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# Designing Human–Robot Collaboration in Elderly Mental Health Services: A Review from A Service Design Perspective

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**ABSTRACT:** Population ageing increases demand for mental health support, yet research on care robots rarely addresses their integration into service systems. This scoping review examines service robots in older adult mental health services from a service design perspective. Scopus was the primary database, and staged screening yielded 36 studies. Thematic synthesis identified three themes: companionship and emotional support; dementia care and cognitive support; and human–robot collaboration and responsibility boundaries. Robots primarily function as supportive service touchpoints rather than independent diagnostic or therapeutic agents. They show potential for companionship, emotional support, cognitive stimulation, and daily care, but service handoffs, human intervention, professional referral, and responsibility allocation remain insufficiently examined. Future research should investigate integration into real care processes and clarify responsibilities among robots, older adults, caregivers, nursing staff, and clinical professionals.

## I. INTRODUCTION

THE world's population is getting older and this is constantly changing the shape of health and care systems. As the population of older people increases, care of older adults has been expanded from treatment of diseases and physical help to mental health, social involvement, and quality of life. Social isolation and loneliness are significant risk factors [1]. These concerns impact not just the health of the individual but also create increased long-term strain on families, communities and health-care systems.

In later age, physical sickness and mental health problems can more easily be missed out. Depression, anxiety, loneliness, social isolation and cognitive impairment may be mistaken for normal ageing or typical reactions to life events, resulting in delayed detection and support. WHO materials on social isolation and loneliness also suggest that these issues may affect physical and mental health, quality of life and longevity and need to be addressed through face-to-face services, digital interventions, community support and increasing age-friendly service systems [2]. Older adult mental health services consequently need to include not only professional therapy but also how hazards are identified, responded to and referred on in everyday life and care routines .

In this sense, the employment of service robots and socially assistive robots is increasingly used in research related to care and mental health of older individuals. Different from traditional mobile apps and web platforms, service robots are physically embodied, socially engaged and contextually present, and they can take part in everyday life through speech, movement, facial expression, screens and spatial presence. Robots can offer companionship, emotional communication, daily greetings, information gathering, screening for risk of depression or loneliness, reminders of

activities, cognitive training, and referral to mental health service specialists for older individuals. Social assistive robots have been studied in the mental health and well-being domain for companionship, communication, psychological support, goal tracking and interactive feedback [3].

Studies of sadness, loneliness and emotional support in elderly people also suggest robots may be able to provide valuable support. A systematic assessment of social robots for late-life depression identified possible decreases in depressive symptoms but the evidence available was insufficient to establish definite conclusions about therapeutic effectiveness [4]. Likewise, a comprehensive review and meta-analysis of AI-based conversational and socially assistive agents found possible reductions in depressed symptoms, while the evidence for reductions in loneliness was mixed [5]. Thus, the value of robots for mental health services for older adults cannot be measured only by technological capabilities or short-term outcomes, but must be seen in the light of the service, the needs of the user and the professional support.

But the conversation is still constrained at the service-system level. Much of the research is on the robot functionalities, user attitudes, single interactions or short-term intervention results and less focus is given to the integration of robots into real-world mental health treatment operations for older individuals. Robots are also typically considered as direct contact partners for elder users while collaboration with psychologists, psychiatrists, nursing personnel and family carers is less emphasized. Research with healthcare professionals suggests they perceive the potential of socially assistive robots to alleviate workload and enhance patient wellbeing, but also have concerns about technical reliability, maintenance requirements and boundaries of role clarity and responsibility [6]. Similarly to the research on robot-assisted diagnosis of peripartum depression, psychiatrists are recommended to prefer the robots to be utilized for supporting duties such as information gathering and standardized questioning, rather than key clinical judgement [7]. These results show that robots are more appropriate as extra service touchpoints rather than alternatives for mental health experts.

There is thus a need for further synthesis to clarify the place of robots in mental health services for older adults, the supportive tasks they undertake, the division of work between robots, clinical professionals and carers, and the existence of clear handoff mechanisms for risk identification, information transfer, professional referral and human intervention. The literature has thus far focused on social robots, mental health support, care for elderly individuals and human-robot interaction, but these threads are not yet integrated. Yet, a systematic synthesis of robot roles, human-robot collaboration, and responsibility boundaries from a service design viewpoint is still missing.

Service design offers a suitable lens to address this gap. It is concerned with the relationships between actors, touchpoints, processes and supporting systems and considers both the customer experience and the wider service operation. In older adult mental health services, a robot is not a single product or interface, but a potential service touchpoint connecting older persons, clinical experts, family carers, community organizations and digital health platforms. Service phases, frontstage and backstage linkages, job distribution, information flows and service breakdowns can be analyzed with the use of tools such as service blueprints, user journey maps, stakeholder maps and role allocation matrices [8], [9]. By adding a service design viewpoint, the scope of robot study is extended from isolated technical effects to service processes and multi-role collaboration.

In this context, this evaluation looks into human-robot collaboration in mental health services for the older individuals using a scoping review technique. Rather than asking whether robots can provide psychotherapy in isolation or investigating the clinical effectiveness of a specific robotic intervention, the study explores the ways in which service robots can participate as supportive touchpoints within mental health services and how the interaction between multiple roles including robots, older adults, carers, nursing staff and clinical professionals may work together. The review is structured around three research questions: RQ1: What are the key roles and functions of service robots in mental health treatment for older adults? RQ2: What is reported in the existing literature about human-robot collaboration between robots, older adults, clinical experts and carers? RQ 3. What are the gaps of service handoffs, human intervention, professional referral and responsibility boundaries from a service design perspective?

## II. RESEARCH METHOD

This study applies a scoping review technique to synthesize literature on service robots and socially helpful robots in

mental health care for older adults. It does not run a meta-analysis or assess clinical effectiveness of a specific intervention. It does this by systematic searching, tiered screening and topic synthesis to include robot roles and duties, human–robot collaboration, human intervention, professional referral and responsibility boundaries. The review methodology is based on existing scoping review methodologies and PRISMA related reporting thinking [10], [11], [12], [13].

The main database used was Scopus, whereas Google Scholar, IEEE Xplore, ACM Digital Library, PubMed, ScienceDirect and SpringerLink were used as additional databases. The search was done on 8 September 2026, and results were based on Scopus export. The search string in Scopus was:

TITLE-ABS-KEY(

("socially assistive robot*" OR "social robot*" OR "service robot*" OR "care robot*" OR "companion robot*")

AND

("older adult*" OR elderly OR "older people" OR geriatric)

AND

("mental health" OR depression OR loneliness OR "social isolation" OR "emotional support" OR wellbeing)

)

Further refinement of the search was made by limiting to publications published in 2016-2026, English language records and document categories Article, Conference Paper and Review. Computer Science, Medicine, Engineering, Social Sciences and Psychology were the subject areas. A total of 332 records were obtained.

Inclusion criteria included studies of older adults or older adult care settings; studies of service robots, social robots, socially assistive robots, care robots, or companion robots; studies of mental health, depression, loneliness, social isolation, emotional support, well-being, or cognitive support; and studies that could inform analysis of robot roles, task allocation, human–robot collaboration, human intervention, professional referral, or responsibility boundaries. We excluded studies that focused only on technical aspects of industrial robots, surgical robots, control algorithms, path planning, or sensor architecture; studies that did not have an older adult care or mental health context; and studies that focused only on general AI, mobile applications, or digital health tools without a robotic context.

The main screening criteria included titles, abstracts, author keywords and indexed keywords. The first stage involved wide relevance criteria and rejected obviously technical or non-service context records, resulting in 150 research. The second stage concentrated on older adult mental health service robots and highlighted companionship, emotional support, depression, loneliness, dementia care, cognitive support, carers, clinical professionals, or human–robot interaction research, reducing the studies to 70. The third step reviewed the fit with the study topics, particularly evidence related to the roles and activities of robots, human–robot collaboration, service handoffs, human intervention, professional referral, and limits of responsibility. The final sample included 36 core investigations, of which 29 journal publications and 7 conference papers.

The last group of studies was examined using thematic synthesis [14]. Data were extracted for robot type, target users, mental health issue, application setting, robot tasks, engagement of carer and clinical professional, human intervention, professional referral, and responsibility boundaries.

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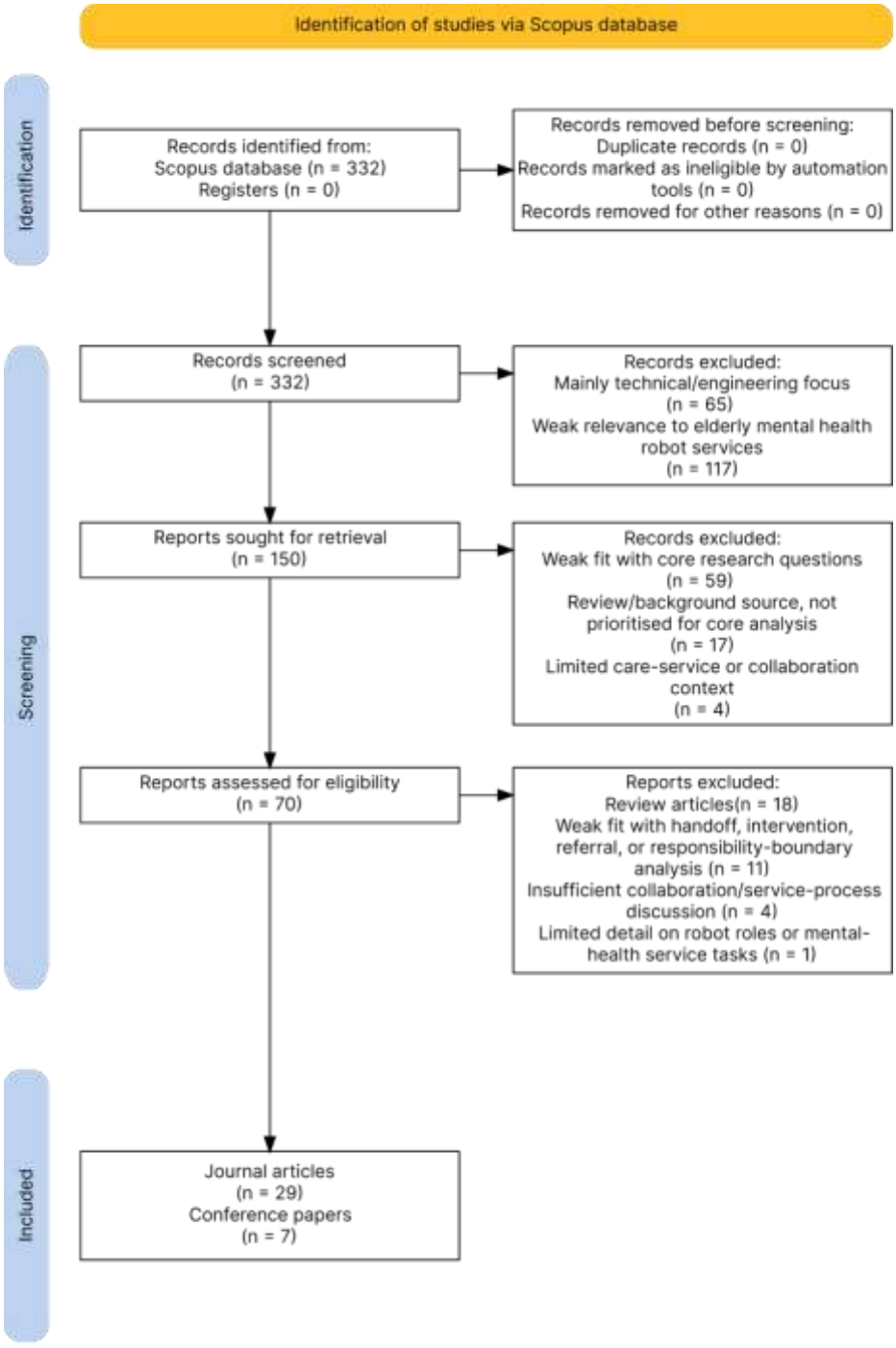



**Fig. 1.** Literature screening process (Source: developed by the author based on the PRISMA 2020 screening framework [12]).

## III. RESULTS AND DISCUSSION

The review comprised 36 studies: 29 journal articles and 7 conference papers. Overall, present research tend not to frame robots as independent diagnostic or therapeutic agents but as supportive service touchpoints in older adult care and mental health assistance. The demographics studied were community-dwelling older persons, people with dementia or mild cognitive impairment, residents of care institutions and older adults receiving home or community care. Most prevalent venues are long-term care facilities, nursing homes, home care, and community services.

The most common types of support provided by robots throughout the included research include companionship,

emotional support, cognitive engagement, daily reminders, information collecting, and aid of care. Key themes for mental health are loneliness, depression, social isolation, emotional wellness, quality of life and dementia support. There is some evidence that socially assistive robots can promote engagement, reduce loneliness and enable emotional expression, but limited evidence on long-term effects, clinical effectiveness and sustained integration in real service systems [15], [16], [17], [18].

Table I outlines the general characteristics of the included research. Rather than reporting individual findings, it synthesizes robot kinds, user groups, application settings, mental health issues, robot roles and important research gaps as a basis for the following thematic analysis.

TABLE I
OVERALL CHARACTERISTICS OF THE INCLUDED STUDIES (SOURCE: SYNTHESIZED BY THE AUTHOR BASED ON THE 36 INCLUDED STUDIES)

| Category | Synthesized findings |
|---|---|
| Included studies | 36 studies: 29 journal articles and 7 conference papers |
| Main robot types | Socially assistive robots, social robots, companion robots, care robots, robotic pets, and humanoid robots |
| Main users | Older adults, older adults with dementia or cognitive impairment, residents of care facilities, home-dwelling older adults, and community-dwelling older adults |
| Main settings | Long-term care facilities, nursing homes, home care, community care, and a small number of clinical settings |
| Mental health topics | Loneliness, depression, social isolation, emotional well-being, quality of life, cognitive support, and dementia care |
| Robot roles | Companion, emotional support provider, activity facilitator, reminder tool, information collector, and risk-prompting touchpoint |
| Main gaps | Insufficient discussion of human–robot collaboration, service handoffs, human intervention, referral mechanisms, and responsibility boundaries |

Table II categorizes the 36 included studies into three topics based on the principal subject of each study and describes the number of studies, research focus, research gaps and exemplary publications within each category. Some research cover more than one theme, and the classification reflects the main contribution of each study.

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TABLE II
Distribution, Research Focus, And Gaps Across The Three Themes (Source: developed by the author based on thematic synthesis of the 36 included studies)

| Theme (n) | Main research focus | Research gaps | Representative studies |
|---|---|---|---|
| Theme 1: Companionship and emotional support 14 studies | Robots support emotional expression, social participation, loneliness reduction, and depression-related support through conversation, greetings, music, games, pet-like interaction, and affective feedback. | Research often remains focused on user experience, acceptance, usability, feasibility, or short-term emotional outcomes; how robot companionship connects to formal mental health services and who should judge, intervene, or refer after risk signals remain unclear. | Albert et al. [19]; Bradwell et al. [20]; Chen, S.-C., et al. [16]; Lee et al. [21] |
| Theme 2: Dementia care, cognitive support, and daily monitoring 12 studies | Robots are used for cognitive stimulation, activity guidance, daily reminders, familiar conversation, behavioral observation, and care routine support for older adults with dementia, Alzheimer's disease, mild cognitive impairment, or those living alone. | How robot-generated information is interpreted and used by nursing staff, physicians, or family caregivers is insufficiently discussed; data flows, professional confirmation mechanisms, and responsibility for interpretation remain unclear. | Amabili et al. [22]; Casey et al. [23]; Nagata et al. [24]; Wu et al. [25] |
| Theme 3: Human–robot collaboration and responsibility boundaries 10 studies | Research examines relationships among robots, caregivers, nursing staff, clinical professionals, and other stakeholders, including robot roles, human oversight, risk prompting, referral, and responsibility allocation within care processes. | This remains the least developed but highly important direction; service handoffs, human intervention, risk escalation, professional referral, and responsibility boundaries are still incompletely addressed. | Hung et al. [26]; Sancarlo et al. [27]; Tobis et al. [28]; Papadopoulos et al. [18] |

For instance, Albert et al. [19] studied the impact of a robot pet companion on the mood of older persons with family carer assistance for companionship and emotional support and Bradwell et al. [20] assessed the use of cheap socially helpful pet robots in care facilities. Chen et al. [16] studied a social robot intervention for depression, loneliness and quality of life in long-term care and Lee et al. [21] on robot interactions among socially isolated older adults in home care. This joint research shows that the companion robots boost mainly the emotional expression and social participation through conversation, greetings, music, games, pet-like interaction and affective feedback.

The 14 studies of this theme nevertheless generally focus on robot companionship, user experience, acceptance, usefulness, practicality or emotional implications and provide relatively little clarification on the way robot companionship link to formal mental health services. Bradwell et al. [29] involved care home residents, staff and family members in user-centered design, and Casey et al. [23] explored perceptions of people with dementia and key stakeholders of the social robot MARIO, but these studies are mostly descriptive in nature about interaction and usage experiences. As such, the research provides relatively little guidance on who should validate the signal, who should intervene and how referral should take place when a robot identifies chronic bad mood, loneliness or other signals of risk.

Amabili et al. [22] studied a social robot-based intervention to manage cognitive decline in dementia care, Nagata et al. [24] studied a conversational robot for cognitively impaired older people living alone, and Wu et al. [25] studied activity engagement with an intelligent humanoid robot in real-world dementia care. Also, the MARIO study of Casey et al. [23] showed that the use of robots in dementia care is connected with not only the direct interaction, but also with the experiences of the carers and other stakeholders.

The findings indicate that robots are well suited to support recurring tasks such as cognitive stimulation, activity direction, everyday reminders, familiar speech and behavioral observation especially in long-term care or home settings. They give us little about how information generated by the robots is taken into consideration when making decisions for care: how the nursing staff, physicians or family carers interpret such information, when professional confirmation is necessary and who is responsible for interpreting the information.

Sancarlo et al. [27] explored the adoption of companion robots by caretakers to understand human–robot collaboration and responsibility boundaries and Tobis et al. [28] studied the influence of stakeholder perceptions on the use of humanoid robots for the care of elderly individuals. Hung et al. [26] examined ethical hazards and boundaries in the employment of social robots to promote older adults' mental health. Lee et al. [6] acknowledged the concerns of healthcare professionals regarding role clarity, technical reliability and duty distribution, but underlined the promise of socially supportive robots.

Overall, the studies imply robots can be good for companionship, reminders, documentation, inquiry and prompting for risk, but diagnosis, treatment recommendations and emergency judgements should remain with human doctors. There is a relative consensus in the existing studies on what robots can do, but less consensus about how humans check robot generated signals, when they should be escalated to nursing or clinical specialists and how referral and follow-up should afterward be established. Hence, from a service design perspective, the main gap is not simply one of technical capabilities, but rather the absence of a clear and continuous human–robot collaboration pathway involving robots, older people, family carers, nursing staff and clinical professionals.

This review develops the human-robot collaboration pathway illustrated in Fig. 2 to further explain the integration of robots in the treatment procedures of older adult mental health. The graphic does not reproduce any existing model, but integrates numerous research views. The overall process structure is built on a service blueprint logic of relationships between users, frontstage service professionals, and supporting processes [8]. Zhong et al. [7] Task allocation and supervision between robots and professionals. Jung et al. [30] Robots as supportive mental health touchpoints. Lee et al. [6] Roles, implementation concerns and responsibility boundaries of carers and clinical professionals. These perspectives are linked with the thematic synthesis of the 36 included research to link the older people, service robots, caregivers/nursing staff, healthcare professionals and formal service channels into a human-robot collaboration process.

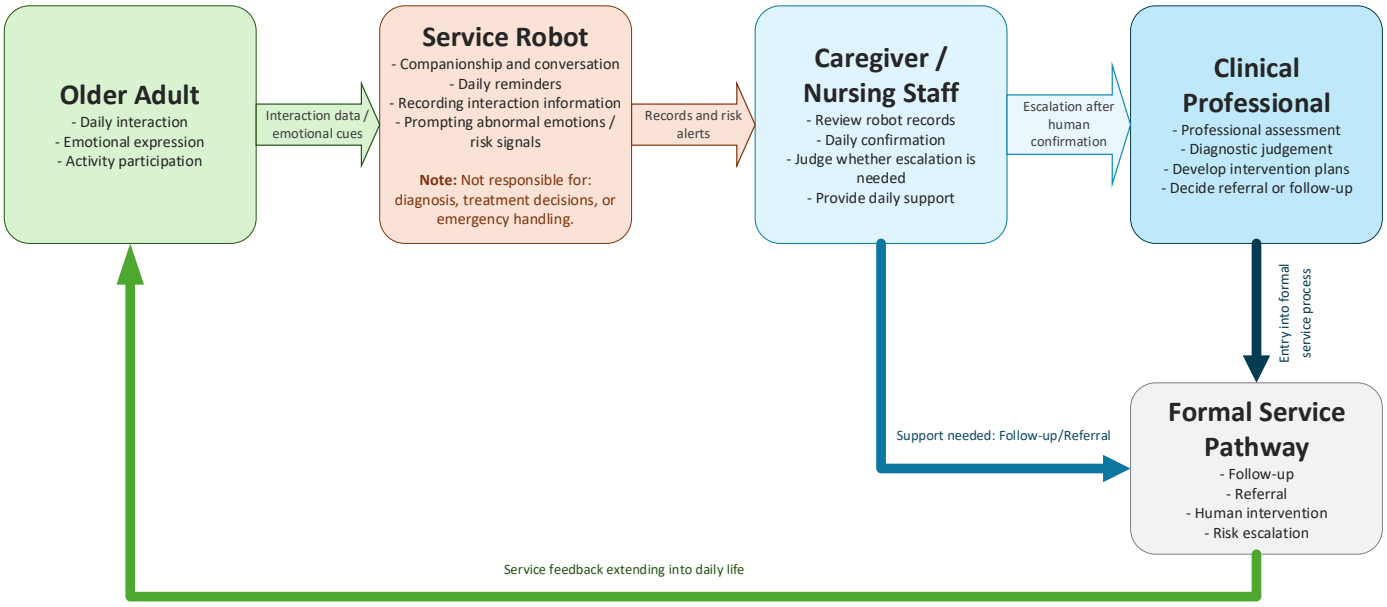



**Fig. 2.** Human–robot collaboration pathway from a service design perspective (Source: developed by the author based on Bitner et al. [8], Zhong et al. [7], Jung et al. [30], and Lee et al. [6], together with the thematic synthesis of the 36 included studies).

The human–robot partnership route from older adults' daily encounters to formal mental health treatments is illustrated in Fig. 2. Older people produce interaction data and emotional indicators via daily speech, emotional expression and activity involvement. Service robots work in the front end of everyday care: companionship and conversation, daily reminders, interaction recording, prompts for abnormal emotional or risk signals. They are not responsible for diagnosis, treatment decisions or emergency handling. Following this, carer or nursing staff analyses and validate robot records and determines whether escalation to clinical professionals is necessary. Clinical professionals are responsible for professional assessment, diagnostic judgement, intervention planning and decisions regarding referral or follow-up.

The "Formal Service Pathway" shown in Fig. 2 describes the services that robot-generated information might enter following human confirmation and professional judgement, including follow-up, professional referral, human intervention, and risk escalation. The pipeline does not end at formal service delivery. Feedback is fed back into everyday life so service outcomes can influence subsequent treatment. Thus, the robot is positioned as a helpful touchpoint that connects daily life to the formal care system, rather than an autonomous medical decision-maker. The main goal of the graphic is to highlight how robot-generated information might flow through human confirmation, professional judgement and formal service response to provide a clearer distribution of responsibility in human-robot collaboration.

A scoping analysis of 36 studies identified key uses, positioning of roles, and gaps in the research of service robots and socially helpful robots in mental health services for older adults. Fourteen research mainly concern companionship and emotional support, 12 on dementia care, cognitive assistance and daily monitoring, and 10 on human–robot collaboration, human intervention and responsibility boundaries. Previous studies have shown the potential of robots to provide companionship, emotional support, daily care, and cognitive help. However, the majority of studies still focus on the direct connection between robots and older individuals. Conversely, there is scant discussion of the integration of robots into entire care processes, the interpretation and validation of information supplied by robots, the timing of human action, and the organization of professional referrals and ongoing follow-up.

## IV. CONCLUSION AND FUTURE DEVELOPMENT

The results show that robots are mainly employed in a supportive position in mental health care for older adults and not as independent diagnosticians or therapists. The most common usage of robots is for companionship, emotional support, cognitive stimulation, activity reminders, daily follow-up and care assistance. Such applications are especially significant in nursing homes, long-term care facilities, home care and community services, where embodied interaction and repetitious assistance may partially compensate for limits in staffing and continuity of traditional care.

But the real question is not whether robots can improve emotional outcomes or user acceptance but what role they should play in the overall service system. There is some movement toward studies that address human-robot collaboration, carer involvement, nursing staff, or other stakeholder views, but just 10 papers on these topics. This is not as developed as research on companionship or cognitive care. In particular, current research does not sufficiently explain how healthcare professionals make use of robot-generated information, how carers are included in risk confirmation, how robot warnings are included into formal referral systems, and how humans and robots share duties.

This is especially the case with mental health treatments for older people. A robot can identify persistent poor mood, increased loneliness or changes in cognitive status through everyday interaction. This information should not be viewed as equivalent to clinical assessment. Service processes need to be clear on who receives the information, who validates the risk, when escalation to nursing or clinical professionals is required and how follow up, referral or human intervention is initiated. Robots are therefore more appropriate as supportive touchpoints for everyday recognition, information gathering and service linkage than as substitutes for professional diagnostic or treatment decisions.

Three directions are suggested for future investigation. First, additional longitudinal studies should be conducted in genuine care settings to explore continued use of robots, maintenance requirements, user adaption and service integration. Second, the division of labor between robots, elderly, family carers, nursing staff and clinical professionals should be clarified. The jobs that can be supported by robots and those that require human confirmation or professional leadership should be distinguished. Thirdly, a more explicit application of service design approaches should be used to assess risk detection, information transfer, human intervention, professional referral, follow-up

feedback and assignment of duty.

Overall, service robots could assist the mental health of older adults, but their future development cannot rely on technical capabilities alone. Research must also explain how robots can be integrated into genuine care procedures, how different service roles comprehend and use them and how clear mechanisms of human-robot collaboration and responsibility frameworks can be formed. The main problem from a service design viewpoint is not just to build a robot that can interact, but to transform it into a service touchpoint that can be accepted, managed and sustained in care systems. This transformation may assist transition older adult mental health care robots from experimental applications to more dependable, sustainable and responsible service practice.

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