75	**76.90%***	-0.07	Stable
Category 6: Engage Residents and their Family Members								
39. Involve residents and their family members	7.82	1.295	**87.50%***	-	-	-	-	-
40. Increase Demand	5.46	2.140	37.50%	4.33	1.865	53.80%	0.28	Unstable

	Round 1			***Round 2***			***Change between rounds***	
	Mean	*SD*	*Level of agreement*	*Mean*	*SD*	*Level of agreement*	*Divergence/ convergence*	*Stability (<15% change in SD)*
Category 7: Use Financial Strategies								
42. Alter Incentives/Allowances Structure(s)	4.29	2.513	42.9%	2.31	1.489	**84.60%***	1.02	Unstable
43. Access New Funding	6.95	1.566	69.60%	7	1.372	**75.00%***	0.19	Stable
44. Fund and Contract for Pet Robots	6.21	2.213	57.10%	5.81	2.197	50.00%	0.02	Stable
45. Place pet robots on fee-for-service lists of the care home/nursing home	5.73	2.292	48.20%	5.48	2.024	44.20%	0.27	Stable
Category 8: Support Clinicians								
46. Facilitate relay of clinical data to care providers	6.61	1.580	55.40%	6.71	1.538	73.10%	0.04	Stable
47. Develop Resource Sharing Agreements	5.79	1.411	71.4%	5.04	1.252	**76.90%***	0.16	Stable
49. Provide non-monetary incentives	-	-	-	4.94	1.96	51.90%	-	-
50. Provide protected time to support clinicians	-	-	-	6.13	1.99	53.80%	-	-
Category 9: Change Infrastructure								
48. Mandate Change	6.32	1.738	51.80%	5.06	1.984	51.90%	-0.25	Unstable

** Strategies that achieved consensus*

(i) Buy-in from local stakeholders

This category describes the overall expert agreement that buy-in from local stakeholders (residents, their family, organisational leaders and staff) was important to support the consistent and sustainable adoption of pet robots. Experts expressed that stakeholders should understand reasons behind using pet robots and have opportunities to discuss their thoughts: "The most important people to get buy in from are care staff themselves. If they do not know why something is being done and are not given the opportunity to discuss and solve barriers the intervention will fail [strategy: conduct local consensus discussions]". Some added that seeing their benefits would facilitate buy-in: "very helpful for staff to see the use of pet robots in their care home to get buy-in. If one resident has a pet robot, others often want it *[Strategy: Inform local opinion leaders]*".

(ii) Building local capacity

This category describes varied views on strategies to build capacity within an organisation to support the adoption of pet robots. Some experts advocated for strategies to support 'selected individuals' (e.g. champions) to facilitate implementation. Others doubted their practicability due to considerations like culture, individuals' attributes and staff turnover: *"I've seen many homes where they have a champion strategy, and when that person leaves no one uses the robots anymore [strategy: identify and prepare champion]".* Correspondingly, some expressed preferences to invest in strategies to build skills of all staff. The viability of strategies also may be influenced by organisational size. Some expressed that educational materials were valuable, however others felt they may not engage staff: *"many care home staff are experiential learners and may not value written information [strategy: distribute educational materials]".* Experts underlined the importance of interactive, practical training: *"staff are poorly paid, have very difficult jobs and deal with acute situations that need their attention. This just won't be high on their priority list so it needs to be engaging [strategy: make training dynamic]".* Nevertheless, some expressed that training was not crucial considering competing work demands, since staff have general skills to deliver interventions.

(ii) Considering organisation context and processes

This category describes how organisational contexts influenced experts' rating. Understanding the organisational context was described as important: *"Some care homes have regular living dog visits or other animal-related activities… So this could be one of the barriers of implementation [strategy: "assess readiness and identify barriers and facilitators]".* Strategies involving developing implementation plans, evaluation and involving governance were favoured by some, who also expressed that such strategies should be simple or be integrated into existing workflows. Others were concerned about them being overly bureaucratic, complicated, or resource straining: *'"… I worry that this may add to increased documentation and bureaucratization of care work and take time away from actually using the robots and caring for residents [strategy: audit and provide feedback]".* Since financial resources were described as limited, funding was crucial.

Table 3: List of the most relevant implementation strategies

No.	Implementation Strategy	Mean	Median	IQR	Rank *(CFIR-ERIC)*	ERIC taxonomy category
Important and Critical						
1	Assess readiness and identify barriers & facilitators	7.64	8	2	3	Evaluative & iterative strategies
2	Purposely re-examine the implementation	7.20	7	1	33	Evaluative & iterative strategies
3	Obtain and use residents' and family feedback	7.96	8	2	21	Evaluative & iterative strategies
4	Involve residents and their family members	7.82	8	2	17	Engage residents and their family members
5	Promote adaptability	7.56	8	1		Adapt and tailor to context
6	Conduct ongoing training	7.37	8	1	9	Train and educate
7	Conduct educational meetings	7.00	7	2	37	Train and educate
8	Conduct local consensus discussions	7.32	8	1		Develop stakeholder interrelationships
9	Organise clinician implementation team meetings	7.27	7	1	2	Develop stakeholder interrelationships
10	Provide local technical assistance	7.02	8	2	23	Provide interactive assistance
11	Access new funding	6.92	7	2	38	Utilise financial strategies
Important (not critical)						
12	Develop resource sharing agreements	5.0	5	2	33	Support Clinicians
Little importance						
13	Alter incentives/allowances structures	2.40	2	2	14	Utilise financial strategies

Table 4: Extent of agreement for implementation strategies that did not achieve consensus

Implementation Strategy	Mean	Median	SD	IQR	Level of agreement	Level of importance	ERIC taxonomy category
70% to ≤75% agreement (Near consensus)							
Conduct cyclical small tests of change	7.12	7	1.263	2	**73.10%**	Important & critical	Evaluative & iterative strategies
Tailor strategies	7.04	7	1.715	2	**73.10%**	Important & critical	Evaluative & iterative strategies
Develop educational materials	6.98	7	1.321	2	**71.20%**	Important & critical	Train and educate
Audit and provide feedback	6.96	8	1.76	2	**73.10%**	Important & critical	Evaluative & iterative strategies
Conduct local needs assessment	6.85	7	1.764	2	**73.10%**	Important & critical	Develop stakeholder interrelationships
Use Train-the-trainer strategies	6.79	7	1.377	2	**73.10%**	Important & critical	Train and educate
Facilitate relay of clinical data to care providers	6.71	7	1.538	2	**73.10%**	Important & critical	Support clinicians
Develop, test and introduce quality monitoring tools and system(s)	5.98	6	1.852	3	**73.10%**	Important & critical	Evaluative & iterative strategies
Visit other sites	5.04	5	1.644	2	**73.10%**	Important (not critical)	Develop stakeholder interrelationships
Shadow other experts	4.92	5	1.493	2	**73.10%**	Important (not critical)	Train and educate
60% to ≤70% agreement (Moderate level of agreement)							
Make training dynamic	7.02	7	1.244	2	**69.20%**	Important & critical	Train and educate
Stage Implementation Scale-up	6.98	7	1.306	2	**69.20%**	Important & critical	Evaluative & iterative strategies
Identify early adopters	6.52	7	1.421	1	**61.50%**	Important & critical	Develop stakeholder interrelationships
Involve governance	6.35	7	1.919	3	**61.50%**	Important & critical	Develop stakeholder interrelationships
Develop academic partnerships	5.73	5.5	1.43	2	**67.30%**	Important (not critical)	Develop stakeholder interrelationships
Use an implementation advisor	5.04	5	1.571	2	**65.40%**	Important (not critical)	Develop stakeholder interrelationships
Work with Educational Institutions	4.58	5	1.661	2	**65.40%**	Important (not critical)	Train and educate

Conduct educational visits	4.56	5	1.673	2	**61.50%**	Important (not critical)	Train and educate
Use Mass Media	4.42	5	1.764	3	**67.30%**	Important (not critical)	Engage residents and their family members
Obtain formal commitments	4	4	1.358	2	**61.50%**	Important (not critical)	Develop stakeholder interrelationships
40% to ≤60% agreement (Lower level of agreement)							
Identify and prepare champions	6.6	7	1.648	3	**59.60%**	Important & critical	Develop stakeholder interrelationships
Distribute educational materials	6.58	7	1.625	2	**57.70%**	Important & critical	Train and educate
Capture and share local knowledge with other care homes/nursing homes	6.48	7	1.527	3	**53.80%**	Important & critical	Develop stakeholder interrelationships
Develop a Formal Implementation Blueprint	6.15	7	1.974	3	**55.80%**	Important & critical	Evaluative & iterative strategies
Provide protected time to support clinicians	6.13	7	1.99	2	**53.80%**	Important & critical	Support clinicians*
Inform local opinion leaders	6.08	6	1.48	2	**55.80%**	Important (not critical)	Develop stakeholder interrelationships
Use a Facilitator	5.92	6	1.631	3	**51.90%**	Important (not critical)	Provide interactive assistance
Fund and Contract for Pet Robots	5.81	6.5	2.197	4	**50.00%**	Important & critical	Utilise financial strategies
Build a coalition	5.71	6	1.419	2	**59.60%**	Important (not critical)	Develop stakeholder interrelationships
Create a Learning Collaborative	5.63	6	1.981	3	**50.00%**	Important (not critical)	Train and educate
Place pet robots on fee-for-service lists of the care home/nursing home	5.48	6	2.024	3	**44.20%**	Important (not critical)	Utilise financial strategies
Recruit, designate and train for leadership	5.4	5	2.154	3	**42.30%**	Important (not critical)	Develop stakeholder interrelationships
Mandate Change	5.06	5	1.984	3	**51.90%**	Important (not critical)	Change infrastructure
Use advisory boards and workgroups	5	5	1.804	2	**59.60%**	Important (not critical)	Develop stakeholder interrelationships
Provide non-monetary incentives	4.94	5	1.955	3	**51.90%**	Important (not critical)	Support clinicians*

(iii) Involving external organisations and stakeholders

This category describes varied opinions on the importance of involving external organisations and stakeholders. Some highlighted the importance of knowledge exchange, however there may be market competition: *"There is often a degree of competition between care home providers… it may take time before they share information about a product that gives them a recognisable improvement in the care they deliver for people with dementia [strategy: Build a coalition]".* Considerations about existing networks also led to expert opinion variations: *"…. whereas big organizations can leverage sharing of resources within their many homes [strategy: build a coalition]".* Although collaborations with other organisations like academic institutions were valuable, some were perceived this as inaccessible. Some acknowledged the value of external stakeholders (e.g. researchers), however others expressed scepticism that external experts rarely understand the reality of care homes, and staff may be resistive: *"… the perception that we need more training (generally from non-care home 'experts') to train staff, for me, has ran its course and we need to challenge this notion - it perpetuates low order status in our health and social care systems [strategy: conduct educational meetings]".*

(iv) Supporting person-centred care provision

This category describes agreement that the implementation of pet robots should support person-centered care, including considerations about residents' preferences, values, current and evolving needs, and adapt pet robot use correspondingly: *"It is vital that robots are introduced in response to unmet needs.. . to be ascertained through needs assessment for individual people with dementia [strategy: conduct local needs assessment].* Some experts also reported concerns about strategies placing excessive focus on pet robots, which could deter person-centred care: *"These can actually be counterproductive, e.g., they drive the implementation of robots, not good dementia care. The end becomes getting the robots in place to tick the box… [strategy: use advisory board and workgroups]"*

Discussion

This study aimed to identify, contextualise and achieve consensus on the most important strategies for implementing pet robots in LTC for residents with dementia. Twelve strategies were established as being most relevant for implementing pet robots, and variations in the extent of agreement were outlined. Reasons included a myriad of considerations, such as the accessibility of strategies, contextual differences like organisational structures and staff turnover. Strategies achieving consensus appeared to accommodate such variations.

Strategies that achieved expert consensus were strategies that primarily involved local stakeholders within the care organisation. These strategies appear to take into consideration organisational contextual factors common across different care organisations. Therefore, they may be more sustainable and less likely to be influenced by factors such as staff turnover, dynamic work environments and resource constraints. Many studies suggest that LTC staff are often overworked and experience a higher level of burnout compared to the general population [32], and the annual staff turnover can range from 14% to 94% % [33-35]. It is therefore unsurprising that strategies involving collective staff members reached agreement by panellists compared to those that involved identifying and training selected individuals (e.g. champions).

While previous studies showed that developing and distributing educational materials were most frequently employed as training and educational strategies [36], these strategies did not achieve expert consensus – possibly because strategies involving written materials are ‘passive’ in nature [37]. In contrast, the two ‘train and educate’ strategies (conducting educational meetings, making training dynamic) that achieved expert consensus provide staff with opportunities for active engagement through dialogue, and in practical, problem-based and solution-driven training [38]. These were considered pragmatic and flexible enough to account for the dynamic environment in LTC, such as workload and fast-changing situations that demand staff attention. Although strategies to explicitly involve residents and their family members were also agreed by panellists as being critical, a scoping review involving 88 studies showed that few studies explicitly involved PWLD and their caregivers in implementation and dissemination interventions [39].

A previous study found that LTC providers hoped to understand other organisations’ experiences of adopting pet robots [19]. Paradoxically, strategies that involved developing partnerships with external stakeholders and organisations received varying levels of expert agreement. This opposes findings from previous research showing that building partnerships were frequently employed strategies [36 39]. While experts underlined the value of learning about how pet robots were implemented in other facilities, some experts expressed hesitancy to share information with their ‘market competitors’ in care provision. This suggests that the nature of LTC facilities can influence the practicability of such strategies.

Strategies involving collaborations with other external organisations and stakeholders (e.g. academic partners), also received mixed responses. While such strategies were valued [40] or have led to positive outcomes [41] in other studies, experts expressed concerns about their inaccessibility and understanding of LTC context, which can lead to change resistance by local stakeholders [42] (i.e., adopting robots). When considered by local stakeholders as being overly complex and burdensome, such strategies interfere with implementation [43]. As such, strategies involving external collaborators should be thoroughly considered and discussed with local stakeholders, which can support change readiness and minimise resistance [42]. With cost being frequently cited as a key barrier to adopting pet robots for dementia care [44], it is unsurprising that ‘access new funding’ was agreed upon as a critical strategy. However, strategies to incentivise care providers were frowned upon due to concerns about over prioritisation or inappropriate use amongst other existing interventions. Residents with dementia have multiple needs and preferences [45 46] and LTC facilities often employ several, varied interventions to support these residents [47]. As pet robots are one of several interventions employed in LTC, the selection and use of strategies to implement pet robots should consider existing care processes and interventions.

Implications for practice and research

Few studies used conceptual frameworks or empirical evidence to select and test strategies for implementing psychosocial interventions for PLWD [36]. Our findings provide empirical evidence for researchers to systematically identify, consider, and test strategies for implementing pet robots for dementia care in LTC. More work is needed to further specify the strategies. Proctor and colleagues suggested seven key steps: 1) name it, 2) define it, 3) operationalise it, 4) specify the actor, 5) specify the action, 6) specify the target of the action, and 7) specify temporality [48]. Since the purpose of our study was to identify a list of strategies, we focused on the first two steps. Each strategy can also be combined to form multifaceted strategies to address multilevel implementation determinants.

Further research could also consider evaluating the mechanisms of change underlying these strategies.

Previous studies that leveraged on the CFIR-ERIC tool to identify implementation strategies in other study contexts did not make these steps explicit enough for us to replicate the process [49 50]. Furthermore, while the tool generated a 'ranked list' of strategies likely to be more relevant in addressing implementation, it had limited utility in identifying the most important strategies for our study - of 12 strategies that were established as important/critical", only three were identified from the list of 'top 12' strategies generated from the tool. By clearly demonstrating how we leveraged, contextualised and operationalised the ERIC taxonomy and the CFIR-ERIC tool for the systematic selection of implementation strategies for pet robot implementation, we suggest a process that future CFIR-ERIC tool users could consider adopting for other study contexts.

Strengths and limitations

Using the ERIC taxonomy enabled us to identify widely-encompassing implementation strategies, and multiple data sources were used for contextualisation. The low attrition rate (<10%) between rounds provides confidence in the validity of our findings. Involving international multilevel experts enriched our findings, as previous studies involving the development/selection of strategies appear to be research-driven [22]. It is possible that in-person meetings could lead to consensus on more strategies. However, this is logistically challenging and would remove experts' anonymity, a strength of the Delphi technique. To mitigate this, participants' comments were fed back to the panel anonymously. There is a higher representation of care providers from LTC organisations in the UK, however, considering that more than half of the experts were from outside the UK, our findings should be considered relevant in other national contexts. Although PLWD in LTC may be able to provide valuable experience-based perspectives, we did not include them in the panel of experts. Many have more advanced dementia, and participation in iterative, online surveys could cause distress. To mitigate this limitation, we consulted a member from the Dementia Research Advisory Team to contextualise strategies specifically in the "residents and their family members" category.

Conclusions and Implications

We established 12 implementation strategies considered crucial for implementing pet robots for dementia care in LTC settings. This provides empirical evidence and guidance for care providers and researchers to systematically select, further specify, combine and test strategies. Our study also advances the field of implementation research and implementation strategies by clearly demonstrating how the ERIC taxonomy and the CFIR-ERIC tool can be operationalised and contextualised.

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Chapter Summary

Paper nine presented findings from a two-round modified Delphi process to establish expert consensus on the most relevant strategies for implementing pet robots for PLWD in long-term care facilities. The statements (i.e., implementation strategies) were identified systematically, using multiple, rich sources of data. Multi-level implementation determinants identified in papers four and six (chapters 5 and 7) were mapped onto the Expert Recommendation for Implementing Change (ERIC), a comprehensive taxonomy of implementation strategies. A list of potentially relevant implementation strategies was identified and tailored to this study context, using empirical data and consultation with five key stakeholders. This resulted in forty-eight implementation strategies which were brought forward as initial statements for round one of the modified Delphi process.

Fifty-six experts, comprising care professionals, organisational leaders and researchers, completed the first Delphi round. Six strategies reached consensus. Fifty-two experts completed round two, reaching further agreement on seven strategies. Overall, 13 strategies achieved consensus. One was established as having little importance. Twelve were agreed as critical and/or important: 1) assess readiness and identify barriers and facilitators, 2) purposely re-examine the implementation, 3) obtain and use residents' and their family's feedback, 4) involve residents and their family, 5) promote adaptability, 6) conduct ongoing training, 7) conduct educational meetings, 8) conduct local consensus discussions, 9) organise clinician implementation team meetings, 10) provide local technical assistance, 11) access new funding and 12) develop resource sharing agreements. Thirty-five initial implementation strategies did not achieve consensus, and reasons for differing expert opinions included differences in contexts, such as organisational infrastructure and culture.

Chapter 10: Discussion

This chapter provides a summary of the key findings in relation to the objectives of this PhD thesis, followed by an integrated summary of the findings across all studies. At the end of this section, the contribution of this work to knowledge, its implications for research, practice and policy, and its strengths and limitations are discussed.

10.1 Summary of key findings

Objective one

The first objective of this PhD research was to explore the impact of lower-cost pet robots on the psychosocial health of older adults and PLWD. A body of research has demonstrated the positive impacts of higher-cost pet robots such as PARO on the psychosocial well-being of older adults and PLWD. However, their affordability can impede their uptake in real-world practice. It was, therefore, valuable to explore the impact of lower-cost alternatives since they could address cost-related implementation barriers. Two studies addressed this objective: a scoping review to explore the impacts of low-cost pet robots **(chapter 2),** and a qualitative content analysis to understand the usability and impact of a low-cost pet robot **(chapter 3)**. The former focused on consolidating evidence on the JfA cat and dog, as they were the only low-cost pet robots that met the criteria of being realistically and familiarly designed at the point of the study. The latter study focused on the JfA cat, as the review showed that it was used in more research studies. The key findings are:

- While few research studies have investigated the impact of low-cost pet robots on the psychosocial health of older adults and PLWD, there is a large amount of user-generated data on consumer websites, where individuals described their experiences and perceptions of using low-cost pet robots with this population. This is possibly due to their affordability and accessibility

- Findings from both studies were in agreement – they revealed that the use of low-cost pet robots for older people and PLWD have led to improved mood, affect, communication and social interaction. Some did not respond or responded negatively to pet robots, and caregiver mediation may be necessary to mediate older people and PLWDs' interactions with pet robots. These findings resonate with the results from other studies which investigated the impact of more technologically advanced and higher-cost pet robots, including the widely researched robotic seal PARO

- Cost appeared to influence intervention delivery. In contrast to higher-costed pet robots which are often shared in group settings, the scoping review showed that low-cost pet robots appear to be used for one-to-one interventions. This has the potential to mitigate implementation barriers relating to potential infection transmission from the shared use of pet robots

Overall, while current evidence is not robust, findings from both studies suggest that low-cost pet robots have the potential to positively impact the psychosocial health of older adults and PLWD. The lower cost also appeared to have influenced the delivery of pet robots in real-world practice, with low-cost pet robots being used on a more individual (rather than group basis). In addition, more individuals appear to be able to access low-cost pet robots. This suggests that low-cost pet robots demonstrate promise in mitigating implementation barriers related to cost and infection control.

Objective two

The second objective was to understand the multilevel determinants of implementing pet robots for PLWD in long-term care facilities. This objective was addressed in chapters 4 to 7.

A scoping review was undertaken to broadly scope extant literature to identify the barriers and enablers affecting the implementation of social robots, including pet robots, for older adults and PLWD **(chapters 4 and 5)**. To further address gaps identified in the review, a qualitative study was conducted. It specifically explored the determinants of implementing pet robots for PLWD in nursing homes **(chapters 6 and 7)**. PARO and the JfA cat were central to the qualitative inquiry. PARO was included as the most widely researched pet robot, with research demonstrating its positive impact on the psychosocial well-being of PLWD. The JfA cat was included based on findings in chapters 2 and 3, which suggested its potential to positively impact the psychosocial health of PLWD despite being a lower-cost and less technologically sophisticated alternative. The CFIR was used in both studies to guide the comprehensive exploration of multilevel implementation determinants within five multi-level domains: (i) intervention characteristics, (ii) outer setting, such as external contextual influences (iii) inner setting (i.e., influences within the organisation), (iv) individuals involved in implementation, and (v) implementation process.

- At the *intervention level*, the review revealed that facilitators included the relative advantage of pet robots compared to live pets, their appealing design and ease of use. High costs, difficulty adapting features, and a ‘toy-like’ appearance were barriers. The qualitative findings were in agreement, and additional barriers and facilitators were identified through the qualitative inquiry. Barriers included the fur-covering of pet robots and a culturally unfamiliar design (i.e., PARO’s design as a seal). Facilitators included participants’ perceived evidence of the impact of pet robots on PLWD, based on their personal experiences. Nevertheless, they expressed a need for evidence on the long-term impacts of pet robots especially PARO, due to its higher cost

- The review revealed that very few studies have explored the *external contextual influences* on implementation. The qualitative study showed that external funding was a barrier, and while the national regulatory authority may facilitate care organisations’ adoption of pet robots to support activity provision, their mandates on infection control could hinder implementation. Although minimal networking occurred between nursing homes, knowing other care organisations’ experiences with pet robots could facilitate implementation

- At the *organisational level*, the review identified determinants which were not reflected in the qualitative study. For instance, identified barriers included institutional regulations on privacy and internet connectivity challenges. These determinants pertained to socially assistive robots, and since some of their attributes differ from pet robots, it is unsurprising that such findings were not reflected in findings from the qualitative study. The qualitative findings revealed implementation determinants relating to the ability or potential of pet robots to address the unmet needs of residents and provide caregiving relief. The alignment of pet robots with work processes, organisational leadership support and resource availability, were also identified as determinants

- At the level of *individuals who are involved in implementation*, the review revealed that care providers' ambivalence and negative attitudes were barriers. Nevertheless, some care providers became more positive after seeing their impact on older people and PLWD. These findings generally resonated with the qualitative findings. Positive attitudes towards pet robots, beliefs in the role of technology in care provision, and confidence in using pet robots were established as implementation facilitators. Some care providers had different opinions on whether they should be used with PLWD who cannot distinguish them as robots

- At the *implementation process* level, the review revealed that assigning the robot with a clear role, engaging key stakeholders, care staff mediation, and support from external change agents such as family members, influenced implementation. The qualitative findings were in agreement, and more facilitators were revealed; this included discussion and information sessions, a thorough assessment and an ongoing review of the suitability of pet robots for PLWD

Overall, although the review was focused on exploring the barriers and facilitators to implementing all social robots regardless of care setting, findings from the review generally corresponded with findings from the qualitative study. The qualitative inquiry provided a more nuanced understanding of multi-level determinants, specifically relating to the implementation of pet robots in long-term care settings. Both studies provided a comprehensive overview of implementation determinants, demonstrating that determinants do not occur in silos and were interrelated at different levels. Although participants in the qualitative study included care providers with and without experiences of using pet robots, their descriptions of implementation determinants were largely similar

Objective three

The final objective was to identify, contextualise and achieve expert consensus on the most relevant strategies for implementing pet robots for PLWD in long-term care facilities such as nursing homes. A two-round modified Delphi study was conducted **(chapters 8 and 9)**. A combination of empirical data and conceptual knowledge was used to identify implementation strategies. Implementation determinants that were identified in previous studies **(chapters 5 and 7)** were mapped onto the ERIC, using the CFIR-ERIC mapping tool. A list of generic implementation strategies was generated and tailored to this study context using findings from chapters five and seven. Key stakeholders were consulted to further refine and contextualise the strategies. Resultant implementation strategies and their descriptions were used as initial statements for the modified Delphi process. Consensus was defined a priori as $\geqslant$75% agreement amongst experts. Reasons for variations in the extent of agreement amongst experts were explored, based on a qualitative content analysis of free-text comments. The key findings were:

- Thirteen implementation strategies achieved consensus amongst an international panel of experts, comprising care professionals, organisational leaders and researchers. Eleven strategies were agreed as critical and important to support the adoption of pet robots for routine dementia in long-term care settings, one was agreed as important but not critical, and one was agreed as having little importance

- Experts agreed that strategies to facilitate buy-in from stakeholders within long-term care facilities were important and/or crucial

- Experts had different opinions on strategies to build organisational capacity to support the implementation of pet robots. For instance, while some favoured identifying and training selected individuals to drive implementation, others favoured more team-based strategies due to considerations such as organisational culture and staff turnover

- Different descriptions of organisational contexts within different care facilities influenced the relevance of implementation strategies. For instance, while some experts favoured concrete plans to integrate pet robots into their workflows, others expressed concerns about these procedures being burdensome or bureaucratic

- Involving external organisations and stakeholders, while identified as valuable by some experts, may not be as relevant for others. This was due to factors such as market competition between different care organisations and the accessibility of external partners

- Experts concurred that implementation strategies should support person-centred care. However, some cautioned against strategies that may place excessive focus on the implementation of pet robots, as they may potentially disregard other existing interventions that are in place

Overall, this study established 12 implementation strategies that are critical and/or important for implementing pet robots. They include: 1) assess readiness and identify barriers and facilitators, 2) purposely re-examine the implementation, 3) obtain and use residents' and their family's feedback, 4) involve residents and their family, 5) promote adaptability, 6) conduct ongoing training, 7) conduct educational meetings, 8) conduct local consensus discussions, 9) organise clinician implementation team meetings, 10) provide local technical assistance, 11) access new funding, and 12) develop resource sharing agreement. These findings provide a robust starting point for care providers, care organisations and researchers to identify, select and adapt strategies to support the implementation of pet robots in different long-term care settings.

10.2 Discussion of the integrated summary

This section presents a discussion on the integrated summary of this body of work. The three overarching discussion points include (i) how implementation research concepts were leveraged throughout this PhD research, (ii) aligning pet robots with real-world needs and capacities, including the bridging of the research-to-practice gap and their integration into long-term care settings, and (iii) the ethical considerations of implementing pet robots.

10.2.1 Leveraging on implementation research concepts

This body of work was conceived to support the translation of pet robots from research to routine dementia care in long-term care settings, given that the application of research into real-world practice is slow and fragmented; studies suggest that practical application of research takes more than 20 to 25 years (Chalmers et al., 2014). In the field of psychosocial interventions in dementia care, a rapid review by Gitlin and colleagues (2015) showed that less than 3% of interventions to support caregivers of PLWD have been translated into practice. The slow (or absence of) translation of research findings into practice is a waste of precious research resources; and it is necessary to better support the implementation of research (Chalmers et al., 2014). This includes the application of pet robots in routine dementia care in real-world practice. To bridge the research-to-practice gap, this PhD thesis leveraged several implementation research concepts.

First, this research project was built upon the proposition that the traditional pipeline of research contributes to the research-to-practice gap - this refers to the traditional focus on the step-wise investigation of intervention efficacy and effectiveness before its implementation is investigated (if this even ensues) (Glasgow et al., 2003; Tunis et al., 2003). The case of PARO well exemplifies this bottleneck predicament - PARO has been developed since 1993. A body of research has investigated PARO's effectiveness and established it as a promising intervention, leading to its classification as a class two medical device in the United States in 2009. Yet, no previous studies have explicitly investigated its implementation (i.e., how it can be adopted as a part of routine care in long-term care facilities for PLWD). This resonates with Melkas and colleagues' (2020) findings that there is a lack of understanding of issues surrounding the implementation of social robots in real-world practice, such as organisational factors. Curran and colleagues (2012) called for the reconceptualisation of this research pipeline, to commence the implementation of an intervention once there is strong face validity of its effectiveness. This PhD research demonstrates the application of this reconceptualisation to the context of pet robots, using non-interventional (descriptive) study designs. To understand if there is value in exploring the implementation of low-cost pet robots alongside more established robots like PARO, efforts were made to establish the impact of low-cost alternatives (chapters 2 and 3). After establishing their potential, the subsequent studies (chapters 4 to 9) focused on understanding how pet robots can be implemented in long-term care settings to support dementia care.

Second, to gain a thorough understanding of barriers and facilitators to implementing pet robots, this PhD research leveraged and built upon relevant taxonomies and frameworks. The initial step of examining the existing literature in this field was challenging; McKibbon et al. (2010) described this as a 'Tower of Babel' after finding that the terms used to describe implementation are wide-ranging. This predicament was similar in the field of social robots - to illustrate, a recent systematic review that was designed to investigate the implementation of socially assistive robots did not include the term 'implementation' in the search strategy (Papadopoulos et al., 2020). To build upon these lessons from previous research, a taxonomy of terms developed to describe implementation outcomes (Proctor et al., 2011) was leveraged to guide the development of the search strings for evidence synthesis in chapters 4 and 5. This proved to be a useful strategy to gather the relevant literature in this field, as 53 articles were yielded and terms in Proctor's taxonomy were included in the title and/or abstract of most articles. While most research studies have been focused on examining the acceptability or impact of social robots (Melkas et al., 2020; Papadopoulos et al., 2020), it is important to note that implementation also influences different levels of operations within and outside an organisation (Granja et al., 2018). To guide the holistic exploration of multi-level implementation determinants, a determinant framework was chosen and integrated as a pivotal element of this PhD research. Nilsen (2015) identified several commonly used determinant frameworks. The Theoretical Domains Framework (TDF) (Michie et al., 2005) and the CFIR (Damschroder et al., 2009) are examples of determinant frameworks that were conceptualised from synthesising existing taxonomies and/or theories. Some, such as PARIHS (Rycroft-Malone, 2004), were developed based on professional experiences of implementation. The CFIR was chosen in the context of this PhD, as it guided the exploration of multilevel implementation determinants. This proved to be invaluable in identifying knowledge gaps in existing literature (chapters 4 and 5) - such as the lack of knowledge on determinants relating to organisational contexts and external contextual influences - that were bridged through the succeeding qualitative study (chapters 6 and 7). Another rationale for choosing the CFIR was its relationship to a taxonomy of implementation strategies

(Powell et al., 2012). The domains and constructs in CFIR domains were used to guide the development of 68 multilevel implementation strategies (Powell et al., 2012). This was further developed into a taxonomy of 73 strategies and termed the Expert Recommendations of Implementing Change (ERIC) (Powell et al., 2015). Since a key objective of this PhD work was to identify strategies for implementing pet robots, choosing a determinant framework that could be linked to a taxonomy of implementation strategies in the succeeding stages of the project (chapters 8 and 9) was particularly valuable.

There is little guidance on how implementation strategies for interventions can be systematically selected to address multilevel implementation determinants (Fernandez et al., 2019). In practice, strategies are often selected without knowing what may work, with little consideration about the mechanism of (anticipated) change (Fernandez et al., 2019). The CFIR-ERIC tool represents a way to systematically identify implementation strategies to address identified implementation determinants (Waltz et al., 2019). While there have been previous studies that leveraged this tool to identify implementation strategies for their research studies, the steps were not made sufficiently explicit for replication. Chapters 8 and 9 clearly demonstrated how this was used to identify and tailor strategies, providing a clear replicable trail that can be used by the research community to identify implementation strategies for different study contexts – thereby making a novel methodological contribution to the field of implementation science.

10.2.2 Alignment with real-world needs and capacities

Bridging the research-to-practice gap using low-cost pet robots

While the use of more technologically advanced pet robots appears to be driven by researchers (i.e., through undertaking empirical research), the adoption of lower-cost pet robots appears to have taken a more “grassroots” approach, where individuals and care organisations acquired, tested and integrated pet robots into dementia care on their own accord or based on anecdotal evidence. This was exemplified in chapter 3, which revealed that there were over 2,400 consumer reviews on the JfA cat within less than half a decade (December 2016 to July 2020), and approximately half described personal experiences of their use with older adults and PLWD. Similarly, in the qualitative inquiry (Chapter 5), some care providers introduced the JfA cat into their organisations for residents on their own accord. These findings suggest that the affordability of pet robots has facilitated their uptake for PLWD in real-world settings. Findings from Chapters 2 and 3 provided preliminary evidence that the impact of low-cost pet robots is similar to other more technologically sophisticated, higher-cost pet robots. The interest in the JfA pet robots continues to rise in both research and real-world settings. In the United States, as of May 2021, approximately 20,000 JfA pet robots have been distributed by twenty-one ageing departments to community-dwelling older people who lived alone to mediate feelings of social isolation and loneliness (Engelhard, 2021). Following the completion of the scoping review (chapter 2) in late 2020, new studies investigating the impact of low-cost pet robots continue to emerge, where findings continue to suggest their positive impacts on PLWD (Thunberg et al., 2020; Van Orden et al., 2022). This broaches an important question on the amount of technological sophistication that is needed for a pet robot to effect positive psychosocial benefits. Findings from previous studies suggest that the interactivity of pet robots plays a role in influencing pet robot-human interaction (Moyle et al., 2017). While there have not been studies that have investigated and confirmed the mechanism by which pet robots impact the psychosocial health of PLWD, the literature on human-animal interactions may shed some insight. Interactions with animals often involve active engagement from both the individual and the animal, which has been described as a possible mechanism for establishing a sense of connection (Rault et al., 2020). For pet robots, interactive functionalities allow them to respond to human touch and human voice, which can make them appear as if they are capable of human connection (Apostolova & Lanoix, 2021). This might explain why some level of interactivity in pet robots may be necessary to effect potential benefits. Technological advancements and the potentially increasing demand for lower-cost technological solutions to support dementia care is likely to continue to drive the continued development of lower-cost pet robots. Emerging examples include Tombot (https://tombot.com/), a robotic dog, and Petbot, a robotic bear that is under development at the Czech Institute of Informatics, Robotics and Cybernetics, of the Czech Technical University in Prague. To the best of my knowledge, no previous studies have compared the effectiveness of less technologically advanced pet robots to more sophisticated (and higher costed) ones. This is pertinent research gap that should be investigated in future studies, given the increasing development and interest in using low-cost pet robots, as well as their potential to address affordability related barriers and promote equal access to this technology.

Integrating pet robots for dementia care into the long-term care context

Caring for PLWD in long-term care settings can be substantially more challenging than caring for other populations (Sheehan et al., 2021). With a growing proportion of PLWD worldwide, the provision of care for residents with dementia in long-term care facilities will continue to be challenged (Apostolova & Lanoix, 2021). As one of the key drivers behind the development of social robots, including pet robots, is to support care provision, it is ironic that insufficient consideration has been paid to integrating pet robots into long-term care settings to support dementia care provision, as outlined in chapter 4. Findings from chapters 5, 7 and 9 elucidate that care provision is often dictated by the context in which the organisation is positioned, with workload and resource constraints consistently reported as some of the most omnipresent considerations. These implementation barriers are not unique to pet robots and have been repeatedly highlighted in research on other interventions in long-term care settings (Kloos et al., 2020; Rapaport et al., 2017). As such, it is imperative to consider how the implementation of an innovation aligns (or misaligns) with care provision. This highlights another irony – although one key driver of developing robots is to support care provision amidst an anticipated dwindling population of caregivers; there is a lack of literature which has explicitly investigated the impact of pet robots on caregiving or how caregivers perceive and experience the implementation of pet robot, although they play active roles in supporting (or impeding) the adoption of an innovation (Greenhalgh et al., 2014). Based on conclusions from a systematic review, Greenhalgh and colleagues (2004) found that care providers "… are not passive recipients of innovations. Rather, they seek innovations, experiment with them, find (or fail to find) meaning in them, develop feelings about them, challenge them, worry about them, complain about them, 'work around' them, gain experience with them, modify them to fit particular tasks, and try to improve or redesign them…" (Greenhalgh et al., 2004, p. 598). This emphasises the necessity to understand care providers' views and experiences of implementing robots. Scerri, Sammut & Scerri (2020) conducted a meta-ethnography involving eight studies and found that care providers acknowledged the potential (positive and negative) impacts of pet robots on residents with dementia. Negative or ambivalent attitudes to pet robots changed after they saw the impact of pet robots. Some raised concerns about organisational challenges such as manpower and resource constraints. These findings aligned with findings in chapter 7, which provided further and more nuanced insights into this topic. Although some care providers expressed that pet robots alleviated care work, some also described additional work that was needed to integrate them into their work and to support residents' engagement with them, especially in instances where residents responded negatively. These findings refute some existing argument-based ethical concerns that robots may replace human caregiving (Vandemeulebroucke, 2022), as support and/or facilitation by caregivers may be necessary to support PLWDs' interactions with pet robots. Therefore, pet robots should not be considered as a replacement for care, but rather, as a supplement to care provision. Furthermore, considering that pet robots' impact on dementia caregiving could facilitate or hinder their adoption in long-term care facilities, future studies may also consider furthering this area of research. Additionally, as highlighted in the findings from chapter 9, care providers (such as nurses, activity coordinators, occupational therapists and managers) should be actively involved in the implementation of pet robots. For example, local consensus discussions should be held to understand and discuss their thoughts and concerns about using pet robots in routine dementia care. This is in agreement with recommendations by Apostolova and Lanoix (2021) to involve and seek input from care providers at all stages of implementation, to ensure that the robot does not become another impediment to navigate in their daily work routine.

While the focus of this PhD research is to support the implementation of pet robots, it is important to mention other interventions have been used to support the care and well-being of PLWD in long-term care settings. Residents in long-term care often have a range of needs. Marshall, James and Carter (2020) outlined the eight key needs of PLWD in care homes, which include: physical comfort and freedom from pain, perception of safety, positive touch, love and belonging, fun, occupation and exploration, esteem and control over environment and possession. These multidimensional needs often mean that several and varied interventions are typically offered to residents, based on individual needs and preferences. Examples of other interventions include reminiscence therapy, doll therapy and music therapy (Johnston & Narayanasamy, 2016). There is no one-size-fits-all intervention - Some people may prefer one intervention over another, and it is important to consider that not everyone will respond to or benefit from pet robots (chapters 2, 3, 7 and 9). Finally, as findings from chapter 9 suggest, not all care organisations and providers will be amenable to implementing pet robots, as the needs of different care organisations and care providers vary (Clemson et al., 2021). Correspondingly, Greenhalgh (2018) outlined that an organisation's readiness to implement new interventions should be considered at the outset. Likewise, chapters 7 and 9 established that a local needs assessment should be conducted to understand the (perceived) needs, barriers and facilitators for pet robots to support dementia care.

10.2.3 Ethical considerations of implementing pet robots

The ethical considerations of autonomy, equal access, deception and potential harm relating to the implementation of pet robots will be discussed in this section.

There have been increasing efforts to support person-centred care in long-term care settings, which entails respecting and understanding each resident as an individual (Fazio et al., 2018). An important facet of person-centred care is to support the autonomy of residents, defined as "one's ability to live the life one wants to live" (Hoek et al., 2020). In an observational study to explore the extent to which nursing homes in the Netherlands supported residents' autonomy, Hoek and colleagues (2020) found that most long-term care providers generally engage in practices to support residents' autonomy in daily care. This resembled findings in chapter 6, where care professionals and organisational leaders unanimously outlined the importance of supporting person-centred dementia care within their organisations, elaborating that the use of pet robots should be also person-centred. Similarly, findings from chapter 9 established that strategies to involve residents in the implementation of pet robots were the most critical. This included involving PLWD in the pre-implementation and implementation phases, to identify their design preference and intervention delivery preferences. These strategies are in concordance with recommendations from other studies stating that an understanding and respect for the autonomy of PLWD is an imperative aspect of good dementia care (Smebye, Kirkevold, & Engedal, 2016; Hoek et al, 2020). However, it is doubtful if the design and application of pet robots have been truly person-centred to support the autonomy of PLWD. Bradwell and colleagues have well demonstrated the incongruence between pet robot designs and the preferences of older adults and care home residents (Bradwell et al., 2019; Bradwell et al., 2021), with researchers and technology developers having a selection bias towards PARO (Hung et al., 2019; Bradwell et al, 2019). These suggest that there has been insufficient consideration of PLWDs' preferences, such as pet robot design and intervention delivery preferences (i.e., whether they prefer individual pet robots or shared use of robots). Current research suggests that intervention delivery currently appears to be constrained by the availability and cost of robots (Abbott et al., 2019). For example, while (higher costed) pet robots have been shared amongst users or used in group settings in several studies, findings from chapters 2, 3 and 5 suggest that PLWD may prefer the individualised use of pet robots, as it provides more opportunities for them to engage in different activities. The lower cost of the JfA pets appear to be able to facilitate such opportunities. However, the ethical issue of societal equity must be considered, and it is important to note that affordability is relative. While the JfA pets are substantially lower costed, their affordability may still be prohibitive, based on context. For instance, Bradwell and colleagues (2020) found that care staff in assisted living facilities in the United Kingdom had concerns about cost of the JfA pets, despite shared use among residents. From an international perspective, such cost-related barriers will be even more prominent lower income countries (Rohwerder, 2018). Nevertheless, the continuing emergence and mass production of low-cost pet robots in response to users' demand, may be a potential driver to increase their affordability and accessibility (Rohwerder, 2018) over time.

Long-term care residents with dementia may have different sentiments and responses to pet robots, whether they perceived them as robots or real animals. For instance, in a qualitative study by Pu et al. (2020), residents with mild cognitive impairment expressed positive experiences of interacting with PARO despite knowing that it was a technological device. However, a study by Demange et al (2019) showed that others may be disinterested or decline the use of PARO as it was not a real pet. These are congruent with findings from chapters 2, 3, and 7. Findings from the qualitative inquiry (chapter 7) revealed that while most care providers expressed their respect for residents' reality, a few were concerned that the use of pet robots might be demeaning or cause distress for residents who may perceive it as real. This finding was discussed with my Patient and Public Involvement (PPI) advisor from the Dementia Research Advisory Team, a group of PLWD and their caregivers who advise and collaborate in dementia research (Alzheimer Society of Ireland, 2020). My PPI advisor, an expert living with dementia, expressed overwhelmingly strong sentiments that the autonomy of residents with dementia should be prioritised and respected; if they regard this as real and want to treat it as real, they should be supported by their caregivers to do so. He advocated for the wishes of PLWD to be at the heart of the decisions to use pet robots. This was a strong voice, which appeared to contradict some ethical arguments against the 'deceptive' use of pet robots (Sparrow, 2002; Sharkey, 2014). Such arguments resemble early arguments relating to doll therapy in dementia care, which have also been described as being deceitful (Mitchell & Templeton, 2014). Nevertheless, the ethical stance behind doll therapy has now shifted towards a 'rights-based' approach, where care professionals are recommended to base the use of dolls on the rights and preferences of PLWD (Mitchell & Templeton, 2014). On a similar note, Vandemeulebroucke et al (2021) argued that rather than using overly restrictive stances in using care robots are 'romanticised' ideals of care provision, care providers' and older adults' ethical views could be employed to guide the application of pet robots. Nevertheless, the ethical views of care providers and PLWD have been under-investigated. Future research studies may consider addressing this knowledge gap.

The use of social robots, including pet robots, can be concerning if they lead to physical or psychological harm (Vandemeulebroucke, 2022). Findings from chapters 2, 3, 5, and 7 showed that some older adults and PLWD have had negative responses to pet robots, such as distress or agitation. These findings have been reported in other literature on pet robots (Moyle et al, 2019; Bemelmans et al., 2015). This should not preclude all PLWD from accessing pet robots. Instead, steps should be taken to ascertain the risk of potential distress to residents by carefully considering their needs and preferences at the outset. For example, findings from chapters 2, 3, 7 and 9 outlined that residents' preferences for animals are important considerations to gauge if he or she is likely to respond positively to the pet robot. Findings from other studies had similar findings that people who had previous experiences with animals are more amenable to accepting pet robots (Moyle et al., 2019; Chiu, Hsieh & Li, 2021). In a study by Jung, van der Leij and Kelders (2017), care professionals highlighted that pet robots could be overstimulating for PLWD; sensory overstimulation could lead to undesirable responses such as agitation or confusion (Day, Carreon & Stump, 2000). These resonate with findings and recommendations from chapters 7 and 9, where experts asserted the value of carefully assessing each resident's values, cognitive, functional and sensory needs, and tailoring the use of the pet robots accordingly to mitigate potential distress or negative responses. In chapter 7, care providers revealed that residents' 'undesirable' responses to pet robots - such as disengagement with care due to their attachment to the robots - were mediated through team discussions. According to Banerjee et al (2021), such discussions can facilitate problem-solving, thereby allowing staff to respond to the dynamic nature of care provision in long-term care facilities. This resonates with recommendations derived from chapter 9, where experts highlighted the importance of clinician implementation team meetings for care providers to reflect on and discuss implementation issues.

10.3 Contribution to knowledge

This body of work made novel and substantial contributions to knowledge in several areas that have been previously under or non-investigated. The contributions are fivefold:

- Established the potential of using low-cost pet robots, potentially in place of more technologically advanced pet robots, to support the psychosocial health of PLWD. This has the potential to address implementation barriers related to affordability and facilitate innovation dissemination

- Characterised the multilevel determinants that influence the adoption of pet robots for routine dementia care in long-term care settings

- Explicitly investigated the implementation of pet robots and generated a list of practical, action-focused strategies that can be of utility to researchers, care providers and organisational leaders and care organisations; this is the first evidence-based compilation of implementation strategies that are critical and/or important for implementing pet robots for dementia care in long-term care facilities

- Clearly demonstrated how implementation research concepts can be consistently applied and adapted to this research context to advance the field of pet robots in dementia care

- Provided methodological contributions to the literature, as shown in chapters 3, 8 and 9. Chapter 3 demonstrates a novel methodology that was employed to explore a large body of publicly available data, supporting the examination of user-driven content. Given that there is a lack of guidance on how implementation strategies can be systematically selected to address implementation determinants, chapters 8 and 9 provided methodological contributions concerning the practical application of the CFIR-ERIC mapping tool to identify and contextualise implementation strategies

10.4 Implications for research, practice and policy

Based on findings from this body of work, the key implications on research, practice and policy are outlined below.

Implications for research

1. Low-cost pet robots are less technologically sophisticated than more advanced pet robots, which are typically substantially higher in cost. The work presented in chapters 2, 3 and 6 revealed that the impacts of low-cost pet robots resemble the effects that more technologically advanced pet robots have on older adults and PLWD. However, there is a dearth of high-quality studies that have examined their effectiveness. Considering that low-cost pet robots can address implementation barriers and promote equal access to such technology - which can have potentially important societal implications - investigating the effectiveness of low-cost pet robots should be an important area of future research. High-quality and adequately powered studies, such as randomised controlled trials, should be undertaken to address this research gap, compare the effectiveness of low-cost robots to more technologically sophisticated ones, and explore the level of interactivity that is needed for pet robots to elicit benefits on PLWD. Cost-effectiveness evaluations may also be conducted

2. The work presented in chapters 5 and 7 characterised the multilevel determinants of implementing social robots, including pet robots, through a scoping review and individual, in-depth interviews. The use of an established conceptual framework guided considerations about the different facets of implementation, beyond the characteristics of pet robots where much of previous research was focused. Future research should build upon this knowledge, pay more attention to the multidimensional aspects of implementation and consider using an established conceptual framework to guide thorough implementation inquiries. In addition, the views of residents with dementia should also be solicited in future studies, as they are important stakeholders (service recipients) in the implementation of pet robots

3. The implementation of pet robots can impact care providers, including care professionals and organisational leaders (chapters 5 and 7). While pet robots could provide caregiving relief, care providers had to support residents' interactions with pet robots. However, few studies have explored care providers' perceptions of the process of implementing pet robots and investigated the impact of robots on care providers. Given that this could potentially facilitate the implementation of pet robots for PLWD in care facilities, future studies could consider further exploring these research areas

4. Chapters 8 and 9 demonstrated how a conceptual framework (CFIR), implementation taxonomy (ERIC) and a matching tool (CFIR-ERIC mapping tool) can be leveraged to systematically select and tailor implementation strategies to this study context. Given that guidance is scarce in the extant literature on how implementation strategies should be systematically selected, the methods used in this work provide useful information for future research to identify and contextualise strategies for other study contexts

5. Through an international consensus study with care professionals, organisational leaders and researchers (chapters 8 and 9), a list of 12 strategies was established as critical and/or important

for implementing pet robots. As the consensus study was not adapted to involve PLWD and their caregivers, future research can build on this work by further refining the list of strategies in consultation with PLWD and their family members. Future studies could also work on further specifying the strategies, such as the stakeholders involved, dosage and targeted outcomes. More work is also necessary to test the implementation strategies. Hybrid implementation-effectiveness trial designs may be suitable study designs to concurrently evaluate the effectiveness of the selected implementation strategies and the effectiveness of pet robots

Implications for practice

1. Low-cost pet robots may be incorporated as a part of routine dementia care in long-term care facilities, as they have shown benefits for PLWD, such as improving mood and social engagement. However, like other interventions (including other pet robots), it is important to consider that not all residents may benefit, and some may decline or experience negative impacts (chapters 2, 3 and 7). Hence, before introducing pet robots, assessments of each individual's needs, preferences and abilities are necessary. The use of pet robots may also require facilitation by care providers. Since the needs and abilities of PLWD can evolve, it is also necessary to re-evaluate the suitability of the robots over time (chapters 7 and 9)

2. While pet robots can alleviate some aspects of care provision by supporting the psychosocial wellbeing of PLWD, care providers also played a role in supporting residents to engage with the robots, especially in mitigating negative or undesirable reactions (chapters 3 and 7). Therefore, it is important to note that pet robots should not be seen as replacements for care, but rather, as a supplement for dementia care provision

3. The list of implementation strategies (chapter 9) established as important and/or critical to address the multilevel barriers and facilitators of implementing pet robots has direct and pragmatic implications for long-term care organisations and care providers. It serves as a list of evidence-based strategies for care providers and organisations to implement pet robots for dementia care. These strategies may be tailored to suit different organisational contexts and needs. They may also be used inform the development or refinement of dementia care pathways within care organisations. This list of strategies has been disseminated to all study participants, including care professionals and organisational leaders from long-term care organisations. The list of implementation strategies has been uploaded onto the Open Science Framework and is freely accessible (https://osf.io/7dywr)

4. Residents with dementia and their informal caregivers, such as their family members, are important stakeholders who should be involved in the implementation of pet robots (chapters 7 and 9). Their views on pet robots, such as their preferred design, intervention delivery and facilitation, should be solicited and re-evaluated, to uphold the person-centred use of the technology

Implications for policy

1. Findings from this thesis outlined that national regulatory authorities could influence the utilisation of pet robots in long-term care settings. Their regulations on infection prevention and control could influence the mode of intervention delivery (e.g., individual or shared use, or the acceptability of cleaning regimes). As outlined in findings from chapter 9, whilst experts agreed that involving governance is important to address such issues, some were concerned that their involvement may be bureaucratic or become too burdensome for care providers. Therefore,

regulatory authorities need to be aware of the prospective impacts of pet robots on PLWD and work with care organisations to develop a realistic and practical standard for the implementation of pet robots

2. Funding has been consistently identified as an important barrier to implementation in chapters 2, 3, and 5, and access to funding was established as a critical strategy to implement pet robots in long-term care for residents with dementia (chapter 9). As the evidence supporting the impacts on residents with dementia (and also potentially on care providers) continues to grow, policymakers need to consider funding provisions in this field to enable care organisations to gain access to pet robots, and to support the sustainable implementation of pet robots for residents with dementia

10.5 Strengths and limitations

The strengths and limitations of individual studies were outlined within each paper (chapters 2 to 9). This section presents the overall strengths and limitations of this thesis.

This thesis has several strengths. This body of work leveraged an established implementation research framework and different taxonomies, which provided conceptual grounding for the design and conduct of each study. In addition, each piece of work was designed to inform the subsequent studies, which reciprocally built on each preceding work. Another key strength of this work is the involvement of multidisciplinary stakeholders. Various organisational leaders and care professionals with different disciplinary expertise, and researchers with different academic expertise (e.g., implementation science, dementia research, psychosocial interventions, social robots) were involved in this PhD research in different study phases, either as participants or as advisors. Patient and public involvement (PPI) from dementia advisors were also sought to ensure that the perspectives of PLWD were represented in this research; this included a PPI member from the Dementia Research Advisory Team and a consultation with the European Working Group of People Living with Dementia. As the implementation of pet robots involves stakeholders at multiple levels, the combination of insights from different stakeholders provided a holistic, multidisciplinary lens on this topic. At the end of the study, participants were acknowledged for their contributions, and the findings of empirical studies were shared with each participant at the end of each study. This can increase participants' trust in the research process and support the dissemination of research findings beyond the academic audience (McElfish et al., 2019). To ensure accessibility, the results were summarised and presented in a more concise and digestible format for distribution to non-academic participants (https://osf.io/pn47q). In addition, open scholarship principles were embedded throughout this PhD research. Open scholarship, or open science, entails making the research and its dissemination openly accessible by anyone (Allen and Mehler, 2019). In line with these principles, the pre-registration and protocols of most papers were made openly accessible. This provided research transparency and allowed the study to be scrutinised and improved before studies were conducted, thereby supporting replicability and rigour (Allen and Mehler, 2019). The preprints of two studies (chapters 3 and 4) were made available to promote the openness of the study. Finally, all studies are published in open-access journals, which promotes visibility and transparency.

The limitations of this work should be acknowledged. One of the key limitations was the exclusion of PLWD as study participants. Before Covid-19, face-to-face interviews with residents with dementia (for the qualitative study) were planned. This plan had to change due to Covid-19 guidelines, including social-distancing restrictions and no visitor access to nursing homes. The study design was then amended to recruit community-dwelling PLWD. However, recruiting PLWD to participate in the qualitative empirical study for online interviews proved unsuccessful. One reason could be that participation would have required individuals to prospectively think about organisational contexts within nursing homes, which may have been a difficult task. Another reason could be their lack of confidence or level of comfort in using videoconferencing technology. The challenge of recruitment has also been exacerbated by the pandemic, which made it harder to reach out to PLWD. Nevertheless, every effort was made to ensure that the views of PLWD were represented (such as PPI consultations) were made to ensure that the views of PLWD were represented. Next, this study relied primarily on self-reported data through qualitative interviews and the consensus study. It may be that this body of work could be made more robust with additional data sources, such as researcher observations of the implementation of pet robots in long-term care facilities. Visitations to nursing homes were planned at the outset of this PhD, however, this was not possible due to pandemic-related restrictions.

10.6 Conclusions

This PhD thesis comprised eight papers, reporting on five studies that were conducted to support the translation of the research on pet robots in long-term care settings for routine dementia care. This research provided new insights on the potential impacts of low-cost pet robots on the psychosocial health of PLWD. The affordability of such low-cost devices has the potential to mitigate implementation barriers related to equal access. However, it important to note that affordability is relative, and the cost of pet robots may still hinder their implementation in real-world practice. This research also characterised the multilevel barriers and facilitators to the implementation of pet robots in long-term care settings, and provided a list of implementation strategies that are important and/or critical for supporting the adoption of pet robots for PLWD in long-term care. This body of work provided a practical, evidence-based list of strategies to guide the implementation of pet robots within their long-term organisations for residents with dementia, and has direct implications for care organisations and providers.

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Appendix 1: Search strategy (Chapter 2)

Appendices

Appendix 1: Search strategy (Chapter 2)

Database	Search strategy
Medline via Ovid	1. Robotics/ 2. Robo*.mp. 3. 1 or 2 4. Animal Assisted Therapy/ 5. Pets/ 6. companion.mp. 7. 4 or 5 or 6 8. 3 and 7 9. robo* cat.mp. 10. robo* dog.mp. 11. robo* anima*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 12. 8 or 9 or 10 or 11 13. Aged/ 14. (age or elderly or senior citizen* or older adult).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 15. Dementia/ 16. dementia.mp. 17. 15 or 16 18. 12 and 17 19. limit 18 to yr="2016 -Current"
PsycINFO via Ovid	1. Robotics/ 2. Robo*.mp. 3. 1 or 2 4. Animal Assisted Therapy/ 5. Pets/ 6. companion.mp. 7. 4 or 5 or 6 8. 3 and 7 9. robo* cat.mp. 10. robo* dog.mp. 11. robo* anima*.mp. [mp=title, abstract, original title, name of substance word, subject

	heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 12. 8 or 9 or 10 or 11 13. Aged/ 14. (age or elderly or senior citizen* or older adult).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 15. Dementia/ 16. dementia.mp. 17. 15 or 16 18. 12 and 17 19. limit 18 to yr="2016 -Current"
CINAHL	1. (MH "Robotics") 2. robo* 3. (MH "Pet Therapy") 4. animal assisted therapy 5. companion 7. S1 OR S2 8. S3 OR S4 9. S7 OR S8 10. robo* cat 11. robo* dog 12. robo* anima* 13. S9 OR S10 OR S11 OR S12 14. (MH "Aged") 15. "older adults" 16. (MH "Dementia") 17. dementia 18. S14 OR S15 OR S16 OR S17 19. S13 AND S19 (Limiters - Published date 2016/01/01 -)
Web of Science Core Collection	1. TOPIC: (robo*) 2. TOPIC: ("pet therapy") 3. TOPIC: ("animal assist* therapy") 4. TOPIC: ("robo* cat") 5. TOPIC: ("robo* dog") 6. TOPIC: ("robo* animal") 7. TOPIC: ("social robot") 8.TOPIC: ("social assistive robot") 9. TOPIC: ("socially asisstive robot" 10. TOPIC: ("companion robot") 11. #3 OR #2

	12. #11 AND #1 13. #12 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 14. TOPIC: ("older people") 15. TOPIC: ("older adult*") 16. TOPIC: ("elder*") 17. TOPIC: (dementia) 18. #17 OR #16 OR #15 OR #14 19. #18 AND #13 20. #18 AND #13 Refined by: PUBLICATION YEARS: (2020 OR 2019 OR 2018 OR 2017 OR 2016)
Scopus	1. TITLE-ABS-KEY (robo*) 2. TITLE-ABS-KEY ("animal assist* therapy") 3. TITLE-ABS-KEY ("pet therapy") 4. TITLE-ABS-KEY ("robo* cat") 5. TITLE-ABS-KEY ("robo* dog") 6. TITLE-ABS-KEY ("robo* pet") 7. TITLE-ABS-KEY ("robo* animal") 8. TITLE-ABS-KEY ("social* assist* robot" 9. TITLE-ABS-KEY ("companion robot") 10. #2 OR #3 11. #1 AND #10 12. #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #11 13. TITLE-ABS-KEY ("older people") 14. TITLE-ABS-KEY ("older adult*") 15. TITLE-ABS-KEY ("elder*") 16. TITLE-ABS-KEY (dementia) 17. #13 OR #14 OR #15 OR #16 18. #12 AND #17 Publication limit 2016 – 2020

Appendix 2: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist (Chapter 2)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	12
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	13
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	14-16
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	15
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Not applicable
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	16-17
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	16
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix 1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	16-17
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	17
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	17
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	17-18
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	17

Appendix 2: PRISMA-ScR Checklist (Chapter 2)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	19
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	20-22
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	18-19
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	20-22
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	23-26
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	26-28
Limitations	20	Discuss the limitations of the scoping review process.	28
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	29
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	29

Appendix 3: Quality appraisal (Chapter 2)

Critical Appraisal Skills Program (CASP) Qualitative Checklist

Question number	Marsilio et al, 2018	Picking and Pike, 2017	Pike et al, 2018	Brecher et al, 2019	Bradwell et al, 2020	Pike et al, 2020	Hudson et al, 2020
1	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Can't tell	Can't tell	Yes	Yes	Yes	Yes	Can't tell
4	Yes	Can't tell	Can't tell	Yes	Yes	Yes	Yes
5	Can't tell	Can't tell	Can't tell	Can't tell	Yes	Yes	Yes
6	No	No	No	No	No	Can't tell	Yes
7	Yes	Can't tell	Can't tell	No	Yes	Yes	Yes
8	No	No	No	Can't tell	Yes	Yes	Yes
9	Can't tell	No	No	Yes	Yes	Yes	Yes

NIH Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group

Question number	Marsilio et al, 2018	Tkatch et al, 2020
1	Yes	Yes
2	Yes	Yes
3	Yes	Yes
4	CD	Yes
5	No	Yes
6	No	CD
7	Yes	Yes
8	No	CD
9	CD	No
10	Yes	Yes
11	No	No
12	NA	NA
Quality rating	Poor	Fair

AACODS Checklist

AACOD questions	McBride et al, 2017
Author	No
Accuracy	No
Coverage	No
Objectivity	No
Date	Yes
Significance	Can't tell

Appendix 4: Research Ethics Committee Approval Letter (Chapter 3)

NUI Galway
OÉ Gaillimh

NUIG RESEARCH ETHICS COMMITTEE DECISION LETTER

REC Application Reference Number: **R20.Jun.12**
Title: **Exploring Users' Experience of Using a Robotic Cat: A Qualitative Content Analysis of User Generated Content.**
Principle Applicant: **Wei Qi Koh**
Application Type: **New**
Meeting Date: **18 June 2020**
Decision: **APPROVAL**

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29 June 2020

Dear Ms Koh,

The Committee was divided regarding whether or not this application requires ethics approval: you are processing freely available data, and have no contact with any subject. However, given the application has been reviewed, I am pleased to inform you that the proposal has been granted **APPROVAL.**

Please note the following:

1. Any significant alterations to an approved proposal must receive prior approval from the REC prior to implementation. Please request an Amendment Form;
2. You are responsible for notifying the REC in the event of serious or unexpected adverse effects, unforseen circumstances, the termination of the study, and any significant decisions by other Ethics Committees. Section 7 of the REC's Standard Operating Procedures gives further details on instances requiring follow-up reviews, and reporting obligations.
3. All NUI Galway Research Ethic Committee approval is given subject to the Principal Investigator submitting annual and final statements of compliance. See annual and final statement of compliance forms attached. The first statement is due on or before 29 June 2021.

When the decision was taken I was chairing the meeting, and the following members were also present:

Dr Kevin Davison (Chair)	Dr Veronica McCauley (VC)	Dr Linda Biesty
Dr Kate Dawson	Dr Alexander de Menezes	Dr Caroline Heary
Dr Vicky Hogan	Dr Edel Hughes (Observer)	Dr Fionnuala Jordan
Dr Martina Kelly	Dr Marie Mahon	Dr Stacey Scriver
Dr Amir Shafat	Mr Patrick Towers	

Appendix 5: Data extraction form template (Chapter 3)

Data extraction field	Description
Reference no.	Numbering of the review extracted
Site	Website where the review was extracted
Country	Website's country of origin
Username	Username of the reviewer who left the review (if available)
Review date	Date of the review (if available)
Rating (star)	Reviewer's rating of the robotic pet (if available)
Reviewer role	Reviewer's description of his/her role in relation to the user of the pet robot (if available)
End user gender	Reviewer's description of the gender of the user of the pet robot (if available)
End user age	Reviewer's description of the age, age group or age range of the user of the pet robot (if available)
End user diagnosis	Reviewer's description of the diagnosis of the user of the pet robot (if available)
Setting	Reviewer's description of the setting which the pet robot was (or is) being used (if available)
Title of review	Title of the review (if available)
Body of review	Content of the review

Appendix 6: Summary and detailed description of coding framework (Chapter 3)

Summary of all codes, sub-categories, and categories

1. Prior expectations	Circumstances	Can't have a real cat
		Covid-19
		Isolation
		Likes cats
	Expectations	Advantages over live cat
		Improve QoL
		Uncertainty and ambivalence
2. Perceptions	Appearance	Looks real
		Not real
	Interactivity	Negative comments about interactivity
		Positive comments about interactivity
	Expectations met	Exceeded expectations
		Gratitude
		Ideally fitting needs
	Not fitting needs	-
	Awareness that the cat is a robot	Aware that the cat is not real
		Not aware that the cat is not real
		Occasionally aware
	Ambivalence and rejection (Primary users)	Confusion about the cat
		Negative reactions
		Tepid responses
	Ambivalence and rejection (Primary users)	Conflicted or tepid responses
		Negative responses
3. A meaningful occupation	Attachment to the cat	
	Companionship	-
	Doing something with the cat	Brushing
		Holding, stroking, or patting
		Keep it on lap
		Naming the cat
		Replaces other activities/lack of activities
		Sleeping with the cat
		Taking the cat to places
		Talking to the cat
	Facilitation and support	-
	Reminiscence	-
	Treating it as if it is real	-
	Shows off cat to others	-
	Topic of conversation	-
4. impacts	Positive impacts on primary user	A welcome distraction
		Comforting and calming
		Positive emotions
		Sustained effects
	Positive impacts on caregivers	Positive emotions
		Caregiver relief
	Positive impacts on others	Positive emotions
		Sharing the pet

	Negative impacts on primary user	
	Negative impacts on secondary user or others	
5. Practicalities	Expensive	-
	Negative aspects	Battery
		Hygiene
		Not robust
		Not worth the money
		Technical malfunction
		Volume
		Disappointment
		Will not repurchase
	Positive aspects	Battery
		Robust
		Volume
		Recommend to others
		Satisfied with purchase
	Suggestions for improvement	-

Description of codes, sub-categories and categories

This is an exemplar of the description od codes, sub-categories and categories. The full, detailed description can be accessed via https://osf.io/gkpbh.

Category	Subcategory	Code	Explanation
1. Prior expectations Prior expectations of the robotic cat by users before actual use. This can include their perceptions of who the robotic cat should be used for, when it should be used for and what they hope for it to do.	Circumstances Personal/environmental circumstances which influenced users' perceptions of the potential value of the robotic cat. Personal circumstances e.g. loneliness, past experiences with cats/animal lover. Environmental circumstances e.g. unable to have a live animal	*Can't have a real cat*	not able to have a real (live) cat or animal due to circumstantial reasons (e.g. not allowed to) or personal reasons (e.g. inability to care for a real animal)
		Covid-19	Influence of COVID-19 pandemic on their perceived utility of the robotic cat (i.e., did they purchase the cat because they perceive it to have benefits to combat effects of the pandemic)?
		Likes cats	previously owned cats, or comments that the primary user (older person/PwD) like cats or have had cats. May also contain comments that users like plush toys/soft toys
	Expectations Expectations of what the cat can offer to the primary user (i.e. older person or person with dementia)	*Advantages over live cat*	benefits of the robotic cat compared to having a live cat
		Uncertainty and ambivalence	uncertainty, ambivalence, or initial scepticism about how the robotic cat may impact the primary user (i.e. older person or person with dementia)

Category	Subcategory	Code	Explanation
2. Perceptions Initial perceptions and evolution of perceptions after using the robotic cat. This includes their perception of the appearance and interactivity of the cat (after	Ambivalence and rejection (Primary users) Ambivalence towards or rejection of the robotic cat by primary users	*Confusion about the cat*	confusion about the robotic cat's actions, purpose or intentions
		Negative perceptions	negative perceptions towards the robotic cat or taking offense to being given the robotic cat. note that this should contain comments that are related to **perceptions.** (for comments about reactions to the cat, code it to one of the codes in the **"Impacts"** category instead).

seeing/using it), whether it meets their initial perceptions (and expectations), and reactions to these perceptions	Ambivalence and rejection (Secondary users) Ambivalence towards or rejection of the robotic cat by secondary users	*Conflicted or tepid perceptions*	conflicted responses or feelings towards the robotic cat, or tepid responses. note that this should contain information about **perceptions.** (for comments about reactions to the cat, code it to one of the codes in the **"Impacts"** category)
	Appearance Appearance (general outlook and design) of the robotic cat: e.g. fur covering, lifelikeness *Note: for comments relating to functions of the cat, e.g. sounds or movement, they should be coded in "interactivity"*	*Looks real*	positive comments that the robotic cat looks real. this can include comments about the fur, size, feels of the robotic cat
		Not real	Negative comments that the robotic cat looks unreal. this can include comments about the fur, size, feels of the robotic cat

Category	Subcategory	Code	Explanation
3. A meaningful occupation Describe the meaningfulness (i.e. utility) of the robotic cat to older persons/people with dementia as an occupation. This can include how the robotic cat serves to provide a sense of meaning to the person (e.g. providing a meaningful occupation or promotes occupational engagement)	Attachment to the cat		negative thoughts and emotions of user due to dependence on cat and problems when it was not working or around the prospect of it being withdrawn. Indications of attachment and negative emotions when attachment interrupted.
	Companionship	*Keep it on lap*	activity of placing or keeping the robotic cat on primary users' laps
	Doing something with the cat Things/activities that can be done with the cat, such as stroking or brushing it, naming it, keeping it on lap etc Facilitation and support Reminiscence Rough or undesirable behaviours	*Naming the cat*	primary user's naming of the cat
		Replaces other activities/lack of activities	References to person not having access to alternative activities
		Talking to the cat	comments that the primary user talked to the cat
	Facilitation and support	-	statements that relate to any form of support that is provided to the older person to use the cat

Appendix 6: Summary and detailed description of coding framework (Chapter 3)

Category	Subcategory	Code	Explanation
4. Impacts Description about the positive and negative impacts of using the robotic cat	Positive impacts on primary user positive impacts of the robotic cat on the primary user (i.e. older person or person with dementia)	*A welcome distraction*	references to the cat being a distraction to user or a focus for them
		Comforting and calming	comfort and calming effects that are derived as a use of the robotic cat. this code may also contain comments about reduction of negative behaviours (e.g. reduced anxiety, reduced stress)
	Positive impacts on caregivers	*Positive emotions*	positive emotions that formal and informal caregivers experience as a result of direct or indirect interaction with the robotic cat
	Negative impacts on primary users	-	negative emotions or other impacts that are derived from the use of the robotic cat. This code may contain comments about the **increase in negative behaviours** (e.g. increased anxiety, increased stress or agitation). If the code is related to perceptions, code it within in the "perceptions" category.

Category	Subcategory	Code	Explanation
5. Practicalities experiences relating to other practicalities involving the robotic cat, including its affordability, technical functions, and robustness. also includes users' overall satisfaction regarding their purchase of the robotic cat	Expensive	**-**	comments stating that the robotic cat is expensive or costly
	Negative aspects negative aspects relating to the technical aspects and practical use of the robotic cat in the real world (e.g. hygiene, infection control), as well as overall dissatisfaction with the purchase *(dissatisfaction about the specific functions of the cat should be coded elsewhere, e.g. appearance/interactivity - negative aspects)*	*Battery*	negative experiences relating to the battery life (or other battery related issues) of the robotic cat
		Hygiene	negative experiences or concerns regarding the hygiene or infection control aspects of using the robotic cat
		Not robust	poor quality or overall condition of the robotic cat
		Not worth the money	expressions that the robotic pet is not worth purchasing (in relation to costs)
		Technical malfunction	all other general technical issues that has resulted in errors or malfunction, or non-function of the robotic cat
		Disappointment	general expressions that the user's negative experiences and disappointment in this purchase
		Will not repurchase	comments that the user will not repurchase the robotic cat, or recommends against the purchase of the robotic cat

Appendix 7: Settings where the pet robot were used (Chapter 3)

Setting	Other terms used to describe settings	No. of reviews
Long term care facility	Nursing home, Care home, aged care home, old age home, old folks home, personal care home, residential care home, residential care facility, residential care, residential care facility, assisted living, assisted living centre, long term care facility, senior assisted living, senior assisted home, senior assisted residence, independent living facility	399
Memory care facility	Memory care, memory support	56
Lives alone	-	19
Retirement home	Retirement community, retirement residence, retirement community	16
Other dementia care facilities	Dementia unit, dementia wing, dementia care community residence, dementia facility, Alzheimer's facility, dementia care community residence, dementia facility, Alzheimer's facility, special care dementia unit, Alzheimer’s day care, dementia drop in cent	13
Others	Hospital, rehab facility, nursing rehab facility, elderly care facility, sheltered housing, adult foster home, group home, hospice, skilled care facility	36

Appendix 8: Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) checklist (Chapter 4)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	57
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	58
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	59-60
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	60
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	61
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	62
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	61-62
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix 9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	61-62
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	63
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Not applicable
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this	Not applicable (appraisal will not be conducted)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	63
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Not applicable at protocol stage
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Not applicable at protocol stage
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not applicable (appraisal will not be conducted)
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Not applicable at protocol stage
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Not applicable at protocol stage
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Not applicable at protocol stage
Limitations	20	Discuss the limitations of the scoping review process.	64
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Not applicable at protocol stage
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	65

Appendix 9: Sample search strategy (Chapter 4)

PsycINFO Search Strategy

1. social* AND robot*.mp.
2. Aged/
3. (age or elderly or senior citizen* or older adult).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
4. dementia.mp. or Dementia/
5. implement*.mp.
6. quality improvement.mp. or Quality Improvement/
7. dissemination.mp. or Information Dissemination/
8. "Patient Acceptance of Health Care"/ or acceptability.mp.
9. satisfaction.mp. or Personal Satisfaction/
10. adoption.mp.
11. uptake.mp.
12. "Delivery of Health Care"/ or utili*ation.mp.
13. appropriateness.mp.
14. cost.mp. or "Costs and Cost Analysis"/
15. Feasibility Studies/ or feasib*.mp.
16. fidelity.mp.
17. sustainability.mp. or Program Evaluation/
18. penetration.mp.
19. 2 or 3 or 4
20. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
21. 1 and 19 and 20

Appendix 10: Categorisation of social robots (Chapter 4)

There have been several proposed ways of categorising social robots based on different attributes (1). For example, Fong et al (2) suggested four ways in which social robots could be classified based on their morphology: anthropomorphic (human-like), zoomorphic (animal-like), caricatured (cartoonish) and functional. Gongora et al (3) proposed the categorisation of social robots into four different categories: (i) pet robot, (ii) humanoid robot, (iii) social assistive robot, (iv) telepresence robot (5). The authors provided examples of social robots in each category; however the definitions and explanation of each category was not elaborated in detail. It is also unclear if the social robots were classified based solely on their morphology or function. For example, the categories 'pet robot' and 'humanoid robot' appears to be categorising them based on their appearances, while 'social assistive robot' appears to be categorised based on their function. In addition, categories – such as "humanoid robot" and "socially assistive robot" - do not appear to be be mutually exclusive. Hence, some subjectivities may be introduced if using this framework for classifying social robots.

The intention of the following categorisation of social robots (Table 1) is for the practical purpose of a categorising social robots for a scoping review (4). Social robots will be categorised into three operational groups based on their functions:

Table 1: Categorization of social robots based on their functions

	Type of social robots	**Functions**
1	Socially assistive robots	Social robots with functions to assist users with tasks (5)
2	Pet robots	Viable substitutes to live animals (6) and functions as pet therapy to provide physiological and emotional benefits for users (7)
3	Telepresence robots	Has a video conferencing system mounted on a mobile robotic base, and has a primary function to provide social interaction between humans (8).

References

1. Čaić M, Mahr D, Oderkerken-Schröder G. Value of social robots in services: social cognition perspective. Journal of Services Marketing. 2019.
2. Fong T, Nourbakhsh I, Dautenhahn K. A survey of socially interactive robots. Robotics and autonomous systems. 2003;42(3-4):143-66.
3. Góngora Alonso S, Hamrioui S, de la Torre Díez I, Motta Cruz E, López-Coronado M, Franco M. Social robots for people with aging and dementia: a systematic review of literature. Telemedicine and e-Health. 2019;25(7):533-40.
4. Koh W, Felding S, Toomey E, Casey D. Barriers and Facilitators to the Implementation of Social Robots for Older Adults and People with Dementia: A Scoping Review Protocol. 2020.
5. Feil-Seifer D, Mataric MJ, editors. Defining socially assistive robotics. 9th International Conference on Rehabilitation Robotics, 2005 ICORR 2005; 2005: IEEE.
6. Leng M, Liu P, Zhang P, Hu M, Zhou H, Li G, et al. Pet robot intervention for people with dementia: a systematic review and meta-analysis of randomized controlled trials. Psychiatry Research. 2019;271:516-25.
7. Abbott R, Orr N, McGill P, Whear R, Bethel A, Garside R, et al. How do "robopets" impact the health and well-being of residents in care homes? A systematic review of qualitative and quantitative evidence. International Journal of Older People Nursing. 2019;14(3):e12239.
8. Stahl C, Anastasiou D, Latour T, editors. Social Telepresence Robots: The role of gesture for collaboration over a distance. Proceedings of the 11th PErvasive Technologies Related to Assistive Environments Conference; 2018.

Appendix 11: CFIR Codebook of Definitions (Chapter 4)

This is an **exemplar** of the codebook that will be used to guide the coding of the barriers and facilitators - the full codebook can be accessed at: https://osf.io/cns9k. This codebook is the result of the operationalisation/adaptation of existing definitions and eligibility criteria for CFIR constructs (available at https://cfirguide.org/) to the topic area (i.e. using social robots for older adults and/or people with dementia). The existing construct definitions and eligibility criteria are adapted to this topic area to ensure coding consistency.

1. Intervention Characteristics

CFIR Constructs	Description	Inclusion and/or Exclusion Criteria
Intervention source	Perception of key stakeholders about whether the innovation is externally or internally developed.	Inclusion Criteria: Include statements about the source of the innovation and the extent to which interviewees view the social robot as internal or external to their organization or setting Exclusion Criteria: Exclude statements related to who participated in the decision-making process to implement social robots and code to **"Engaging"**, as an indication of early (or late) engagement.
Evidence strength & quality	Stakeholders' perceptions of the quality and validity of evidence supporting the belief that social robots will have desired outcomes	Inclusion Criteria: Include statements regarding awareness of evidence and the strength and quality of evidence, as well as the absence of evidence or a desire for different types of evidence instead of evidence from the literature. Exclusion Criteria: Exclude code statements regarding the receipt of evidence as an engagement strategy to "**Engaging: Key Stakeholders"**
Relative Advantage	Stakeholders' perception of the advantage of implementing social robots compared to the status quo or an alternative.	Inclusion Criteria: Include statements about stakeholders' perceptions that the social robot is better (or worse) than the status quo or an alternative intervention. Exclusion Criteria: Exclude statements that do or do not demonstrate a strong need for social robot and/or that the current situation is untenable (e.g. statements that social robots are absolutely necessary or absolutely redundant) and code to **"Tension for change''**. Exclude statements regarding specific needs of end users (i.e. older adults and/or people with dementia) that demonstrate a need for social robots and code to **"Users' Needs & Resources"**

2. Outer Setting

CFIR Constructs	Description	Inclusion and/or Exclusion Criteria
Needs and Resources (of end users)	The extent to which the needs of end users (i.e. older adults and/or people with dementia), as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organisation/setting	Inclusion Criteria: Include statements demonstrating (lack of) awareness of the needs and resources of end users (i.e. older adults and/or people with dementia). For example, users' demand for social robot, barriers and facilitators experienced by end users to using social robots, end users' satisfaction with social robot) Exclusion Criteria: Exclude consumer feedback on whether the social robot is having the desired outcome and code to **"Evidence Strength & Quality".**

Cosmopolitanism	The degree to which the care setting or organisation is networked with other external organizations (i.e. external people and groups).	Inclusion Criteria: Include descriptions of outside group memberships and networking done outside the care setting/organisation Exclusion Criteria: Exclude statements of networking with external organisations, general networking, communication that did not exist prior to the social robot implementation and code to **"Network and Communication"**
External Policy & Incentive	A broad construct that includes external strategies to spread innovations, including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines and public reporting.	Inclusion Criteria: Include descriptions of external strategies (outside the care setting/organisation) to social robot(s) (e.g. policies, regulations, guidelines).

3. Inner Setting

CFIR Constructs	Description	Inclusion and/or Exclusion Criteria
Culture	Norms, values, and basic assumptions of the setting	Inclusion Criteria: Include statements related to concepts captured in the Competing Values Framework approach - four archetypical organizational cultures: team culture, hierarchical culture, entrepreneurial culture and rational culture. (Note: Culture is often viewed as relatively stable, socially constructed, and subconscious)
Implementation climate	The absorptive capacity for change, shared receptivity of involved individuals to the social robot(s), and the extent to which use of that intervention will be rewarded, supported, and expected within their setting	Inclusion Criteria: Include statements regarding the general level of receptivity to implementing the social robot
(i) Tension for change	The degree to which stakeholders perceive the current situation as intolerable or needing change.	Inclusion Criteria: Include statements that (do not) demonstrate a strong need for the social robot and/or that the current situation is untenable (e.g. statements that the social robot is absolutely necessary or that it is redundant with other programs). Exclusion Criteria: Exclude statement regarding specific needs of end users that demonstrate a need for the social robot, but do not necessarily represent a strong need or an untenable status quo and code to **"Needs and Resources"**. Exclude statements that demonstrate the intervention is better (or worse) than existing programs and code to **"Relative Advantage"**

Appendix 11: CFIR Codebook of Definitions (Chapter 4)

4. Characteristics of Individuals

CFIR Constructs	Description	Inclusion and/or Exclusion Criteria
Knowledge & beliefs about the social robot	Individuals' attitudes toward and value placed on the social robot as well as familiarity with facts, truths, and principles related to the innovation	Inclusion Criteria: Include statements related to individuals' attitudes towards and value placed on the social robot as well as familiarity with facts, truths, and principles related to the innovation Exclusion Criteria: Exclude statements related to familiarity with the evidence regarding social robot(s) and code to **"Evidence Strength and Quality"**
Self-efficacy	Individual belief in their own capabilities (confidence in their ability) to execute courses of action to achieve implementation goals (i.e. to carry out steps required to implement the social robot)	Inclusion Criteria: Include statements related to belief in their own capabilities (confidence in their ability) to execute courses of action to achieve implementation goals

5. Process

CFIR Constructs	Description	Inclusion and/or Exclusion Criteria
Planning	The degree to which a scheme or sequence of tasks for implementing the social robot are developed in advance, and the quality of those schemes or tasks.	Inclusion Criteria: Include evidence of pre-implementation diagnostic assessments and planning, as well as refinements to the plan.
Engaging	Attracting and involving appropriate individuals in the implementation and use of the intervention through a combined strategy of social marketing, education, role modelling, training, and other similar activities.	Inclusion Criteria: Include statements related to engagement strategies and outcomes (i.e. if and how stakeholders became engaged with the social robot and what their role is in implementation). Exclusion Criteria: Exclude statements that are captured in the sub-codes below.
(i) Opinion leaders	Individuals in the care setting/ organisation who have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing the social robot	Inclusion Criteria: Include statements related to engagement strategies and outcomes (e.g. how the opinion leader became engaged with the social robot and what their role is in implementation). Double code statements to the CFIR sub-construct **"Leadership Engagement"** (under the 'Inner Setting' domain) if the formally appointed internal implementation leader is also the organisational leader

Appendix 12: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist (Chapter 5)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	67
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	68
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	69-70
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	70
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	70
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	71
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	71
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix 13
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	71
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	71-72
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Not applicable
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this	Not applicable (appraisal not conducted)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	72
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	73
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	74-79
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not applicable (appraisal not conducted)
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	74-79
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	80-89
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	89-92
Limitations	20	Discuss the limitations of the scoping review process.	91-92
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	92
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	93

Appendix 13: Sample search strategy (Chapter 5)

Medline search strategy

1. (social* and robot*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
2. Aged/
3. (age or elderly or senior citizen* or older adult).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
4. dementia.mp. or Dementia/
5. implement*.mp.
6. quality improvement.mp. or Quality Improvement/
7. program evaluation.mp. or Program Evaluation/
8. dissemination.mp. or Information Dissemination/
9. "Patient Acceptance of Health Care"/ or acceptability.mp.
10. satisfaction.mp. or Personal Satisfaction/
11. adoption.mp.
12. uptake.mp.
13. "Delivery of Health Care"/ or utili*ation.mp.
14. appropriateness.mp.
15. cost.mp. or "Costs and Cost Analysis"/
16. Feasibility Studies/ or feasib*.mp.
17. fidelity.mp.
18. sustainability.mp
19. penetration.mp.
20. 2 or 3 or 4
21. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
22. 1 and 20 and 21

Appendix 14: List of articles excluded after full-text screening, with reasons (Chapter 5)

This is an exemplar of the list of articles that were excluded after full-text screening. The full list can be found at: https://osf.io/b7eax

Article	Author, year	Reason for excluding
"Kampai, go docking pleasei" - Large Scale Field Test of a Social Robot in Users' Homes	Toth et al, 2019	Conference abstract, no full-text available
"THIS ISN'T ME!" - The Role of Age-Related Self- and User Images for Robot Acceptance by Elders	Dudek et al, 2020	Single or once-off use/testing of social robot
A Feasibility Study of a Social Robot Collecting Patient Reported Outcome Measurements from Older Adults	Boumans et al, 2020	Single or once-off use/testing of social robot
A multimodal robot game for seniors	Hansen et al, 2017	Single or once-off use/testing of social robot
A socially assistive robot to support physical training of older people - An end user acceptance study	Werner & Krainer, 2013	Conference abstract, no full-text available
A Telemedicine Robot System for Assisted and Independent Living	Koceska et al, 2019	Single or once-off use/testing of social robot
Acceptability of a teleoperated android by senior citizens in Danish society: A case study on the application of an embodied communication medium to home care	Yamazaki et al, 2014	Single or once-off use/testing of social robot
Acceptance of a minimal design of a human infant for facilitating affective interaction with older adults - A case study toward interactive doll therapy	Sumioka et al, 2020	Single or once-off use/testing of social robot
Acceptance of an animaloid robot as a starting point for cognitive stimulators supporting elders with cognitive impairments	Greco et al, 2009	Single or once-off use/testing of social robot
Acceptance of Social Robots by Elder People: Does Psychosocial Functioning Matter?	Baisch et al, 2017	Single or once-off use/testing of social robot

Appendix 15: Standards for Reporting Qualitative Research Checklist (Chapter 6)

Title and Abstract	**Page Numbers**
Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	Title page
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	Pages 1 – 2
Introduction	
Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	Pages 3 – 6
Purpose or research question - Purpose of the study and specific objectives or questions	Pages 7
Methods	
Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale	Pages 7
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	Page 13
Context - Setting/site and salient contextual factors; rationale	Pages 8 - 11
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale	Page 12
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	Pages 15-16
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale	Pages 14 – 15
Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	Page 14
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	Not applicable at this stage
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and	Page 15

security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	Page 15
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Pages 17 – 18
Results/Findings	
Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	Not applicable at this stage
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Not applicable at this stage
Discussion	
Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	Not applicable at this stage
Limitations - Trustworthiness and limitations of findings	Not applicable at this stage
Other	
Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	Title page
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	Title page

Appendix 16: Research Ethics Committee Approval Letter (Chapter 6)

This project received full ethical approval on 16th November 2020.

NUI Galway
OÉ Gaillimh

NUIG RESEARCH ETHICS COMMITTEE DECISION LETTER

REC Application Reference Number: 2020.10.014
Title: Barriers and facilitators to the implementation of robotic pets for people with dementia in nursing homes
Principle Applicant: Wei Qi Koh
Application Type: New
Meeting Date: 22 October 2020
Decision: Approval

---

16 November 2020

Dear Ms Koh,

I write to you regarding the above proposal, which was submitted for Ethical review. Having reviewed your response to my letter, I am pleased to inform you that your proposal has been granted full **APPROVAL.** You may begin the research as outlined in the revised research proposal submitted to the REC.

Please note the following:

1. This submission has been reviewed primarily from an ethical perspective. It is the responsibility of the Principal Applicant to ensure and monitor compliance with any relevant legislation/public health guidelines in the country where the study is due to take place or any local policy in the site where the study is due to take place. It is also the researcher's responsibility to undertake this research in accordance with the National and NUI Galway guidelines and protocols regarding **Covid-19** which are in effect at the time of data collection.
2. Any significant alterations to an approved proposal must receive prior approval from the REC prior to implementation. Please request an Amendment Form;
3. You are responsible for notifying the REC in the event of serious or unexpected adverse effects, unforeseen circumstances, the termination of the study, and any significant decisions by other Ethics Committees. Section 7 of the REC's Standard Operating Procedures gives further details on instances requiring follow-up reviews, and reporting obligations.
4. Principal Applicants given NUI Galway REC approval must, upon completion of the approved research, submit an End-of Study report. Failure to submit such a report may impact upon future ethics applications.

Yours sincerely

Dr Kevin Davison

Chair, Research Ethics Committee

Appendix 17: Research Ethics Committee Approval for Amendments (Chapter 7)

17.1: Ethical approval for first study amendment

We sought ethical approval for the following amendments to the research protocol:

1) Administer consent forms and demographic forms via online platform that is compliant with the General Data Protection Regulation (GDPR) platform, instead of using hardcopy forms

An amendment request was made to the research ethics committee on 22 September 2021, and received approval on 23 September 2021.

NUI Galway
OÉ Gaillimh

NUIG Research Ethics Committee

AMENDMENT APPROVAL		
Any significant alteration to a previously approved proposal must receive prior approval from the REC <u>before implementation.</u>		
SECTION A: GENERAL INFORMATION		
1. Date of Request:	22.09.2021	
2. REC Reference Number:	2020.10.014	
3. Project Title:	Barriers and facilitators to the implementation of robotic pets for people with dementia in nursing homes.	
4. Name of Applicant / PI: *(Surname / First Name)*	Ms Koh Wei	
5. Name of Supervisors / Head of School:	Casey, Dympna	
6. NUIG School and College:	School of Nursing & Midwifery	
SECTION D: APPROVAL *(NUIG REC office use only)*		
1. Approval Reference Number:	2020.10.014; Amend 2109	
2. Date of Approval:	23.09.2021	
3. Signature of Approver:	Veronica McCauley	Dr Veronica McCauley REC Vice Chair
4. Terms of Approval:	NIL	

17.2: Ethical approval for second study amendment

We sought ethical approval for the following amendments to the research protocol:

1) Expand recruitment efforts to recruit people with dementia through the following avenues (additional recruitment platforms: (i) Dementia Care Services in Ireland, (ii) European Working Group of People with Dementia, (iii) Join Dementia Research UK, (iv) Social media)
2) To distribute a research recruitment to the above-mentioned organisations/groups and social media platform to support the recruitment process

An amendment request was made to the research ethics committee on 1 November 2021 and received approval on 9 November 2021.

NUI Galway
OÉ Gaillimh

NUIG Research Ethics Committee

AMENDMENT APPROVAL

Any significant alteration to a previously approved proposal must receive prior approval from the REC __before implementation.__

SECTION A: GENERAL INFORMATION

1.	**Date of Request:**	01.11.2021
2.	**REC Reference Number:**	2020.10.014
3.	**Project Title:**	Barriers and facilitators to the implementation of robotic pets for people with dementia in nursing homes
4.	**Name of Applicant / PI:** ***(Surname / First Name)***	Ms Wei Qi Koh
5.	**Name of Supervisors / Head of School:**	Casey, Dympna
6.	**NUIG School and College:**	School of Nursing and Midwifery

SECTION D: APPROVAL *(NUIG REC office use only)*

1.	**Approval Reference Number:**	2020.10.014; Amend 2110	
2.	**Date of Approval:**	09.22.2021	
3.	**Signature of Approver:**	Veronica McCauley	Dr Veronica McCauley REC Vice Chair
4.	**Terms of Approval:**	NIL	

Appendix 18: Invitation Letter for Nursing Homes (Chapter 7)

NUI Galway
OÉ Gaillimh

Scoil an Altranais agus an Chnáimhseachais

School of Nursing and Midwifery

2nd September 2021

Good day,

My name is Wei Qi Koh. I am a PhD candidate in the National University of Ireland Galway, and my primary research supervisor is Professor Dympna Casey Head of School of Nursing & Midwifery at the National University of Ireland Galway. We are writing to you to request permission to access staff from [redacted] to participate in an online interview as part of my PhD research study to explore the barriers and facilitators to the implementation of pet robots in nursing homes for people with dementia.

Pet robots are a type of robot, which are designed to look and behave like pets or companion animals. Research show that using pet robots can lead to positive benefits for people with dementia, particularly those who live in nursing homes. However, research and real-world practice are often different. Hence, the purpose of this study is to understand factors that can help or hinder the use of pet robots for people with dementia in nursing homes (real-world practice). This is part of a larger project, which aims to develop recommendations for the implementation of pet robots for dementia care in nursing home.

In this study, we plan to interview staff from different nursing homes, including: 1) healthcare professionals (e.g. nurses, nurse assistants, occupational therapists, social workers), and 2) managers or directors (e.g., Director of Nursing).This will be a one-off interview, and each interview is expected to last between 45-60 minutes. The interview will be done via Zoom or via the telephone at a time and date that is most convenient for each participant. Information from the interviews will help us better understand how to introduce pet robots into nursing homes. All responses will remain fully confidential and anonymous.

This study has been approved by the Research Ethics Committee in the National University of Ireland Galway (Ref no: 2020.10.014). Further information about this study can be found in the participant information leaflet that is attached in this email.

We plan to recruit 2 – 3 healthcare professionals and 2 – 3 managers, directors or assistant directors of nursing from different nursing homes. As such, I would like to seek permission to identify and access staff from Coral Haven Residential Nursing Home, who have experience in providing care for residents with dementia. With your support and permission, I will arrange for an online meeting or telephone call with each staff, based on their preferences and availabilities to explain about this research, answer any questions that they may have, and to invite them to participate in this research.
Your support is very much appreciated, and if there are any questions, please feel free to contact me at weiqi.koh@nuigalway.ie or at 0899556484. I will follow up on this email with a phone call in the next couple of days. Thank you so much once again for considering our request.

Sincerely,

(Ms) Wei Qi Koh
PhD candidate student/Marie Skłodowska-Curie Fellow
School of Nursing & Midwifery
National University of Ireland Galway

Prof Dympna Casey
Established Prof of Nursing & Head of School
School of Nursing & Midwifery
National University of Ireland Galway

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Bóthar na hOllscoile,
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F +353 91 494 537

nursing.midwifery@nuigalway.ie
www.nuigalway.ie/nursing.midwifery

Appendix 19: Participant Information Sheets and Consent Forms – Nursing home staff (Chapter 7)

NUI Galway
OÉ Gaillimh

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

STUDY INFORMATION

Title of Study

Barriers and facilitators to the implementation of pet robots in nursing homes for people living with dementia

Researcher

Ms Wei Qi Koh
Aras Moyola Building
National University of Ireland Galway
University Road, Galway

PURPOSE OF RESEARCH STUDY

You are being invited to participate in a research study. Before you take part in this research study, the study must be explained to you and you must be given the chance to ask questions. Please read carefully the information provided here. If you agree to participate, please sign the consent form. You will be given a copy of this document to take home with you.Pet robots are a type of robot that are designed to look and behave like pets and companion animals. They have been developed to benefit the wellbeing of people who live with dementia. Research studies showed that using pet robots can lead to positive benefits. However, we need to learn more about the factors that can affect the use of pet robots in real world practice. The purpose of this study is to understand barriers and facilitators to the implementation of pet robots in nursing homes for people living with dementia.

WHO IS DOING THIS RESEARCH?

The research will be conducted by Wei Qi Koh as part of her PhD in the School of Nursing and Midwifery at the National University of Ireland Galway. Wei Qi Koh is clinical occupational therapist with experience working in care facilities for older adults and people with dementia.

STUDY PROCEDURES AND VISIT SCHEDULE

If you agree to take part in this study, you will be invited to participate in a 60-minute interview session. The interview session will be conducted at the nursing home to ensure a comfortable environment and convenience for you. However, in view of the COVID-19 pandemic. if access to the nursing home is not possible, the interview may be conducted virtually or via a telephone interview, depending on which mode is the most convenient for you. This will be a single interview session, no follow up will be required.

POSSIBLE RISKS, DISCOMFORTS AND INCONVENIENCES

There are no known risks for participating in this study. This study involves participating in this interview for 60-minutes in a seated position, in which you may experience fatigue. Rest breaks will be given to address this issue.

POTENTIAL BENEFITS

Your contribution will also contribute to the knowledge about the barriers and facilitators affecting the implementation of robotic pets for people with dementia in nursing homes, which can help to facilitate improved healthcare and service provision for this population.

WITHDRAWAL FROM STUDY

You are free to withdraw your consent and discontinue your participation at any time without prejudice to you. If you decide to stop taking part in this study, you should tell the Researcher.

CONFIDENTIALITY OF STUDY

Information collected for this study will be kept confidential. Your records, following the General Data Protection Regulation (GDPR) regulations, will be kept private and confidential. Only the researcher will have access to the personal information being collected. This includes all information, including personal information and data collected during the audio-recorded interview, will be anonymised and kept private and confidential. It is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.

All personal data and information collected from you using audio-recorded interviews will be stored for a period of seven years, after which the information will be destroyed in accordance to the NUI Galway Data Protection and Security Policies and Procedures. By signing the Consent Form, you provide explicit consent to the collection, access to, processing and storage of your Personal Data by the NUI Galway. In the event of any publication regarding this study, your identity will remain fully confidential.

WHO TO CONTACT IF YOU HAVE QUESTIONS REGARDING THE STUDY

If you have questions or concerns about data protection from your participation in this study, you may contact the researcher Ms Wei Qi Koh at, or contact the Data Protection Officer at dataprotection@nuigalway.ie. You also have the right to lodge a complaint with the Data Protection Commissioner (https://www.dataprotection.ie/en/contact/how-contact-us). If you have questions about this research study during the course of this study, you may contact the Researcher Ms Wei Qi Koh at 091493687 or weiqi.koh@nuigalway.ie or the NUI Galway Research Ethics Committee at ethics@nuigalway.ie

WHO HAS REVIEWED THE STUDY?

This study has been reviewed and approved by the Research Ethics Committee in National University of Ireland Galway.

CONSENT FORM

Details of Research Study

Study Title:

Barriers and facilitators to the implementation of pet robots in nursing homes for people living with dementia

Researcher: Ms Wei Qi Koh (Telephone: 091493687, Email: weiqi.koh@nuigalway.ie)

Participant's Consent

I have read and understood the information sheet about this study.	Yes / No
Iinformation about the study has been fully explained to me	Yes / No
All my questions have been answered to my satisfaction	Yes / No
I understand that my participation in this study is completely voluntary, and I can opt out of this study any time	Yes / No
I understand that my personal data will be kept private and confidential. Any information about me will be anonymized	Yes / No
I understand that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, she will be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.	Yes / No
I give explicit consent to have my information processed as part of this research study	Yes / No
I understand that information will be collected from me using audio-recorded interviews and destroyed after the results are compiled, according to the NUI Galway Data Protection and Security Policies and Procedures	
I understand that personal information that was collected will be stored for seven years, after which the information will be destroyed according to the NUI Galway Data Protection and Security Policies and Procedures	Yes / No
I would like to participate in this study	Yes / No

____________________	____________________	____________________
Name of participant	Signature	Date of signing

Researcher's Statement

I, the undersigned, certify to the best of my knowledge that the participant signing this consent form had the study fully explained and clearly understands the nature, risks and benefits of his/ her/ his ward's/ her ward's participation in the study.

____________________	____________________	____________________
Name of Researcher/ Person obtaining consent	Signature	Date of signing

Appendix 20: Summary of PPI meetings (Chapter 7)

Date	Mode	Duration	Agenda
13 Jul 2021	Meeting	1H	Explained about project to PPI member, discussed about potential PPI input in this research and project timelines
13 Jul 2021	Email (pre-meeting preparation)	0.5H	Emailed interview guide to PPI member one week in advance in preparation for the next meeting
19 Jul 2021	Meeting	1H	Discussed and sought feedback on interview guide for PLWD
5 Aug 2021	Meeting	1H	Showed video of pet robots to PPI member and sought feedback on the video
13 Sep 2021	Meeting	1H	Discussed about difficulties recruiting people with dementia as participants and discussed other potential recruitment platforms
21 Jan 2022	Email (pre-meeting preparation)	0.5H	Emailed document on a summary of qualitative study findings to prepare for next meeting
26 Jan 2022	Meeting	1H	Discussed about data from qualitative study and interpretation

Appendix 21: Video content (Chapter 7)

Video content

- Self-Introduction

- Introduction to PARO
    - Demonstrate how PARO can be switched on/off
    - Soft, white fur covering
    - Sensors (touch sensors, temperature sensors, position sensors, voice recognition)
    - Movements (making sounds, moving its flippers, looking at the user)
    - Ability to learn behaviours that the user enjoys and develop a personality
    - Length and weight
    - Battery duration, charging and charging duration
    - Cost of PARO and warranty

- Introduction to the Joy for All cat
    - Demonstrate how the Joy for All cat can be switched on/off
    - Sensors (touch sensors, light sensors
    - Movements (purring, vibration, meowing, body movements, eye movements)
    - Not able to learn behaviours or develop a personality
    - Length and weight
    - Battery duration, battery type and compartment
    - Cost of the Joy for All cat and warranty

- Overall care of the pet robots
    - Ways that the pet robots can be damaged
      (holding them too tightly or dropping them on the floor)
    - Non-waterproof and cleaning using wipes and sprays

Total length of the video: 05:48 minutes

Narrator: Wei Qi Koh

Acknowledgements:
We are grateful to Mr Fergus Timmons and Ms Mary Higgins from Alzheimer Society Ireland (ASI) for the loan of PARO and the Joy for All cat.

Appendix 22: Demographic forms and Interview Guide: Nursing home staff (Chapter 7)

22.1: Demographic form: Healthcare Professionals

1. Gender

Male ☐ Female ☐ Prefer not to say ☐

2. Age

20 - 29 ☐ 30 - 39 ☐ 40 - 49 ☐

50 - 59 ☐ 60 - 69 ☐ 70+ ☐

3. Occupation

Please state your current occupation: _______________________________________

How long have you been working in this position? _____________________________

What your key responsibilities in this this position? (Tick all that applies)

Provide therapy interventions ☐ Provide counselling ☐

Administer medications ☐ Assist in self-care ☐

Others (please specify) ☐ ____

____

4. Years of experience working with people with dementia

How many years have you worked with people with dementia?

Less than 1 year ☐ 1 – 3 years ☐ 4 – 6 years ☐

7 – 9 years ☐ Over 10 years ☐

5. Experience with animals

Have you owned an animal or a pet?

Yes ☐ No ☐

If yes, please specify the type of animal(s) or pet(s) ____________________________

6. Experience with animals

Do you like animals or consider yourself as an animal lover (enjoy having animals as company)?

Yes ☐ No ☐ Unsure ☐

7. Experiences with pet robots

Have you seen or used pet robots? (Tick all that applies)

Yes, I have seen it ☐ Yes, I have used it ☐ No I have not seen or used it ☐

Comments about where you have seen or used it (if any): __________________________________

____

8. Is there a pet robot(s) at the nursing home that you are working in?

Yes ☐ No ☐ Unsure ☐

Appendix 22: Demographic form and Interview Guide: People with dementia (Chapter 7)

22.2: Demographic form: Organisational Leaders

1. Gender

Male ☐ Female ☐ Prefer not to say ☐

2. Age

20 - 29 ☐ 30 - 39 ☐ 40 - 49 ☐

50 - 59 ☐ 60 - 69 ☐ 70+ ☐

3. Structure of the Nursing Home

Total number of staff: ______________________________

Number of nurses and nurse assistants ______________________________

Number of therapists and therapy assistants ______________________________

Number of other staff, if any ______________________________

Job titles of other staff ______________________________

Total number of residents: ______________________________

Total number of residents with dementia ______________________________

(Diagnosis of dementia, and/or present with symptoms of dementia)

Ratio of nurses and nurse assistants to residents on an average day ________________

Comments (if any) ____

4. Occupation

Please state your current occupation: ____

How long have you been working in this position? ______________________________

What are some key responsibilities in this this position?

Manage budget/finance resources ☐ Manage physical infrastructure/supplies/ equipment ☐

Delegate tasks to staff members ☐ Support or coach staff members ☐

Ensure resident/family satisfaction ☐ Clinical work (provide direct patient care) ☐

Modify/improve current services ☐ Report to local or national level healthcare system ☐

Review information/data about service delivery *(e.g. current care, conduct adherence checks)* ☐

Others (please specify) ☐ ____

____

5. Years of experience working with people with dementia

Less than 1 year ☐ 1 – 3 years ☐ 4 – 6 years ☐

7 – 9 years ☐ Over 10 years ☐

6. Experience with animals

Have you owned an animal or a pet?

Yes ☐ No ☐

If yes, please specify the type of animal(s) or pet(s) ____________________________

7. Preferences for animals

Do you like animals or consider yourself as an animal lover (enjoy having animals as company)?

Yes ☐ No ☐ Unsure ☐

8. Experiences with pet robots

Have you seen or used pet robots? (Tick all that applies)

Yes, I have seen it ☐ Yes, I have used it ☐ No I have not seen or used it ☐

Comments about where you have seen or used it (if any): ___________________________________

____

9. Is there a pet robot(s) at the nursing home that you are working in?

Yes ☐ No ☐ Unsure ☐

22.3: Interview Guide

Hello, my name is [name of interviewer]. The purpose of this research is to understand your thoughts about how pet robots can be used in nursing homes for people with dementia as part of routine care. Your interview will help us better understand some of the challenges and successes that may be encountered when introducing pet robots in nursing homes for dementia care. We will be recording today's conversation, so we can transcribe and analyse the data. Your name will be kept fully confidential and your responses will remain fully anonymous. Please stop me anytime if you have any questions for me. Do you have any questions for me? [Answer interviewee's questions]

Are you ready to begin? I will start recording now. I will first show you a short video of pet robots, to give you an idea of how they look like and what they can do. After that, I am going to ask you some questions. Please keep in mind that there are no right or wrong answers. I want to learn more about your thoughts, so please do not hesitate to share them.

1. **What do you think about the two pet robots that you saw in the video?**
   (Features of the pet robots: Appearance, interactivity, cost, battery, adaptability)?
   - What did you like/not like about the pet robots? Can you tell me more?
   - In your experience, can (the feature) affect how pet robots can be used in your workplace?
   - Should the pet robots be changed in any way so that they can be used for people with dementia in your workplace? Can you tell me more about this?

2. **Would you want to introduce pet robots into your workplace for residents with dementia? If yes, why (and if no, why not)?**
   - How will the pet robots meet (or not meet) the needs of residents with dementia?
   - How would having a pet robot influence/impact your day-to-day routine at work? Can you tell me more?
   - What are the resources that are available (or not available) to support the introduction of pet robots in your workplace?
     (e.g., time, money, staff, physical space)

3. **What are some local or national policies or guidelines (if any) that has influenced dementia care in your setting?**
   - How will using pet robots fit (or not fit) with these policies/guidelines?
   - Can you tell me more?

4. **Do you know of other nursing homes or care organisations that have introduced pet robots for dementia care?**
   - Will knowing this influence your thoughts about using pet robots in your nursing home? Can you tell me more?

5. **How do you feel about using pet robots as a part of your day-to-day work with people with dementia?**
   - Can you tell me more about this please?
   - What would make it more likely for you to use a pet robot with a resident with dementia?
   - What would make it less likely for you to use a pet robot with a resident with dementia?

6. **What do you think would be required to introduce pet robots for residents with dementia in your workplace?**
    - Should be a leader or champion to introduce pet robots in your nursing home? Why or why not?
    - What are some strategies that can encourage people to use pet robots for dementia care? Can you tell me more?

Appendix 23: Recruitment and data collection materials for people with dementia

23.1 Participant information sheet and consent form (people with dementia)

NUI Galway
OÉ Gaillimh

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

TITLE OF STUDY

Barriers and facilitators to the implementation of pet robots in nursing homes for people with living with dementia

WHAT IS THE STUDY ABOUT?

You are being invited to participate in a research study. Before you take part in this research study, the study must be explained to you and you must be given the chance to ask questions. Please read carefully the information provided here and take as much as you need to read and think about it. If you agree to participate, please sign the consent form.

Pet robots are a type of robot, which are designed to look and behave like pets and companion animals. They have been developed to benefit the wellbeing of people who live with dementia. Research studies showed that using pet robots can lead to positive benefits. However, research and real-world practice are often different. We need to learn more about factors that can affect the use of pet robots in real-world practice. The purpose of this study to understand factors that can help or hinder the use of pet robots in nursing homes for people living with dementia.

WHO IS DOING THIS RESEARCH?

The research will be conducted by Wei Qi Koh as part of her PhD in the School of Nursing and Midwifery at the National University of Ireland Galway. Wei Qi Koh is clinical occupational therapist with experience working in care facilities for older adults and people with dementia.

WHAT DO I HAVE TO DO IF I TAKE PART IN THIS STUDY?

If you agree to take part in this study, we will interview you for 30 – 40 minutes. Our conversation will first be audio recorded, then transferred into a written document. This document will be transferred onto a computer so that the researcher can analyse it.

WHAT ARE THE POSSIBLE RISKS OR INCONVENIENCES TO ME?

There are no known risks for participating in this study. However, since this is an interview, you may feel tired. However, we can stop and take a break, or continue the interview at a later time or date as you wish.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART?

Your contribution will help us to understand how to implement robotic pets for people with dementia in nursing homes.

WHAT ARE MY RIGHTS?

Your participation in this study is entirely voluntary. Your questions will be answered clearly and to your satisfaction.

WITHDRAWAL FROM STUDY

You are free to withdraw your consent and discontinue your participation at any time without prejudice or consequences. If you decide to stop taking part in this study, you should tell the Researcher.

CONFIDENTIALITY OF STUDY

All your information will be kept private and confidential. Only the researcher will have access to this information. They will be stored securely for seven years, and they will be destroyed after that. This follows the NUI Galway Data Protection and Security Policies and Procedures. By signing the Consent Form, you provide explicit consent to the collection,

access to, processing and storage of your Personal Data by NUI Galway. In the event of any publication regarding this study, your identity will remain fully confidential. It is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.

WHO TO CONTACT FOR QUESTIONS REGARDING THE STUDY

If you have questions or concerns about data protection from your participation in this study, you may contact the researcher Ms Wei Qi Koh at 091493687 (weiqi.koh@nuigalway.ie), or contact the Data Protection Officer at dataprotection@nuigalway.ie. You also have the right to lodge a complaint with the Data Protection Commissioner (https://www.dataprotection.ie/en/contact/how-contact-us).

If you have questions about this research study during the course of this study, you may contact the Researcher Ms Wei Qi Koh at 091493687 or weiqi.koh@nuigalway.ie or the NUI Galway Research Ethics Committee at ethics@nuigalway.ie.

WHO HAS REVIEWED THE STUDY

This study has been reviewed and approved by the Research Ethics Committee in National University of Ireland Galway.

CONSENT FORM

Details of Research Study

Study Title:

Barriers and facilitators to the implementation of pet robots in nursing homes for people with living with dementia

Researcher:

Ms Wei Qi Koh (Telephone: 091493687, Email: weiqi.koh@nuigalway.ie)

Participant's Consent

I have read and understood the information sheet about this study.	Yes / No
The information has been fully explained to me	Yes / No
All my questions have been answered to my satisfaction	
I understand that my participation in this study is entirely voluntary, and I can opt out of this study any time	Yes / No
I understand that my personal data will be kept private and confidential. Any information about me will be anonymized	Yes / No
I understand that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting me, she will be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.	Yes / No
I give explicit consent to have my information processed as part of this research study	Yes / No
I understand that information will be collected from me using audio-recorded interviews and destroyed after the results are compiled, according to the NUI Galway Data Protection and Security Policies and Procedures	
I understand that personal information that was collected will be stored for seven years, after which the information will be destroyed according to the NUI Galway Data Protection and Security Policies and Procedures	Yes / No
I would like to participate in this study	Yes / No

Participant's Consent

Name of participant	Signature	Date of signing

Researcher's Statement

I, the undersigned, certify to the best of my knowledge that the participant signing this consent form had the study fully explained and clearly understands the nature, risks and benefits of his/ her/ his ward's/ her ward's participation in the study.

Name of Researcher/ Person obtaining consent	Signature	Date of signing

23.2 Participant information sheet and consent form (Next-of-kin)

NUI Galway
OÉ Gaillimh

School of Nursing & Midwifery
National University of Ireland Galway
Galway

Date: XX/XX/XX

Dear Family Member,

We want to tell you about a research study that we will be conducting to understand how pet robots can be used in nursing homes for people with dementia. We would like to let you know about the study that your relative will be invited to participate in.

Please read the attached 'Participant Information Sheet (Next-of-kin/relative)' which will give you more detailed information about the study. It also explains what your relative's participation will entail.

The researcher will explain the study in person to your relative. Once your relative demonstrates an understanding of the study and agrees to participate, we will invite him/her to participate in this research.

Your relative is free to withdraw them from the study at any time without any reason given, without consequence or prejudice. The information he/she shares will be kept securely in line with NUI Galway Policies and Procedures, and his/her privacy will be protected. It is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.

This study has been approved by the Research Ethics Committees of NUI Galway. If you have any queries or wish to discuss any part of the information, please contact Wei Qi Koh at: weiqi.koh@nuigalway.ie or 091493687.

Thank you for your time and consideration.

Yours Sincerely,

Wei Qi Koh

STUDY INFORMATION

Title of Study

Barriers and facilitators to the implementation of pet robots in nursing homes for people living with dementia

Researcher

Ms Wei Qi Koh
Aras Moyola Building
National University of Ireland Galway
University Road, Galway

PURPOSE OF THE RESEARCH STUDY

Your relative is being invited to participate in a research study. Before he or she is invited to take part in this research study, the study must be explained to you, and you must be given the chance to ask questions. Please read carefully the information provided here. If you would like your relative to take part, it is important that you can confirm if you are legally supported by the assisted decision-making process. This means that the person with dementia has your support to make decision if the person's capacity is in doubt.

Pet robots are a type of robot, which are designed to look and behave like pets and companion animals. They have been developed to benefit the wellbeing of people who live with dementia. Research studies showed that using pet robots can lead to positive benefits. However, research and real-world conditions are often different. Hence, we need to learn more about real-world factors that can affect the use of pet robots. The purpose of this study to understand factors that can help or hinder the use of pet robots in nursing homes for people living with dementia.

WHO IS DOING THIS RESEARCH?

The research will be conducted by Wei Qi Koh as part of her PhD in the School of Nursing and Midwifery at the National University of Ireland Galway. Wei Qi Koh is clinical occupational therapist with experience working in care facilities for older adults and people with dementia.

STUDY PROCEDURES AND VISIT SCHEDULE

Once your relative demonstrates an understanding of this study and is agreeable to take part in this study, we will invite them to participate in an interview. The interview session will be conducted at the nursing home. The interview will take 20 – 30 minutes. This will be a single interview session, and no follow up will be required.

POSSIBLE RISKS, DISCOMFORT AND INCONVENIENCES

There are no known risks for participating in this study. This study involves participating in this interview for 30 - 40 minutes in a seated position, in which your relative may experience fatigue. Rest breaks will be given to address this issue. If your relative demonstrates any signs of distress, the researcher will terminate the data collection processes and will adhere to an agreed ethical protocol. This protocol prioritizes the needs of your relative all times and supports will be offered to your relative if he or she gets upset.

POTENTIAL BENEFITS

Your relative's contribution will contribute to the knowledge about the barriers and facilitators affecting the implementation of robotic pets for people with dementia in nursing homes, which can help to facilitate improved healthcare and service provision for people with dementia

PARTICIPANT'S RIGHTS

Your relative's participation in this study is entirely voluntary. All your questions will be answered clearly and to your satisfaction. By signing and participating in the study, your relative does not waive any of his/her rights to revoke his/her consent and withdraw from the study at any time.

WITHDRAWAL FROM STUDY

Your relative is free to withdraw consent and discontinue his/her participation at any time without prejudice or consequences in any way.

CONFIDENTIALITY OF STUDY

Information collected for this study will be kept confidential. Your relative's records, following the General Data Protection Regulation (GDPR) regulations, will be kept private and confidential. Only the researcher will have access to the personal information being collected. This includes all information, including personal information and data collected during the audio-recorded interview, will be anonymised and kept private and confidential. It is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting your relative, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.

All personal data and information collected from your relative using audio-recorded interviews will be stored for a period of seven years, after which the information will be destroyed in accordance to the NUI Galway Data Protection and Security Policies and Procedures. By signing the Consent Form, your relative will provide explicit consent to the collection, access to, processing and storage of his/her Personal Data by the NUI Galway. In the event of any publication regarding this study, your relative's identity will remain fully confidential.

WHO TO CONTACT IF YOU HAVE QUESTIONS REGARDING THE STUDY

If you have questions or concerns about data protection from your participation in this study, you may contact the researcher Ms Wei Qi Koh at, or contact the Data Protection Officer at dataprotection@nuigalway.ie. You also have the right to lodge a complaint with the Data Protection Commissioner (https://www.dataprotection.ie/en/contact/how-contact-us). If you have questions about this research study during the course of this study, you may contact the Researcher Ms Wei Qi Koh at 091493687 or weiqi.koh@nuigalway.ie or the NUI Galway Research Ethics Committee at ethics@nuigalway.ie

This study has been reviewed and approved by the Research Ethics Committee in National University of Ireland Galway

23.3 Recruitment poster

NUI Galway
OÉ Gaillimh

We'd love to hear your thoughts on using pet robots!

Invitation for people living with dementia to join a research study

Pet robots are a technology-based alternative for pet therapy that have been used in dementia care. We want to understand what you think about them.

Your voice is important! Please reach out to us if you are:

- **Aged 65 and above**
- **Living with dementia**
- Willing to participate in a **20 - 30 min Zoom interview** (one-to-one)

Contact us!
Wei Qi Koh, PhD researcher
National University of Ireland Galway
Email: weiqi.koh@nuigalway.ie
Phone: **089 955 6484**

23.4 Demographic form

Demographic Form

1. Gender

Male ☐ Female ☐ Prefer not to say ☐

2. Age

65 - 69 ☐ 70 - 75 ☐ 75 - 79 ☐ 80+ ☐

3. Marital Status

Single (never married) ☐ Married / domestic partnership ☐

Widowed ☐ Divorced ☐ Separated ☐

4. Length of time with dementia

How many years have you had dementia?

Less than 1 year ☐ 1 – 3 years ☐ 4 – 6 years ☐

7 – 9 years ☐ Over 10 years ☐ Prefer not to say ☐

5. Experience in nursing homes

Have you spent time living in a nursing home?

Yes ☐ No ☐

If yes, how long did you live in a nursing home?

____

6. Experience with animals

Have you owned an animal or a pet?

Yes ☐ No ☐

If yes, please specify the type of animal(s) or pet(s) _____________________

7. Preferences for animals

Do you like animals or consider yourself as an animal lover (enjoy having animals as company)?

Yes ☐ No ☐ Unsure ☐

23.5 Interview guide

Pet Robots

Figure 2: Robotic Seal

Figure 3: Robotic Cat

Hello, my name is [name of interviewer]. The purpose of this research is to understand what you think about pet robots.

We will be recording today’s conversation so we can transcribe and analyse the data. Your name will be kept fully confidential and your responses will remain fully anonymous. Please stop me anytime if you have any questions for me. Do you have any questions for me? [Answer interviewee’s questions]

I will start recording now. I will first show you a short video of pet robots. This will give you an idea of how they look like, and what they can do. After that, I am going to ask you some questions. There are no right or wrong answers, and I am interested to know what you think.

1. **Can you tell me what you think about the pet robots in the video?**
- What do you think about their appearance (how do they look)? Can you tell me more?
- You saw the way the pet robots move, did you like their movements? Why is that?
- If you could change anything about the pet robots, what would it be?

2. **Do you see yourself using pet robots?**
- If no, why not?
- If yes, why would you like to use it? In what situations would you like to use them?
- A seal is an animal that we don’t usually see, and a cat is a pet that people are usually more familiar with. Which pet do you prefer/choose? Why is that?

3. **What would make it more likely for you to use a pet robot?**
- Is it important for you to have your own pet robot? Why or why not?
- How should your supporter/loved one to support you to use pet robots? (Would you like them to show to you how to use it? Can you tell me more?)

4. **Living in nursing homes and living at home can be quite different. For example, people with dementia who live in nursing homes may feel lonelier (or receive visitors less regularly). In such cases, some people find that pet robots can provide companionship. What do you think about this?**

- Do you think this might work?
- Some people say that pet robots can be a topic of conversation (generate chit chat) for people with dementia/memory in nursing homes. What do you think about this?

5. **Some people say that pet robots are very realistic. People with dementia might think that they are real, but still enjoy them. If you were in the situation, how would you feel?**

- Some people feel that pet robots are somewhat like toys. They may think that giving a pet robot to a person with dementia means treating them as a child. What do you think about this?

Is there anything else you would like to tell me?

Thank you for your time.

23.6 Ethical protocol when interviewing people with dementia

This procedural protocol was developed to ensure that the well-being and right of the person with dementia are protected. The steps outlined below are for participants' benefit in the event that they become distressed while being interviewed and to guide the interviews for people with dementia. It is important that you know that the researchers have a special responsibility and a legal obligation or duty of care for safeguarding you when partaking in the study.

Dealing with distress
In the event that the person with dementia demonstrates signs of distress during the interview including: restlessness, agitation, repetitive questioning, wandering, crying, the interview will stop, and check with the person with dementia whether they wish to continue or not.

If the person wishes to continue the interviewer will continue to be vigilant about distress. If the person continues to show signs of distress, the interview will be terminated. The interviewer will stay with the person until they become calm again and will discuss with the carer the distress and the supports available.

In the event the person does not wish to continue, the interview will be terminated, and the interviewer will stay with the person until they are calmer. They will report the distress to the carer and discuss what needs to be put in place to support the person with dementia.
The researcher will, with the participant's consent:

- Ask if it is ok to check in later in the day or the next day to make sure they are okay
- Alternatively, the researcher will ask if they would like staff of the nursing home to check in to make sure they are ok

If the person demonstrates that he or she is not safe and in danger in any way, it is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. Where for example, the researcher is told about a clear and serious danger to the person, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University REC.

Appendix 24: Framework for data analysis (Chapter 7)

This is an exemplar of the framework that was developed for data analysis (framework analysis). The full framework can be accessed via https://osf.io/a4wg9.

CFIR domain / node / subnode	Description
1. Intervention characteristics	
Adaptability	Includes statements pertaining to the extent to which/how the use of pet robots can or should be adapted, tailored, refined or reinvented to meet the local needs of residents with dementia in the nursing home. Exclude statements relating to the design (e.g. suggestions that the pet robot should be designed as a dog or another animal) that people are more familiar with, and code it to "Design quality and packaging - Familiarity"
Complexity	Includes statements pertaining to the perceived difficulty of using pet robots, as reflected by the scope, intricacy, number of steps or duration needed to use pet robots. This includes all elements of using pet robots including the manner in which they are charged.
Design quality and packaging	Include generic statements regarding the perceived excellence in how pet robots are bundled, presented and assembled (design quality and their packaging) that do not fit in any of the sub codes below Exclude statements that can be captured in the sub-codes below, and code it to the relevant subcode
Familiarity (cultural relevance)	Include statements about the familiarity or unfamiliarity of PARO or the JfA cat's design (as a seal/cat), and comments about the cultural relevance of the design to residents and staff. Also include comments relating to alternative designs (other animals) which may be more familiar or culturally relevant
2. Outer setting	
Cosmopolitanism	Includes statements about how the nursing home is networked with other external organisations/nursing homes, or descriptions of outside group memberships and networking between the nursing home and other care setting/organisations
External funding bodies	Includes statements or comments about the external funding bodies that can directly influence the funding that is necessary to support the introduction of pet robots (e.g. HSE, public funding, charity organisations, fund raising etc)
External policies and incentives	Include statements about the external strategies (national or wider policies, regulations, and guidelines) outside the nursing home that has influenced or could influence the introduction/implementation of pet robots for dementia care Excludes statements relating to external funding and code it to “external funding bodies”
3. Inner setting	

Appendix 24: Framework for data analysis (Chapter 7)

CFIR domain / node / subnode	Description
Compatibility	This code describes the degree of tangible fit between how using pet robots aligns with/does not align with the existing work flows and systems in the nursing home. Code the relevant codes into the relevant subcodes below (based on their description).
Care process for residents	Include statements that demonstrate the level of compatibility the social robot has with the work processes of providing care for residents with dementia. This may also include statements about whether using pet robots is/would be an added workload to the current care processes for residents
Tension for change	Includes statements that demonstrate a strong need for pet robots or that the current situation in the nursing home is untenable (e.g. comments that pet robots are absolutely necessary or absolutely redundant) Exclude statements that demonstrate the innovation is better (or worse) than existing programs and code to Relative Advantage.
4. Characteristics of individuals	
Knowledge and beliefs about the intervention	Includes general statements about the individual's attitudes and values placed on pet robots or similar interventions (e.g. technology in dementia care, doll therapy) that cannot be coded into any of the subnodes below. Exclude statements that can be coded into any of the subnodes below, and code to the relevant subnodes
Perceptions for future use of technology	Include statements mentioning the individual's general belief or attitudes about the future use of technology (including pet robots) in dementia care and/or in nursing homes (i.e., Perceptions of technology in general in dementia care)
Personal experience with using similar interventions	Include statements of personal experience in interventions similar to pet robots (e.g. doll therapy, plush toys, technological devices) to support dementia care for PLWD. Exclude statements that directly compare these interventions with pet robots in terms of their relative advantages/disadvantages, and code to "Relative advantage"
5. Process	
Engaging	Include statements related to engagement strategies and outcomes (i.e. if and how stakeholders became engaged with the social robot and what their role is in implementation). Exclude statements that are captured in the sub-codes below.
Champions	Include statements related to how the individuals within the organisation (who identify themselves as champions to support, market, 'drive through', or, overcome indifference or resistance) engaged with the implementation of pet robots, Exclude statements regarding leadership engagement, and code to "Leadership Engagement" e.g. if a champion is also an organizational leader, e.g., if a director of primary care takes the lead in implementing pet robots

Appendix 25: Standards for Reporting Qualitative Research Checklist (Chapter 7)

Title and Abstract	Page Numbers
Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	2-3
Introduction	
Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	4-6
Purpose or research question - Purpose of the study and specific objectives or questions	6
Methods	
Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale	7 and qualitative research protocol (Koh et al, 2021)
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	Qualitative research protocol (Koh et al, 2021)
Context - Setting/site and salient contextual factors; rationale	7-8
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale	7-8
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	7
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale	7 and qualitative research protocol (Koh et al, 2021)
Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	11-12, Additional File 3, Additional File 4
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	8
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and	12-13

security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	12-13
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Qualitative research protocol (Koh et al, 2021)
Results/Findings	
Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	13-21
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	13-21
Discussion	
Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	22-25
Limitations - Trustworthiness and limitations of findings	25-26
Other	
Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	27
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	27

References

Koh, W. Q., Felding, S. A., Toomey, E., & Casey, D. (2021). Barriers and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review protocol. *Systematic Reviews,* 10(49), 1-6. https://doi.org/10.1186/s13643-021-01598-5.

Appendix 26: Conducting and REporting DELphi Studies (CREDES) checklist (Chapter 8)

CREDES Items	**Reported in Page**
Rationale	
1. Provide a rationale/justify the choice of using the Delphi technique	139
Planning and design	
2. State the aims and purpose of the study, and the plans and processes for conducting the Delphi technique. If any modifications are to be made to technique, justifications should be provided and the method used should be systematic and rigorous	138
3. An a priori criterion for consensus should be defined. This should include clear and transparent guide on: (i) how to proceed with certain items or topics through the survey rounds, (ii) threshold to terminate the Delphi process, and (iii) procedures to be followed, whether consensus is reached/not reached after one or more iterations	143-144
Study conduct	
4. All materials provided to the Delphi experts at the outset of the project should be carefully reviewed and piloted in advance in order to examine the effect on experts' judgement and prevent bias	Not applicable at this stage
5. Researchers need to take measures to avoid influencing the experts' judgements. If the researcher has a conflict of interest, it is recommended to seek an independent researcher to coordinate the Delphi responses	Not applicable at this stage
6. Interpretation of results: Consensus may not necessarily just refer to the right answer or judgement. Non consensus and stable disagreement provide important insights and highlight differences in perspectives	Not applicable at this stage
7. The final draft of the resulting best practice guidelines should be reviewed and approved by an external board or authority (for external validation) before publication and dissemination	Not applicable at this stage
Reporting	
8. The purpose of the study should be clearly defined, and the appropriateness of using the Delphi technique to address the research objectives must be rationalised	138-139
9. Information about the expert panel should be clearly described - Criteria for the selection of experts and information on the recruitment process, experts' sociodemographic details (including their expertise regarding the research topic), response and non-response rates over the Delphi rounds should be reported	140-142
10. The method should be clearly described – This should include information about preparatory steps (i.e., how was available evidence on this topic synthesised), piloting of material and survey instruments, design of the survey, the number and design of survey rounds, data analysis methods, how responses are proceeded in preparation for next Delphi rounds, and methodological decisions taken by the researcher	139-145

11. The procedure of the Delphi process (including the preparatory phase, actual Delphi rounds, interim steps of data processing and analysis, and concluding steps) should be illustrated using a flow chart	140
12. The definition and attainment of consensus should be clearly stated, so that the reader can comprehend how consensus was achieved, and how non-consensus is dealt with	143-144
13. It is highly advisable to report results separately for each round, so that the evolving consensus over the different rounds can be made transparent. This may include figures to show average group responses, changes between rounds, as well as any modifications to the survey e.g., deletion, addition or modification of survey items based on previous rounds)	Not applicable at this stage
14. The researcher should critically reflect and report on potential limitations and their impact on the resulting guidance	145
15. The conclusions should adequately reflect the outcomes of the Delphi study in relation to the scope and applicability of the resulting practice guidelines	145
16. The resulting guidance should be clearly identifiable from the publication, including recommendations for translation into practice and implementation. If the publication does not allow for a detailed presentation of either practice guidance or the methodological features of the applied Delphi technique (or both), reference to a more detailed presentation elsewhere should be made (e.g. availability of the full guideline, publication of a separate paper reporting on methodological details and particularities of the process)	Not applicable at this stage

Appendix 28: Conducting and REporting DELphi Studies (CREDES) checklist (Chapter 9)

Appendix 27: Research Ethics Committee Approval Letter (Chapter 9)

NUI Galway
OÉ Gaillimh

NUIG RESEARCH ETHICS COMMITTEE DECISION LETTER

REC Application Reference Number: 2022.02.014
Title: Strategies for implementing pet robots in nursing homes for people with dementia: A modified Delphi study
Principal Applicant: Wei Qi Koh
Application Type: New
Meeting Date: 16 February 2022
Decision: Approval

24 February 2022

Dear Ms Koh,

I write to you regarding the above proposal which was submitted for ethical review. I am pleased to inform you that your proposal has been granted full **APPROVAL.** You may commence data collection as described in your application.

Please note the following:

1. This submission has been reviewed primarily from an ethical perspective. It is the responsibility of the Principal Applicant to ensure and monitor compliance with any relevant legislation/public health guidelines in the country where the study is due to take place or any local policy in the site where the study is due to take place. It is also the researcher's responsibility to undertake this research in accordance with the National and NUI Galway guidelines and protocols regarding **Covid-19** which are in effect at the time of data collection.
2. Any significant alterations to an approved proposal must receive prior approval from the REC prior to implementation. Please request an Amendment Form.
3. You are responsible for notifying the REC in the event of serious or unexpected adverse effects, unforeseen circumstances, the termination of the study, and any significant decisions by other Ethics Committees. Section 7 of the REC's Standard Operating Procedures gives further details on instances requiring follow-up reviews, and reporting obligations.
4. Principal Applicants given NUI Galway REC approval must, upon completion of the approved research, submit an End-of Study report (attached). Failure to submit such a report may impact upon future ethics applications.

When the decision was taken I was chairing the meeting. The following members were present:

Dr Kevin Davison	Dr Linda Biesty	Dr Sinead Duane	Dr Ciara Eagan
Dr Caroline Heary	Dr Edel Hughes	Dr Martina Kelly	Dr Marie Mahon
Dr Veronica McCauley	Dr Stacey Scriver	Dr Amir Shafat	Dr Brian Tobin
Mr Patrick Towers			

Yours sincerely

Dr Kevin Davison

Chair, Research Ethics Committee

Appendix 28: Conducting and REporting DELphi Studies (CREDES) checklist (Chapter 9)

CREDES Items	Reported in Page
Rationale	
17. Provide a rationale/justify the choice of using the Delphi technique	Reported in protocol
Planning and design	
18. State the aims and purpose of the study, and the plans and processes for conducting the Delphi technique. If any modifications are to be made to technique, justifications should be provided and the method used should be systematic and rigorous	152
19. An a priori criterion for consensus should be defined. This should include clear and transparent guide on: (i) how to proceed with certain items or topics through the survey rounds, (ii) threshold to terminate the Delphi process, and (iii) procedures to be followed, whether consensus is reached/not reached after one or more iterations	154-155
Study conduct	
20. All materials provided to the Delphi experts at the outset of the project should be carefully reviewed and piloted in advance in order to examine the effect on experts' judgement and prevent bias	153-154
21. Researchers need to take measures to avoid influencing the experts' judgements. If the researcher has a conflict of interest, it is recommended to seek an independent researcher to coordinate the Delphi responses	n/a
22. Interpretation of results: Consensus may not necessarily just refer to the right answer or judgement. Non consensus and stable disagreement provide important insights and highlight differences in perspectives	154
23. The final draft of the resulting best practice guidelines should be reviewed and approved by an external board or authority (for external validation) before publication and dissemination	n/a
Reporting	
24. The purpose of the study should be clearly defined, and the appropriateness of using the Delphi technique to address the research objectives must be rationalised	Reported in protocol
25. Information about the expert panel should be clearly described - Criteria for the selection of experts and information on the recruitment process, experts' sociodemographic details (including their expertise regarding the research topic), response and non-response rates over the Delphi rounds should be reported	Reported in protocol and 153
26. The method should be clearly described – This should include information about preparatory steps (i.e., how was available evidence on this topic synthesised), piloting of material and survey instruments, design of the survey, the number and design of survey rounds, data analysis methods, how responses are proceeded in preparation for next Delphi rounds, and methodological decisions taken by the researcher	Reported in protocol and 153-154

27. The procedure of the Delphi process (including the preparatory phase, actual Delphi rounds, interim steps of data processing and analysis, and concluding steps) should be illustrated using a flow chart	Reported in protocol
28. The definition and attainment of consensus should be clearly stated, so that the reader can comprehend how consensus was achieved, and how non-consensus is dealt with	153-154
29. It is highly advisable to report results separately for each round, so that the evolving consensus over the different rounds can be made transparent. This may include figures to show average group responses, changes between rounds, as well as any modifications to the survey e.g., deletion, addition or modification of survey items based on previous rounds)	155-166
30. The researcher should critically reflect and report on potential limitations and their impact on the resulting guidance	168
31. The conclusions should adequately reflect the outcomes of the Delphi study in relation to the scope and applicability of the resulting practice guidelines	168
32. The resulting guidance should be clearly identifiable from the publication, including recommendations for translation into practice and implementation. If the publication does not allow for a detailed presentation of either practice guidance or the methodological features of the applied Delphi technique (or both), reference to a more detailed presentation elsewhere should be made (e.g. availability of the full guideline, publication of a separate paper reporting on methodological details and particularities of the process)	163, and Table 3 (in-text)

Appendix 29: Participant information sheet and consent Form (Chapter 9)

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

NUI Galway
OÉ Gaillimh

STUDY INFORMATION

Title of Study

Strategies for implementing pet robots into nursing homes for residents with dementia: A modified Delphi study

Researcher

Ms Wei Qi Koh
Aras Moyola Building
National University of Ireland Galway
University Road, Galway

PURPOSE OF THE RESEARCH STUDY

You are being invited to participate in a research study. Pet robots are a type of robot that are designed to look and behave like pets and companion animals. Research studies showed that using pet robots can lead to positive benefits. However, little is known about how they can be introduced into nursing homes for dementia care. The purpose of this study is to identify strategies for implementing pet robots in nursing homes for residents with dementia.

WHO IS DOING THIS RESEARCH?

The research will be conducted by Wei Qi Koh as part of her PhD in the School of Nursing and Midwifery at the National University of Ireland Galway. Wei Qi Koh is clinical occupational therapist with experience working in care facilities for older adults and people with dementia.

STUDY PROCEURES AND VISIT SCHEDULE

If you agree to take part in this study, you will be invited to participate in a modified Delphi study, which involves **two rounds of survey over a three-month period**. This group consensus will enable us to identify strategies for implementing pet robots in nursing homes for dementia care. Each round of the survey is expected to take approximately **35-40 minutes** to complete. You will be given **three weeks** to complete each round of the survey.

In the first round of the survey, you will be invited to rate the importance of a list of implementation strategies on a 4-point scale (1-Strongly disagree, 2-disagree, 3-agree, 4-strongly agree). This survey was informed by 1) an extensive literature review, and 2) findings from a qualitative study, where interviews were conducted to understand barriers and facilitators to implementing pet robots. You will also be provided with the opportunity to suggest new strategies that are not listed in the survey.

In the second round of the survey, you will be invited to review 1) implementation strategies that did not receive consensus from participants, and 2) new implementation strategies that are proposed from the previous round. Similarly, this would involve rating the implementation strategies on a 9-point scale.

POSSIBLE RISKS, DISCOMFORT AND INCONVENIENCES

There are no known risks for participating in this study. This study involves participating in the online survey for approximately 35-40 minutes for each round of the survey, at your convenience.

POTENTIAL BENEFITS

Your contribution will also contribute to the knowledge about how pet robots can be introduced for residents with dementia in nursing homes, which can help to facilitate improved healthcare and service provision for this population.

PARTICIPANTS' RIGHTS

Your participation in this study is entirely voluntary. Your questions will be answered clearly and to your satisfaction. By signing and participating in the study, you do not waive any of your rights to revoke your consent and withdraw from the study at any time.

WITHDRAWAL FROM STUDY

You are free to withdraw your consent and discontinue your participation at any time without prejudice to you. If you decide to stop taking part in this study, you should tell the Researcher.

CONFIDENTIALITY OF STUDY

Information collected for this study will be kept confidential. Your records, following the General Data Protection Regulation (GDPR) regulations, will be kept private and confidential. Only the researcher will have access to the personal information being collected. This includes all information, including personal information and data collected during the audio-recorded interview, will be anonymised and kept private and confidential. It is important to know that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, the researcher will then be obliged to disclose this information to the nursing home, Gardai and the University Research Ethics Committee.

All personal data and information collected from you using audio-recorded interviews will be stored for a period of seven years, after which the information will be destroyed in accordance to the NUI Galway Data Protection and Security Policies and Procedures. By signing the Consent Form, you provide explicit consent to the collection, access to, processing and storage of your Personal Data by the NUI Galway. In the event of any publication regarding this study, your identity will remain fully confidential.

WHO TO CONTACT IF YOU HAVE QUESTIONS ABOUT THE STUDY

If you have questions or concerns about data protection from your participation in this study, you may contact the researcher Ms Wei Qi Koh at, or contact the Data Protection Officer at dataprotection@nuigalway.ie. You also have the right to lodge a complaint with the Data Protection Commissioner (https://www.dataprotection.ie/en/contact/how-contact-us).

If you have questions about this research study during the course of this study, you may contact the Researcher Ms Wei Qi Koh at +(353) 899 556 484 or weiqi.koh@nuigalway.ie or the NUI Galway Research Ethics Committee at ethics@nuigalway.ie

WHO HAS REVIEWED THE STUDY

This study has been reviewed and approved by the Research Ethics Committee in National University of Ireland Galway.

CONSENT FORM

Details of Research Study

Study Title:

Barriers and facilitators to the implementation of pet robots in nursing homes for people living with dementia

Researcher: Ms Wei Qi Koh (Telephone: 091493687, Email: weiqi.koh@nuigalway.ie)

Participant's Consent

I have read and understood the information sheet about this study.	Yes / No
Information about the study has been fully explained to me	Yes / No
All my questions have been answered to my satisfaction	Yes / No
I understand that my participation in this study is completely voluntary, and I can opt out of this study any time	Yes / No
I understand that my personal data will be kept private and confidential. Any information about me will be anonymized	Yes / No
I understand that there are limits to the researcher's ability to keep certain types of information disclosed to them that is confidential. If the researcher is told about a clear and serious danger or issue affecting you, she will be obliged to disclose this information to the University Research Ethics Committee.	Yes / No
I give explicit consent to have my information processed as part of this research study	Yes / No
I understand that information will be collected from me will be destroyed after the results are compiled, according to the NUI Galway Data Protection and Security Policies and Procedures	
I understand that personal information that was collected will be stored for seven years, after which the information will be destroyed according to the NUI Galway Data Protection and Security Policies and Procedures	Yes / No
I would like to participate in this study	Yes / No

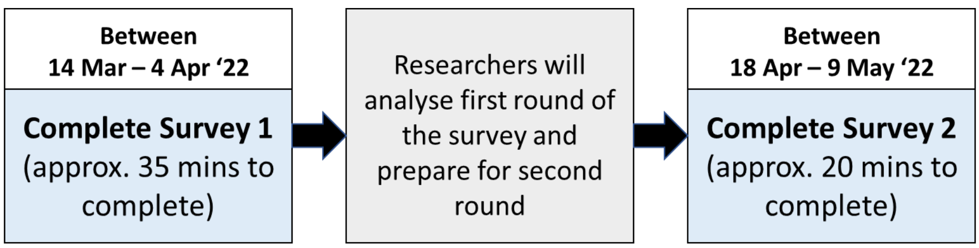
Appendix 30: Letter of invitation (Chapter 9)

Date: ___________

Dear ___________,

My name is Wei Qi Koh, and I am a doctoral candidate in the National University of Ireland Galway. I would like to invite you to participate in a study titled ***"Strategies for implementing pet robots in nursing homes for residents with dementia: A modified Delphi study".*** Pet robots are a type of robot, which are designed to look and behave like pets or companion animals. However, little is known about how they can be introduced into nursing homes for residents with dementia.

The purpose of this study is to identify implementation strategies for embedding pet robots into nursing homes for dementia care. We are inviting 54 healthcare professionals, organisational leaders and academic researchers, to participate in **two rounds of fully-anonymised online survey** (modified Delphi study) that will be conducted between March to May 2022.



In **Round 1** of the survey, we will present a summary of the barriers and facilitators that have been described to affect the implementation of pet robots. After that, a list of implementation strategies to embed pet robots in nursing homes for dementia care will be presented. You will be invited to rate how important and critical each strategy is, using on a 9-point scale (1 to 3 – Limited importance; 4 to 6 – Important but not critical, 7 to 9 – Important and critical). You will also be provided the option to suggest strategies that are not included in the list. This survey is expected to take approximately **35 minutes to complete,** and has to be completed between **14 March to 4 April 2022 (a 3-week period)** so that we can collate and analyse the responses, to prepare for the next survey round.

In **Round 2**, strategies that participants did not agree on from the Round 1, and new strategies that were suggested. Similarly, you will be invited to rate the relevance of each strategy. This survey is expected to take **20 minutes** to complete, and has to be completed **between 18 April to 9 May 2022 (a 3-week period).**

Your input will be extremely valuable, and it will contribute to the development of recommendations for how pet robots can be embedded into dementia care in nursing homes.

If you wish to participate in this study, please open the link at the bottom of this email. support will be very much appreciated. If there are any questions, please feel free to contact me at weiqi.koh@nuigalway.ie, or at (+353)899556484. Thank you so much once again for your consideration.

Sincerely,

Researcher
(Ms) Wei Qi Koh
PhD candidate student / Marie Skłodowska-Curie Fellow
National University of Ireland Galway, Ireland

Project Supervisors
Dr Elaine Toomey
Lecturer in Physiotherapy
University of Limerick, Ireland
Professor Dympna Casey
Professor and Head of School of Nursing and Midwifery
National University of Ireland Galway, Ireland

Appendix 31: Recruitment poster (Chapter 9)

Help us understand how to introduce pet robots into nursing homes for dementia care

Pet robots are a technology based substitute for animal assisted therapy that have had positive benefits for people living with dementia. The purpose of this study is identify strategies for implementing pet robots in nursing homes for dementia care

We are looking for:

Health & social care professionals

- Anyone who provides care to nursing home residents with dementia
- Nurses, physiotherapists, occupational therapists, activity coordinators etc

Managers & directors

- Any leadership position in a nursing home caring for residents with dementia
- Include nurse or therapy managers and directors etc

Researchers

Working in the field of implementation science, using technology and/or psychosocial interventions in dementia care

What will I have to do?

Complete 2 online surveys (approx. 35 mins each)

First survey to be completed between **14 Mar – 4 Apr 2022**

Second survey to be completed between **18 Apr – 8 May 2022**

Your contribution will further build our knowledge on how pet robots can be adopted as a part of dementia care in nursing homes. To learn more or to participate, please contact:

Miss Wei Qi Koh (PhD candidate)
weiqi.koh@nuigalway.ie

NUI Galway
OÉ Gaillimh

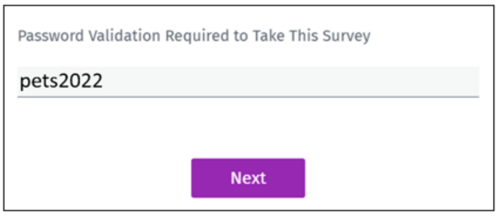
Appendix 32: Sample emails to participants (Chapter 9)

32.1: Email invitation to Round 1

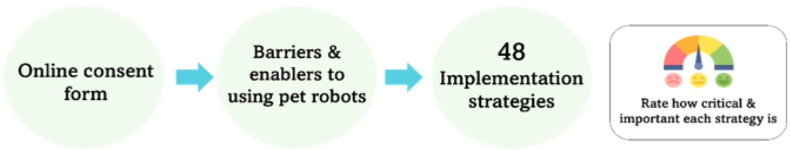
Dear ____________,

I hope you've had a very wonderful weekend. Once again, thank you for agreeing to join this study, and contribute your expertise as a __________! Your contributions will be very important in helping us develop knowledge on strategies to help care homes & nursing homes adopt pet robots as a part of routine dementia care. I am very honoured to share that we have will have representation from a panel of experts (researchers, care professionals and organisational leaders) from over 10 different countries.

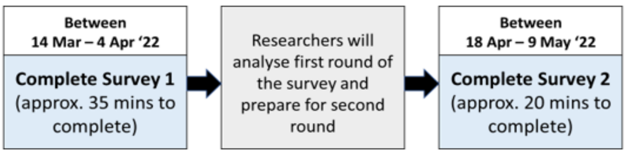
The first Delphi survey round will begin today. Here is the link: https://implementationstrategies-surveyround1.questionpro.eu/ to it. This survey should only be completed by you, so please do not share the link with others. To access the survey, please enter the password **pets2022** (as shown in picture below).



In the survey, you will first be invited to complete the consent form. Next, you will be shown a summary of research findings of the barriers and enablers that have influenced the use of pet robots in care homes/nursing homes. After that, 48 implementation strategies will be presented, and you will be invited to rate how critical & important each strategy is.



The survey is expected to take approximately **35 to 40 minutes to complete**. It will remain open for 3 weeks (until 4 April), so you can complete it at a time that is most convenient. Since the survey will be fully anonymised, I will not know if you have completed the survey. However, your response is really important to us. As such, I will send up to three email reminders (i.e., one reminder a week) to gently remind you to complete the survey, if you have not done so. Responses from the first round of the survey from all will help us develop the second survey, which is expected to start on 18 April.



Please feel free to reach out to me if you have any questions, and I will do my best to respond as soon as I can. Thank you so much once again for being so generous in contributing your time and expertise! Looking forward to receiving your response on the survey 😊

Best wishes,
Wei

____

Wei Qi Koh
PhD student / Marie Skłodowska-Curie Fellow
DISTINCT (Dementia: Intersectorial Strategy for Training and Innovation Network for Current Technology)
Room 338, Aras Moyola Building
School of Nursing and Midwifery
National University of Ireland Galway
(+353) 91493687

32.2: Email invitation to Round 2

Dear ____________,

I hope you had a really lovely weekend. Thanks to your contribution and the contribution of other experts, I am delighted to share that we are ready to start Round 2 of the survey today! Here is the link to the survey: https://nuigalway.questionpro.eu/implementation-strategies-round2. This survey should only be completed by you, so please do not share the link with others. To access the survey, please enter the password **surveyround2**

About this survey round (Round 2)

The purpose of this survey round is to determine if participants can agree (or disagree) on the importance of the strategies for implementing pet robots. Strategies that had mixed responses in the previous survey are brought forward to Round 2, and a summary of previous responses are presented. We invite you to reconsider your responses based on other participants' feedback, and re-rate how important you consider each strategy to be. New strategies that were suggested previously are also presented. Please be assured that all responses are *fully anonymised*.

Completing the survey

The survey is expected to take approximately **40 minutes to complete**. We are genuinely sorry that that we are not able to keep this survey shorter like how we had initially planned – This is due to the comprehensive comments from participants in the previous round, and a lack of agreement on more strategies than we had anticipated. However, we have now added an option that would allow you to 'save' your response and continue the survey at later time/date. The survey will remain open for **3 weeks (until 9 May),** so you can complete it at a time that is most convenient. If you would like more time to complete the survey, please let me know, and we are more than happy to extend the deadline by one additional week.

Your experiences with _________________ is extremely important and valuable to us - it will help us generate knowledge on how pet robots can be introduced in long term care settings. As such, I will send up to three email reminders (i.e., one reminder a week) to gently remind you to complete the survey. Alternatively, it would be lovely if you could let me know once you've done the survey. Please feel free to reach out to me if you have any questions, and I will do my best to respond as soon as I can. Thank you so much once again for being so generous in contributing your time and expertise. Looking forward to receiving your response on the survey 😊

Best wishes,
Wei

____

Wei Qi Koh
PhD student / Marie Skłodowska-Curie Fellow
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Appendix 33: Original and contextualised implementation strategies (Chapter 9)

33.1 Original and contextualised ERIC strategies

This is an exemplar of the original ERIC strategies and the contextualised strategies. The full list of original and contextu alised strategies can accessed via https://osf.io/bd9f2.

ERIC Strategies (Cumulative %)	**Original description**	**Original Ancillary material**	**Contextualised description & data source** *1- Scoping review* *2 - Qualitative study* *3 - Original description/ancillary material* *4 - Stakeholder consultation and/or PPI consultation*	**Data for contextualisation** *(Data sources from scoping review and/or qualitative study pertaining to relevant CFIR constructs)*
1. Identify and prepare champions (876%)	Identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance that the intervention may provoke in an organization.	This strategy includes preparing individuals for their role as champions. Champions are primarily internal to the organization. Additional issues raised include the need for guidance regarding: a) Methods and considerations related to the selection and identification of champions. Social network theory and methods may be useful in this regard. b) Training and or providing champions support materials. c) Addressing incentives or disincentives to the champion role. d) Whether there are needs for champions at different levels of an organization (e.g., clinic, region, national). Champions are often distinguished from opinion leaders. Opinion leaders may be considered more of an objective third party with relevant expertise.	Identify and prepare individuals within the care home/nursing home who dedicate themselves to championing* pet robots 1) Identifying champions - Allow staff who are interested in the champion role to volunteer themselves for this role *(4)*. It may be desirable for potential champions to have following attributes/qualities: An interest in technology *(2)*, positive attitudes to new interventions/pet robots *(1)(2)(4)* 2) Preparing champions: - Provide Training and support. For example: ○ Increase knowledge on the evidence behind pet robots *(1)(2)(4)* ○ Inform them of the advantages of using pet robots compared to other interventions/activities *(1)(2)(4)* ○ Provide incentives/disincentives for the champion role *(3)* **Championing includes supporting, marketing, driving through the use of pet robots, and/or overcoming resistance to using pet robots within the home*	1. Identifying champions - Champions - Knowledge and beliefs - Individual stage of change - Evidence strength and quality 2. Preparing champions - Evidence strength & quality - Relative advantage - Tension for change - Leadership engagement

2. Conduct local consensus discussions (651%)	Include local providers and other stakeholders in discussions that address whether the chosen problem is important and whether the clinical innovation to address it is appropriate.	Identify stakeholders relevant to each project. Further, with each project, there will be a need to identify whether the goal of the consensus discussion is to characterize consensus or build consensus. Utilizing community based participatory research principles may be relevant to many innovations. Notably, the chosen problem needs to be a high enough priority, compared to other problems, that attention and resources will be dedicated to addressing the problem.	Conduct local (internal) consensus discussions among (local/internal) stakeholders* within the care home/nursing home, about the importance of introducing and adopting pet robots for residents with dementia Discussions may include: • The importance of bringing in/using pet robots to address a chosen problem *(1)(2) (4)* - e.g. to address residents' needs or support care staff • Appropriateness of using pet robots to address the problem(s) - e.g. whether pet robots align with workflows *(1)(2) (4)* **Internal stakeholders may include (but are not limited to): care staff, activity coordinators, therapists, managers, and family members (1)(2)(4)*	- Key stakeholders - Tension for change - Relative priority - Residents' needs and resources - Evidence strength & quality - Compatibility
3. Assess for readiness and identify barriers and facilitators **(580%)**	Assess various aspects of an organization to determine its degree of readiness to implement, barriers that may impede implementation, and strengths that can be used in the implementation effort.	Readiness assessments may focus on agency finances, staffing levels, and other material or logistical resources needed, or available, to support the implementation effort. Further this assessment may also focus on leadership support, the organizational priority for change, and the presence of successful experience with quality improvement techniques and change management. Additional aspects for assessment may include other services provided, as well as community support, stakeholder attitudes, and beliefs and perceptions of evidence for the innovation or change. Rationale for current practices, organizational climate and culture, structure, decision-making styles, and the perceived needs of frontline stakeholders to implement the change or innovation (consider adaptation needs and limits) are also important aspects to consider in this assessment.	Assess the care home/nursing home's readiness to introduce and use pet robots in routine dementia care within the care home/nursing home *(2) (3)*, and identify and barriers and facilitators to readiness. The following aspects should be assessed: 1) Financial resources - E.g. Assess the financial resources needed for the purchase and maintenance of pet robots *(1)(2)(3)(4)* 2) Manpower - E.g. Assess if pet robots can be integrated into existing workflow of all key stakeholders*, consider number of residents and their care overall dependencies *(1)(2)(4)* 3) Logistical resources	1. Financial resources - available resources 2. Manpower - available resources - compatibility 3. Logistical resources - available resources - planning - key stakeholders 4. Existing services - Relative priority - Tension for change - Residents' needs and resources

		Readiness assessments can be used to vet, eliminate, or prioritize implementation sites. More so, the assessment can help make internal decisions about whether to go ahead with an implementation initiative. Some barriers can be difficult to observe prior to implementation. Specific measures have been created to assess readiness for change, which may be useful	- E.g. Assess the logistics needed to introduce pet robots, such as the physical environment and whether there are sufficient charging points or batteries *(2) (4)* 4) Existing services/activities provided - E.g. Consider existing services or activities (such as music, reminiscence activities) that available to support the needs of residents with dementia, and assess whether these can hinder or support the introduction of pet robots *(2)(4)* *Stakeholders may include activity coordinators, care staff (nurses and care assistants), occupational therapists, psychologists, care homes and nursing home managers/directors *(1)(2)(4)*	
4. Inform local opinion leaders (582%)	Inform providers identified by colleagues as opinion leaders or ‘educationally influential’ about the clinical innovation in the hopes that they will influence colleagues to adopt it.	The opinions of individuals who refer people to services, or who initiate the connection to services also function in a key opinion role. Keeping opinion leaders informed from pre-implementation through maintenance of the clinical innovation is important. Ensuring that opinion leaders do not serve as implementation obstacles if they are not actively promoting the innovation is also important.	Inform local opinion leaders* in the care home/nursing home about pet robots, in hopes that they will influence other colleagues to adopt it *(1)*. This can include information about supporting evidence *(2) (4)*, the relative advantages of using pet robots as compared to other existing interventions *(1) (2)*, and the need to introduce pet robots *(2).(4)* **Opinion leaders are individuals who are perceived by colleagues in the home as being credible and trustworthy, and being able to influence attitudes (3)*	- Evidence strength & quality - Relative advantage - Tension for change
5. Build a coalition	Recruit and cultivate relationships with partners in the implementation effort.	Partnerships can develop around cost-sharing, shared resources, shared training, and the division of responsibilities among partners. This work may proceed naturally from local consensus discussions. Coalition members commonly have defined roles in the implementation effort.	Establish and cultivate relationships between local disciplinary groups* (within the care home/nursing home) and/or with other nursing homes who have implemented pet robots, or are keen to introduce pet robots. These relationships can involve sharing of information on experiences, resources and information, such as training resources or educational resources. 1) Establish and cultivate relationships with other care homes or nursing homes *(2)(3) (4)*	- Cosmopolitanism - Evidence strength and quality

			- Care homes/nursing homes that have existing relationships with other homes (e.g. being under the same management) can leverage on these relationships *(2)* - Other care homes/nursing homes may consider identifying potential partners (other homes) through national representative bodies *(2)* 2) Establish and cultivate relationships between local disciplinary groups: - An example may include creating opportunities for interdisciplinary discussions and learning *(2)(3)(4)*	
6. Conduct educational meetings	Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders) to teach them about the clinical innovation.	The content of the education may include information regarding what to expect as implementation moves forward. It is useful to ensure that meeting attendees are relatively homogeneous so that the education can be targeted toward the stakeholder group's needs. For example, some educational meetings may inform the stakeholder group about the clinical innovation in a way intended to increase demand, while others may preview the clinical innovation for providers and administrators. It is often useful to have recordings or other materials from the educational meetings available to those who cannot attend the meetings (e.g., those covering patient care at the time of the meeting, new hires subsequent to the meeting).	Conduct educational meetings that are targeted to specific stakeholder groups to provide them with knowledge on the role of pet robots for dementia care. Educational meetings should be recorded, so that those who cannot attend these meetings, or new staff can have access to these information *(2)(3)(4)*. The educational content may be different to target on the needs of each stakeholder groups. Examples of content may include: - Evidence behind pet robots: E.g., information about their impacts on residents, sustainability for long-term engagement, who may benefit and risk of distress *(1)(2) (4)* - How pet robots can support caregiving E.g., Information on the potential impacts of caregiving burden on nursing home staff *(1)(2) (4)* **Stakeholders may include different care professionals, administrative staff, management/leadership staff, care home/nursing home residents and family members*	- Knowledge and beliefs - Evidence strength & quality - Access to knowledge and information

33.2 Strategies removed or combined after stakeholder consultation

This is an exemplar of the ERIC strategies that were removed after stakeholder consultation. The full list can be found at https://osf.io/bd9f2.

Promote network weaving (Combined with 'build a coalition' after stakeholder consultation, due to difficulties distinguishing between the 2 strategies)	Identify and build on existing high quality working relationships and networks within and outside the organization, organizational units, teams, etc. to promote information sharing, collaborative problem-solving, and a shared vision/goal related to implementing the innovation.	Individuals functioning as network weavers usually have external links outside of the community to bring in information and ideas. An example would be nurses and doctors who staff hospitals and skilled nursing facilities, and the patients who rotate among these facilities. Networks are somewhat more organic than collaboratives and are often enduring and durable	Identify and build on existing high quality working relationships and networks within and outside the nursing home or disciplinary teams. This may include network weaving between different nursing homes, or between different professions within the nursing home (e.g. activity coordinators, nurses, occupational therapists, physiotherapists) *(2)(3)* For example, this can include: - supporting staff to share information with each other and to support each other *(2)* - create opportunities for formal and informal discussions *(2)* The purpose of the network weaving is to promote information sharing, collaborative problem-solving, and a shared vision/goal related to adopting pet robots within the nursing home for dementia care *(3)*	- Key stakeholders - Network and communication
Provide ongoing consultation (Removed after stakeholder consultation, due to difficulties distinguishing between this strategy and other strategies involving consultation, e.g. use an implementation advisor)	Provide ongoing consultation with one or more experts in the strategies used to support implementing the innovation	Ongoing consultations could include in-person or distance consultation and feedback on taped clinical encounters. Consultations are tailored to the clinician's actual practice, thus, differentiating a consultation from ongoing trainings. Feedback may be from a consultant external to the organization, which distinguishes consultation from clinical supervision. Some practice changes can involve a recertification process, thus, involving consultation ensures adequate fidelity. Consultation may also be necessary for non-clinical staff such as administrators and those responsible for billing, constructing feedback systems, or other staff with duties that impact the implementation process.	Provide ongoing consultation with an expert (or experts) in the strategies that are used to support the adoption of pet robots. The consultants/experts may be external to the nursing home (which makes it different to clinical supervision) *(3)*	n/a

Appendix 34: Statement revision after Round 1 (Chapter 9)

This is an exemplar of how statements were revised after round 1 for representation in round 2. The full list can be accessed via https://osf.io/m8jsz

Strategy (R1) - Original	**Revised (for Round 2)**	**Summary of main changes**
1. Conduct Local Consensus Discussions Conduct local (internal) consensus discussions among (local/internal) stakeholders* within the care home/nursing home, about the importance of introducing and adopting pet robots for residents with dementia Discussions may include: • The importance of bringing in/using pet robots to address a chosen problem - e.g. to address residents' needs or support care staff • Appropriateness of using pet robots to address the problem(s) - e.g. whether pet robots align with workflows *Internal stakeholders may include (but are not limited to): care staff, activity coordinators, therapists, managers, and family members	**1. Conduct Local Consensus Discussions** Conduct local (internal) consensus discussions among (local/internal) stakeholders* within the care home/nursing home, about the importance of introducing and adopting pet robots for residents with dementia. These discussions are important to allow key internal stakeholders to discuss their thoughts and potential barriers, which can enhance their support, openness and buy-in towards pet robots Discussions may include: • The importance (or unimportance) of bringing in/using pet robots to address a chosen problem - e.g. to address residents' needs or support care staff • Appropriateness of using pet robots to address the problem(s) - e.g. whether pet robots align with workflows *Internal stakeholders may include (but are not limited to): all care staff (e.g. activity coordinators, therapists), managers, residents with dementia and their family members. Each of these key stakeholders can play important and unique roles	1) Enhanced description of rationale for strategy: - Rationale for including strategy, such as to enhance buy-in, encourage an open-mind, and to discuss and solve barriers 2) Involve residents with dementia as stakeholders - Discussing, listening and understanding their needs - Note that some may not like pets - Potential to be misunderstood *(Without the informed support of stakeholders (chiefly, patients & their representatives) the initiative has the potential to be both misunderstood and ineffective)*
2. Identify and Prepare Champions Identify and prepare individuals within the care home/nursing home who dedicate themselves to championing* pet robots Identifying champions - Allow staff who are interested in the champion role to volunteer themselves for this role. It may be desirable for potential champions to have following attributes/qualities: An interest in technology, positive attitudes to new interventions/pet robots	**2. Identify and Prepare Champions** Identify and prepare individuals within the care home/nursing home who dedicate themselves to championing* pet robots. This strategy may be especially relevant if pet robots are considered to be 'novel' (i.e., 'new') within the care home/nursing home. Identifying champions - Allow staff who are interested in the champion role to volunteer themselves for this role. It may be desirable for potential champions to have following attributes/qualities: An interest in technology, positive attitudes to new interventions/pet robots	1) Added that the **novelty** of pet robots can influence the salience of the champion role at different stages of the implementation 2) Provided elaboration on how to prepare champions (provide information: when to use pet robots) 3) Provided an example of the **incentive** for champions

Preparing champions:
- Provide Training and support. For example:
  o Increase knowledge on the evidence behind pet robots
  o Inform them of the advantages of using pet robots compared to other interventions/activities
  o Provide incentives/disincentives for the champion role
 	
**Championing includes supporting, marketing, driving through the use of pet robots, and/or overcoming resistance to using pet robots within the home*
	Preparing champions:
	- Provide them with time, training and management support. For example: provide information to:
	  o Increase knowledge on the evidence behind pet robots
	  o Inform them of advantages (e.g. when to use pet robots) compared to other interventions/activities
	  o Provide incentives/disincentives for the champion role (e.g. providing a certificate for the champion role)
	
	Other considerations about this strategy
	- The staff turnover rate in care homes/nursing homes may influence the sustainability of the champion role.
	- The culture (e.g. attitudes of individuals) within the care/nursing home may influence the need for this strategy of having a champion
	- The role of the champion may be more salient at different stages of implementing pet robots. When the technology becomes more familiar and accepted as part of a norm within the care home/nursing home, the role of the champion may become less salient.
	- Consider using this strategy alongside other team-based strategies, where other members of the care team should also be involved in supporting the use of pet robots
	
	**Championing includes supporting, marketing, driving through the use of pet robots, and/or overcoming resistance to using pet robots within the home*
		4) Added other considerations about this strategy
		- Staff turnover rate
		- Culture
		- Consider combing with team based approach/ strategies

3. Inform Local Opinion Leaders Inform local opinion leaders* in the care home/nursing home about pet robots, in hopes that they will influence other colleagues to adopt it. This can include information about supporting evidence, the relative advantages of using pet robots as compared to other existing interventions, and the need to introduce pet robots	Inform local opinion leaders* in the care home/nursing home about pet robots, in hopes that they will influence other colleagues to adopt it. This can include providing information about the supporting evidence, or the relative advantages of using pet robots as compared to other existing interventions, and the need to introduce pet robots. Other considerations about this strategy - The role of the opinion leader may be more salient at different stages of the implementation. For example, for this role may be more salient during the early stages of implementation to support buy-in	Description of strategy amended slightly, to state more explicitly that information should be provided to opinion leaders *(i.e., 'this can include providing information…)* Added other considerations about this strategy - May be more salient during initial phase of implementation

*Opinion leaders are individuals who are perceived by colleagues in the home as being credible and trustworthy, and being able to influence attitudes.	- The role of the opinion leader may be limited in some circumstances, for example, by attitudes of other individuals who are negative or resistive towards pet robots - Consider combining this strategy with other strategies (e.g. with the role of the champion, or with other team-based strategies) *Opinion leaders are individuals who are perceived by colleagues in the home as being credible and trustworthy, and being able to influence attitudes of other staff within the care home/nursing home*	- Role may be limited by other individuals - Consider combining strategy Description of opinion leader amended slightly to highlight their role in influencing attitudes of staff within the care home/nursing home, since this point was mentioned a few times (in support of the strategy/reason to include opinion leaders)
4. Identify Early Adopters Identify early adopters* locally, and learn from their experiences of using pet robots for residents with dementia **Early adopters are individuals who are typically the first to be on board with new innovative solutions. They may be the among the earliest to adopt and use pet robots within routine dementia care in the care home/nursing home where pet robots are available.*	Identify early adopters* locally (from within the care home/nursing home), and learn from their experiences of using pet robots for residents with dementia. Early adopters may draw on their experiences with pet robots to influence, normalise and provide role modelling for the use of pet robots by other staff within the nursing home. Early adopters may be a good pool of individuals to identify a champion(s) Other considerations: - It is important to consider that pet robots are not a one-size-fits all approach, and may not be suitable for every resident. - Early adopters who have had negative initial/early experiences with using pet robots, and these experiences may deter implementation efforts - The support of management (leaders) and governance (e.g. at the governmental level) may influence the feasibility of this strategy - Consider combining this strategy with other strategies (e.g. integrate this as a part of the 'champion' role). **Early adopters are individuals who are typically the first to be on board with new innovative solutions. They may be the among the earliest to adopt and use pet robots within routine dementia care in the care home/nursing home where pet robots are available.*	1) Description of strategy amended slightly, to state more explicitly that locally refers to 'within the care home/nursing home' 2) Added more information about the potential role of early adopters (influence, normalise and provide role modelling for the use of pet robots); and that it could be a good pool to identify champions 3) Added other considerations about this strategy - Not a one-size-fits all approach; may not be suitable for all residents - Early adopters with negative initial/early experiences can deter implementation - Management and governance support may influence the feasibility of this strategy - Combining this strategy with other strategies