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Possible Applications and Conditions for the Development and Integration of Robotic Assistance Systems in the Acute Inpatient Setting from the Perspective of Nursing Professionals: A Qualitative Study

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Abstract
Robotic assistance systems are considered a promising approach to addressing nursing staff shortages and improving the quality of care in acute inpatient settings. Successful implementation requires not only the definition of practical application scenarios, but also the systematic identification of facilitating and hindering factors for real-world integration. The objective of this study was to explore nursing staff's perspectives on the potential application of robotic assistance systems in clinical settings. In a qualitative cross-sectional study, 12 individuals involved in nursing care were interviewed using a semi-structured guide. The questions focused on potential applications and areas of use for robotic assistance systems in acute care settings. The data were analyzed using structuring qualitative content analysis. From the perspective of nursing staff, robotic assistance systems have the potential to add value to acute clinical care. They can be used in various ways, such as transporting materials, meals, and beverages, or supporting nursing staff in prophylactic measures and vital sign monitoring. Additional applications include organizational tasks and documentation. Potential areas of deployment were identified, including surgery, urology, and isolation units. Furthermore, spatial, personnel, organizational, and technological conditions for the development and integration of robotic assistance systems were outlined. The development and implementation of robotic assistance systems in clinical settings are complex undertakings. Institutional and technical conditions must be considered alongside person-centered factors. A user- and benefit-oriented approach to technology development can only succeed if user perspectives are consistently integrated throughout all phases of development, testing, and implementation.

Keywords Assistive robotics · Clinical nursing · Qualitative research

1 Introduction

Demographic change and epidemiological developments pose major challenges to healthcare systems aiming to provide nursing care that is both high-quality and economically sustainable. The nursing profession in particular faces numerous structural pressures, chief among them a growing shortage of qualified personnel. This shortage directly affects daily routines and contributes to an increased perception of workload. Nurses also spend much of their time on paperwork, support tasks, and long walking routes instead of caring for patients. Frequent interruptions—such as requests, alarms, or calls—add to the pressure. As patient numbers continue to rise, these disruptions become more frequent, undermining process efficiency and staff satisfaction, with potentially adverse effects on care quality [1–4].

Against this backdrop, robotic technologies are increasingly being explored as a promising means of supporting high-quality nursing care while reducing the burden on staff. In acute, inpatient, and outpatient settings, robotic systems aim to relieve workload and promote patient well-being—without compromising care standards or replacing essential

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human interaction [5, 6]. This raises two central questions: Which types of robotic systems are suitable for use in nursing contexts, and what kinds of tasks can they meaningfully support in everyday practice?

Robotic systems in healthcare are typically categorized according to their functional roles—such as logistical assistance, monitoring, or social interaction. A central distinction is made between service robotics and socially assistive robotics. Socially assistive systems promote emotional interaction and cognitive engagement, for example through communication or memory-supporting tasks [7, 8]. Service robots, by contrast, are designed to support practical, often repetitive tasks in a (semi-)autonomous way. These systems are commonly equipped with mobility functions, sensors, and programmable task logic [9]. In clinical settings, robotic systems can be used to transport food, beverages, medications, or laboratory materials, to support infection control (e.g. during the COVID-19 pandemic), and to facilitate internal communication [8, 10–13].

However, many robotic assistance systems are still in the development or early testing phases and have yet to be integrated into routine clinical practice. One key reason for this is the insufficient alignment between technical capabilities and the actual demands of nursing care. It is particularly problematic that nursing professionals—although they represent the primary user group—are often only marginally involved in the design of use cases. This shows the importance of participatory research based on real needs and teamwork across disciplines. In addition, systematic studies across different hospital departments are necessary to better understand the context-specific potential and limitations of robotic systems [8, 14, 15].

The REsPonSe project (Robotersystem zur Entlastung des Pflegedienstes von Servicetätigkeiten - Robot System to Relieve the Nursing Service of Service Activities) addresses precisely this gap. The project focused on testing and adapting an existing robot—JEEVES®, originally from the hospitality sector—for clinical use. In combination with the communication app Cliniserve®, the system was adapted to meet the specific requirements and IT infrastructure of clinical nursing environments (see Fig. 1). The central objective was to explore whether such a robotic service solution could help reduce nursing workload—for example by minimizing walking distances and optimizing communication processes [16, 17].

This study aimed to identify potential applications and suitable hospital units for deploying the JEEVES® robot in clinical settings, based on the perspective of nursing staff.

Fig. 1 Service robot JEEVES® ©Robotise AG 2020

The findings provided the foundation for developing a use case, which was subsequently tested in everyday nursing practice [17]. The study aims to strengthen the user perspective in development and support a needs-based, benefit-oriented integration of robotic assistance in clinical care. The central research question guiding this study was:

> *What potential applications and areas of use for robotic assistance systems in clinical patient care can be identified from the perspective of nursing staff?*

2 Method

A qualitative cross-sectional design with an exploratory, descriptive nature was selected [18, 19]. Qualitative methods make it possible to gain a broad, open understanding of the technology's intended use—taking into account various options, perspectives, and contextual factors [20].

2.1 Participants and Setting

Maximum variation sampling was employed to achieve the most heterogeneous sample possible [21, 22]. Variation was ensured across gender, experience, department, qualifications, role (e.g., ward manager), and clinic location. Based on these factors, participants were eligible for inclusion if they met the following criteria:

2.1.1 Inclusion Criteria

- Nursing professionals from inpatient and outpatient clinical settings.
- Nursing professionals with completed training.
- Nursing professionals currently in training.
- Support staff involved in direct patient care.

Table 1 Sample description

Demographics		Quantity $N=12$ (100%)
Gender	female	10 (83%)
	male	2 (17%)
Years on the job (without training)		Range: 1–25 Median: 9
Management position	yes	4 (33%)
	no	8 (67%)
Areas	Internal Medicine	4 (34%)
	Surgery	3 (25%)
	Intermediate Care	1 (8%)
	Outpatient Clinic	1 (8%)
	Emergency Room	1 (8%)
	Changing Areas	2 (17%)

Nursing staff working in outpatient or long-term inpatient care, as well as individuals not directly involved in patient care, were excluded.

Data collection was conducted in two German tertiary care hospitals, each providing partial or full inpatient care to approximately 600,000 patients annually. Recruitment was coordinated by the Institute of Nursing Science and the hospitals' Nursing Practice Development Units. After participants expressed interest, the two first authors contacted them by phone or email. After consent was given, participants received study details and a cover letter via email. A total of 12 individuals from both hospitals participated in the interviews. The composition of the sample is detailed in Table 1.

2.2 Study Context: Project REsPonSe

The study was conducted within the REsPonSe project, which is part of the "Robotic Systems for Nursing" initiative funded by the Federal Ministry of Research, Technology and Space [23]. The study was part of the first project phase, which focused on identifying use cases and analyzing requirements for deploying technology in clinical care.

Use cases were developed based on technical specifications such as robot size, autonomous navigation capabilities, load capacity, and app functions including task assignment, communication functions, and a customizable request interface, as well as current research [8], and user perspectives (Fig. 2). Several scenarios were explored, including deployment on a maternity ward for fetching and delivery tasks, support during patient admission, and assistance in contact-reducing care situations, for example in cases of protective isolation due to chemotherapy, radionuclide therapy, or infectious diseases. From these, one use case was selected for implementation: the support of contact-reducing fetching and delivery tasks on a radiation therapy ward. This use case was tested in a clinical setting outside regular operations, followed by a six-month pilot phase, which was scientifically evaluated [17]. Between both test phases, the technology partners improved system integration and made technical adjustments for use in a real clinical setting.

2.3 Data Collection

Data were collected through guided expert interviews with a narrative-episodic focus. The aim was to elicit both general or comparative experiences and personal situations, attitudes, and viewpoints, conveyed through episodic narration. Linking narrative and semantic knowledge helped place definitions and concepts into context [24]. Experts were defined as individuals with specialized knowledge relevant to the research objective [25]. To support the study's

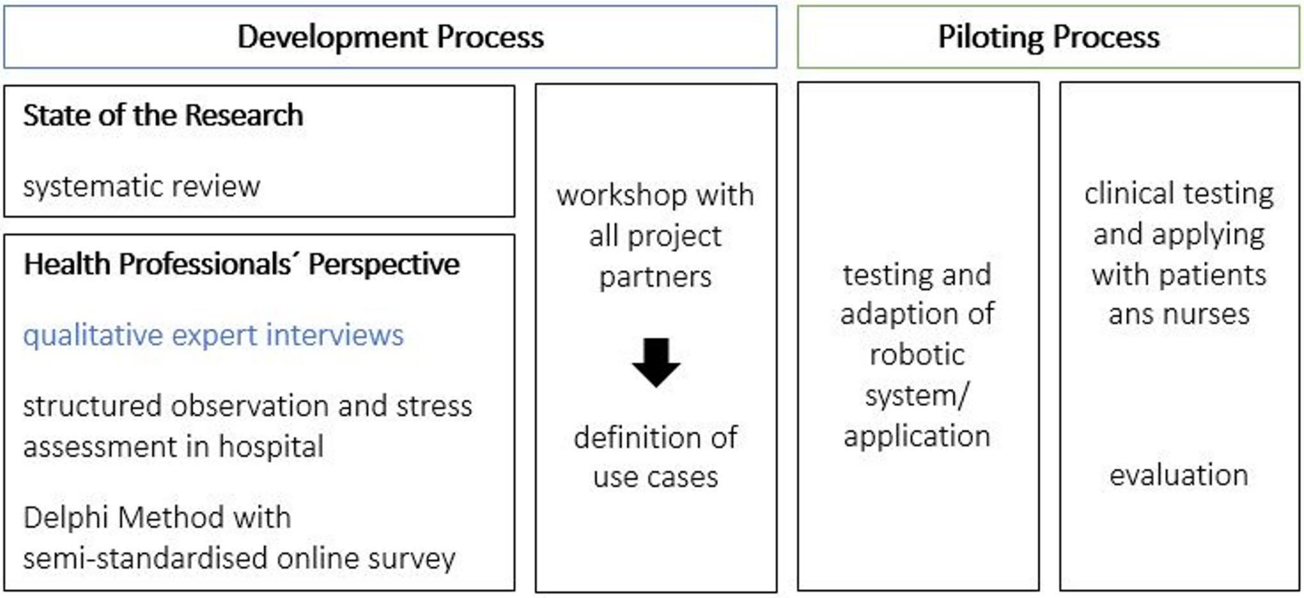

Fig. 2 Project process REsPonSe (own presentation)

Table 2 Topic blocks of the interview guide

Topic block	Aim and content	Sample questions
Potential Use Cases	Identify application scenarios for robotic assistance systems	What application possibilities can you envision under current technical conditions? (Reference to the REsPonSe project).
Future Use Cases	Explore future use scenarios beyond current technical limitations.	What possible applications of robotic assistance systems in patient care do you see in the future?
Attitude and Acceptance	Assess professional attitudes toward robotic assistance systems	What is your opinion on the use of robotic assistance systems in hospitals?

participatory approach, the focus was deliberately placed on users' perspectives.

The semi-structured interview guide was developed using the SPSS method (collecting, checking, sorting, and subsuming) [26]. The guideline was divided into three thematic blocks (see Table 2).

Two pilot interviews were conducted. Afterwards, participants gave feedback on the clarity, structure, and length of the interview. The interview guide was found to be appropriate, and both pilot interviews were included in the final sample. The structure of the interviews followed four phases [27]:

- Information Phase: Introduction to the study purpose, explanation of data protection and informed consent, collection of socio-demographic information.
- Introduction Phase: Initial stimulus using video clips from the REsPonSe project and an open introductory question.
- Main Phase: Five flexible, conversation-based questions based on thematic blocks.
- Closing Phase: Follow-up questions and discussion of any missing topics.

Notes on content and atmosphere were taken during and right after each session. Data collection took place between December 2020 and March 2021. Saturation was reached after 12 interviews. Interviews ranged from 9 to 45 min (average: 26.5 min).

The shortest interview (9 min) reflected the participant's clear and focused view of relevant applications. Despite further questions, the conversation could not be extended. As the content was still valuable, the interview was included in the sample.

All interviews were conducted by the two lead authors (CO and NSt) and audio-recorded. Due to hygiene and contact restrictions imposed by the SARS-CoV-2 pandemic, participants were offered the option of participating via video conferencing (Zoom or Webex), which five participants selected.

2.4 Data Analysis

The data analysis followed the method of structuring qualitative content analysis according to Kuckartz and Rädiker [28] and was conducted using both deductive and inductive approaches. Initially, two deductive main categories—application possibilities and application areas—were derived from the research objectives and the interview guide. In a second step, the entire interview material was analyzed inductively.

The transcripts were processed sequentially. Relevant text passages were identified, coded, and assigned to the main thematic categories. Similar or identical codes were then grouped into subcategories. Inductive subcategories that did not fit the two main categories were grouped separately. This process led to the formation of an additional inductively derived main category: conditions. This approach allowed themes to emerge that had not been anticipated or explicitly addressed in the interview guide [28, 29].

All interviews were transcribed by the two lead authors (CO and NSt), in accordance with the transcription standards of Dresing and Pehl [30]. In line with these standards, speech pauses in the transcripts were marked using one to three dots in brackets—ranging from (.) for a short pause of about one second to (…) for a pause of approximately three seconds.

Both authors coded the data independently using MAXQDA 2022 [31], followed by a consensual coding process. In cases of disagreement, the categories in question were discussed and resolved collaboratively within the research team.

2.5 Ethics and Data Management

The study was reviewed and approved by the ethics committee of the LMU Hospital Munich, Germany (20–0954). All participants provided written informed consent by signing a consent form. Participation was voluntary and could be withdrawn at any time without providing reasons.

The study was conducted in accordance with the General Data Protection Regulation (GDPR). Prior to data collection, approval was obtained from the responsible data protection officer. Audio files and pseudonymized data were stored on a secure university server with restricted access. Access was password-protected and restricted to the research team. Audio recordings were deleted following transcription. Transcripts were pseudonymized using the label "IP" (Interview Partner) followed by a numerical code (e.g., IP1). Consent forms and participant data were stored separately to ensure confidentiality.

2.6 Rigour and Trustworthiness

To ensure quality, Steinke's criteria for qualitative research were applied [32], including intersubjective comprehensibility, process transparency, empirical grounding, limitation, reflexivity, relevance, and coherence. The study was designed and carried out in a transparent and well-documented way. In addition, rule-guided methods were applied [20–22, 26–29], and findings were supported by empirical quotes. The chosen design aimed to foster closeness to the subject and support transfer into practice. Reflexivity was a continuous element throughout the research process, particularly with regard to the researchers' role and their relationship to the field. For transparent reporting, the Consolidated Criteria for Reporting Qualitative Research (COREQ) were followed [33].

3 Findings

Table 3 comprises the developed main and subcategories, along with specific examples. The main categories "Application possibilities" and "Application areas" were formed deductively based on the research questions or the guideline. The main category "Conditions" and all subcategories were developed inductively based on the data.

3.1 Application Possibilities

The interview focused on project-relevant as well as general, project-independent application possibilities. These are summarized and presented below. The application possibilities can be divided into four areas: fetching and delivery activities, nursing and patient-related interventions, organizational tasks, documentation and information.

3.1.1 Fetching and Delivery Activities

Fetching and delivery activities can be differentiated on two levels: by type (tasks vs. materials) and by the individuals involved (nursing staff vs. patients). The respondents can envision the transport of laboratory samples, blood products, medications, and nursing materials: *"Yes, perhaps also errands within the facility, that would also be an idea (.) from one ward to another"* (IP12, Pos. 28) and *"[…] also for transportation tasks maybe, well, often it happens that you quickly need to fetch something from the pharmacy or currently a lot from the emergency center because the (.) items*, etc., *are all dropped off downstairs (.) and especially on weekends, the nursing staff has to go down and fetch the things"* (IP6, Pos. 10). But also robotic systems for the delivery and distribution of meals and drinks were considered: *"Then definitely bring drinks, just as it is described in hotels, that is (.) a few tea glasses, water bottles, whatever, because that is really a lot of walking work"* (IP5, Pos. 15).

The respondents distinguished between two main user groups: nursing staff and patients. Robotic assistance systems could support nurses by acting as mobile ward round carts. The delivery of prescribed medications and other

Table 3 Findings table with main categories, subcategories, and illustrative examples (own presentation)

Main categories	Subcategories	Examples
Application possibilities (deductive)	Fetching and delivery activities	• Transport of laboratory samples, medications, and nursing materials. • Fetching items from pharmacy or storage, especially on weekends. • Delivering of e.g., meals, drinks, and personal items to patients. • Supporting nursing staff with mobile ward rounds and delivering materials.
	Nursing and patient-related interventions	• Assistance with eating, mobility, and patient positioning (e.g., lifting, pushing). • Support for mobilizing patients, e.g., reminding them to walk and tracking progress. • Prophylactic measures, e.g., supporting physiological breathing and movement. • Monitoring and surveillance, e.g., detecting near-falls and tracking vital signs. • Measurement of vital signs (e.g., blood pressure) with automatic reporting of abnormalities.
	Organizational tasks	• Household activities, restocking, and automated orders (e.g., ordering items when stock is low). • Transport or accompaniment of patients (e.g., from ward to CT) and items (e.g., pushing beds, delivering materials). • Robotic assistance for physically demanding tasks (e.g., pushing beds during shifts).
	Documentation and information	• Direct patient communication via digital technology. • Remote consultation e.g., between nurse and doctor (e.g., sending wound documentation for assessment). • Direct digital documentation during nursing tasks.
Application areas (deductive)	Potential application areas	• Conservative and operative areas: e.g., surgery, urology, oncology, paediatrics, gynaecology, maternity, isolation, private ward, emergency department, cleaning/supply. • Support for patients with limited mobility (e.g., after chemotherapy or childbirth).
	Limits for application areas	• Intermediate and intensive care units, emergency departments.
Conditions (inductive)	Public space	• Sufficient space for parking and maneuvering the robot. • Barriers in corridors and lack of automated doors • Robot perceived as a potential obstacle or fall risk. • Need for structural adjustments to enable integration.
	Person-centered factors	Nursing staff-related factors: • Positive competence and adaptability perception. • Restrictive factors: scepticism, language barriers, age. • Concerns about additional workload (e.g., patient training). • Perceived usefulness boosting staff motivation. • Need for comprehensive training and clear instructions. Patient-related factors • Limited use of technology associated with: older age, illness severity, cognitive decline, mobility limitations, impaired vision, and limited technological competence/control. • Younger patients perceived as more competent with technology. • Biographical events, such as experiences in war, may affect comfort with technology (e.g., robots with flashing lights).
	Clinic-specific requirements	• Technical infrastructure: Update technology and expand IT systems. • Hygiene compliance: Meet hygiene standards (e.g., cleaning after patient contact). • Department-specific adaptation: Customize systems for different departments. • Continuous support: Ensure ongoing contact for troubleshooting.
	Technology-specific requirements	• Reliable operation and user-friendly design, especially for non-tech-savvy persons. • Key features: Obstacle detection, voice control, speech output, driving speed. • Safety: Quick removal in emergencies. • Power: Knowledge of charging time, backup power, battery life.

materials directly to the patient's bedside was also discussed. *"When you are, for example, during the rounds, changing a bandage, and then you always need something that is not in the room. That you somehow click, and then the robot starts and brings you (.) dressing material XY (...) without constantly having to leave the room, I think everyone benefits a bit from that"* (IP6, Pos. 30). The patient-oriented scenario has a service character; robotic assistance systems could deliver not only drinks and snacks but also magazines, phone cards, headphones, pillows, and hygiene items to the patients. These scenarios are also attributed with a potential for relief: *"These are just little things, but I do believe that it would be a relief" (IP3, Pos. 6) "and indeed, that it [the robot] can also bring something to the patient, which we don't necessarily have to bring, where they know: Oh, I can press there, the robot comes, I don't have to ask the nurse"* (IP4, Pos. 34).

3.1.2 Nursing and Patient-Related Interventions

The respondents mentioned a variety of patient-related interventions: assistance with eating, mobility, and patient positioning. *"It is, of course, hard work to wash, care for, position, lift, push up someone, so technology could be used, so to speak (.) to cover the strength part, I think that's obvious (.). Support in terms of strength, mobilizing someone or so, so supportive, that would come to my mind"* (IP11, Pos. 20). The use in prophylactic measures to maintain physiological breathing and movement was also mentioned. *"Okay, I could actually imagine it in mobilization. So [...] as a reminder function, that it drives to the patients and says they have to walk now - something like that - that the patient gets up now, can possibly hold onto it like a walker, and then it says [...] he has walked so and so much and such"* (IP1, Pos. 20).

Furthermore, respondents described various monitoring functions, including the detection and prevention of near-fall events using sensors, patient location tracking, and vital sign monitoring. *"So, if it has arms, then it can measure blood pressure for each patient every day [...]. So (.) yes, it would also need a blood pressure monitor integrated ((laughs)). But I can also imagine that [...] Yes, now, I would say, the robot could already take over assisting tasks, so measuring vital signs, that it just drives through and measures each patient once, so to speak, and in case of abnormalities, that it then reports it to the staff"* (IP3, Pos. 30).

3.1.3 Organizational Tasks

In addition to nursing and person-centered activities, organizational tasks that are distant from patients were considered. The subcategory includes tasks such as household activities, restocking, and the execution of automated orders. *"So, also all these orders (.) that's the point that takes up a lot of time and is just totally unnecessary. [...] Either I order it because the robot tells me, okay, the package is empty, or it orders it automatically, and then another robot comes and brings me the package, either I sort it in or (.) it is then sorted in [...]. Or that I can also see right away, okay, how many ampoules do I have, I have five ampoules [...] oh darn, but I need six, (.) okay then I tell him to order more right away. Because that really takes a lot of time during the night shift"* (IP1, Pos. 65–70).

The transport or accompaniment of patients to diagnostic procedures, such as CT scans (computed tomography scans), was also mentioned by interviewees as a potential area of relief. *"[...] driving the patient from A to B, that would be an option, if I may fantasize, so to speak. (.) Patient has to go to CT, is picked up, goes to CT and comes back"* (IP11, Pos. 14). In addition to transport, the respondents noted that robotic assistance could ease physical strain by taking over tasks like pushing beds, which could become increasingly strenuous during busy shifts: *"What simply makes physical work easier for you, because that is a point that actually increasingly (.) yes (.) has a negative impact on us in the hospital because you physically can't handle it in part. If I push 20 beds during the late shift, I'm done. (.) And if, for example, a device helps there and takes half the work off my hands, it's good for my health"* (IP5, Pos. 39).

3.1.4 Documentation and Information

The combination of digital (communication) technology and robotic assistance systems was particularly considered in the subcategory of Documentation and Information. Patients can communicate their needs directly to nursing staff or other professional groups through digital communication technologies, by doing so, walking distances can be reduced and work processes optimized. *"I think that knowing in advance what the patient needs, with the emergency call or other calls, definitely saves time and distance, because you don't have to walk twice if you already know that he needs a bowl, he needs a glass of water, you have to unplug him, then you can take all of that with you"* (IP4, Pos. 6).

Communication between nursing staff and doctors can also be optimized through these means. *"When the doctor is on the move in the hospital, I can (.) take a photo of the wound, for example, I can say (.) what do you think about this, this is my opinion, or if he's sitting somewhere completely different and I tell the wound specialist, should we do this or that, then you could save a lot of paths, not all of them (.) because seeing the person is still something else, that's important"* (IP2, Pos. 22).

One scenario described the use of robotic assistance systems to support nursing rounds: *"For example, if we're doing basic care for someone in the morning, and then we need a body lotion, for example, and the robot is stocked with the items; every station knows what it needs, and then I call him, and then he brings me the body lotion. Then I think: Oh, you enter that right into the system because then you won't forget it later. And then, if I had some kind of display where I enter it right away and it's documented immediately, I think it would also run better, that the documentation just runs better... because it's stressful at noon, and many forget to document it"* (IP4, Pos. 38). This scenario is also associated with a fetching and delivery activity but demonstrates the advantage of direct, digital nursing documentation.

3.2 Application Areas and Limits

Respondents identified several conservative and operative units as potential application areas in acute inpatient care, including surgery, urology, isolation units, supply and cleaning services, private wards, emergency departments, paediatrics, oncology, gynaecology, and maternity care. For example, one participant stated: *"On my ward, with oncology patients, I can already imagine that they, when they're just lying in bed because they're tired, have just had chemotherapy, and simply can't or don't want to get up"* (IP3, Pos. 10), and another mentioned, *"I could imagine it very well in gynaecology, usually, maternity patients, they are usually cognitively fit"* (IP1, Pos. 47).

On the other hand, the areas of intermediate care and the intensive care unit were discussed with caution: *"Everything from IMC onwards, I would be more cautious (.). Because there, the patients are very sick, and I believe that it makes sense for all activities to be carried out by humans, just to notice a change"* (IP12, Pos. 14), and "[…] *where I couldn't imagine it at all is, of course, somewhere in an intensive care unit (…) it's difficult to imagine there because you usually have ventilated patients"* (IP1, Pos 47). In the emergency department, services for patients were endorsed. *"Yes, the emergency department, I could imagine that as well. […] Especially since the waiting time is so long. For example, drinks could be delivered"* (IP8, Pos. 14). Other than this application, the use of the robotic assistance system in the emergency department is viewed critically due to the stressful work environment.

3.3 Conditions

In addition to the deductive categories "Application possibilities" and "Application areas," the analysis also identified an inductive main category: "Conditions." Participants emphasized the importance of considering spatial, person-centered, clinic-specific, and technology-related factors when developing and integrating robotic assistance systems.

3.3.1 Public Space

As a prerequisite for effective and sustainable integration, participants emphasized the need for adequate space: *"So you would need the space accordingly (…) spatially speaking, where can you park it best, what are the possibilities?"* (IP5, Pos. 33). This is due to narrow corridors, missing features such as automatic doors, and the fact that the robot itself can be perceived as an obstacle. *"Because I would have seen it as a disruptive factor, as the patient walks down the corridor, he might not see it"* (IP5, Pos. 9), and "*[…] then you might have your risk of falls again*" (IP7, Pos. 14). To integrate robotic assistance systems in hospitals, "*[…] you would have to change quite a bit spatially*" (IP7, Pos. 30).

3.3.2 Person-Centered Factors

The person-centered factors relate to both the care-dependent individuals and the nursing professionals.

3.3.3 Nursing Staff-Related Factors

Nursing professionals perceive themselves as competent in operating robotic assistance systems: *"I am now in a generation that has grown up a bit with it, (.) or has gotten it early on and (…) I believe it would work. So (.) I think if you have the willingness for it, then it's doable"* (IP6, Pos. 26). They also attribute competence to their team members in handling new technologies: *"I would generally consider us competent (…) So, yes, I believe in us, I could imagine that my team can handle it and apply it"* (IP3, Pos. 18).

Restrictive factors mentioned include general scepticism towards new things, language skills, and the age of nursing professionals. *"Especially with the slightly older generation, I see it as more challenging, (.) there's a bit of a lack of this know-how, this general sense of how to deal with technology"* (IP1, Pos. 82). Furthermore, participants noted that technology should not lead to additional burden: *"And the moment the patient presses the wrong button, of course, the nursing staff has more work. […] This happens even with patients who are not cognitively impaired. So practically for the nursing staff working there, cognitively impaired patients have to be accompanied, which means more work than it originally was. So you always have to weigh: What do I want with the service and what does it bring me? Or does it basically just bring me additional work because I have to care for and accompany the patients who are restricted in a different way?"* (IP11, Pos. 4). For a successful development and testing of robotic systems, the intrinsic motivation of nursing professionals must be aroused because *"[…] it always has to be made palatable to the staff or you really have to see what the advantage is"* (IP6, Pos. 14). A *"[…] basic prerequisite is always communication, like how do the people from the companies developing these systems instruct the caregivers?"* (IP9, Pos. 36).

In the context of testing and integrating robotic systems, one participant emphasizes that *"[…] the introduction of the whole thing and the training of those affected must be well thought out (…) and should happen several times, not just once" (IP12, Pos. 50).* In addition to training nursing professionals, instructing patients was also emphasized: *"That you somehow instruct the patients well or that you can give them a relatively compact overview, what can be done, how to deal with it, without taking up too much time and that it is understandable, even for different age groups. (…) That all roles are included there."* (IP6, Pos. 22). One participant noted that training patients is an additional task for nursing professionals, which means an additional workload.

3.3.4 Patient-Related Factors

According to the participants, the use of robotic assistance systems can only occur by taking patient-related factors into account. The health condition, age, competencies, and biography of the patients were deemed important.

As a prerequisite for the use, the health condition of the patients is mentioned: *"[...] regardless of whether it's cardiology, gynaecology (...) urology or so, I can imagine this very well, because they are basically all fit"* (IP10, Pos. 10). In contrast, patients beyond a certain degree of illness are considered unsuitable for handling robotic systems, as *"[...] patients who are very severely restricted (...) due to their illness, let's assume stroke, chemotherapy, are sometimes massively overwhelmed with such systems"* (IP 11, Position 4). Continuing from there, factors such as visual impairments, mobility status, and the degree of care dependency must be taken into account. *"Very old patients who are also (...) totally in need of care, I believe, for them, I cannot imagine that it would work because (...) they are probably overwhelmed by the robot "* (IP3, Pos. 10).

From the perspective of the interviewed professionals, age was described as a continuum in relation to the use of new technologies. Younger patients were generally perceived as more competent in handling robotic technologies. In contrast, one participant referred to middle-aged and older adults, stating: *"[...] this transitional generation, let's say everyone who is now maybe (.) between 40 and 60, if I think back then, my parents' generation and my grandparents, they find it difficult"* (IP 5, Pos. 21). This sentiment can be summarized with the following quote from a participant: *"A normal patient on a surgical ward, I assume (.), where there are no older people, where many young people are operated on, such an automatic, such a drink transporter or another service system is certainly feasible. Everywhere patients (.) are, be it in the outpatient area, on the ward, (.) where many older patients are lying [...] they are sometimes massively overwhelmed by such systems"* (IP1, Pos. 4).

In addition to physical conditions, cognitive abilities also play a role. The use was favored for individuals who are *"cognitively capable"* (IP12, Pos. 12). In contrast, the use in people with cognitive or dementia-related illnesses was viewed critically: *"Demented patients (...) confused patients (...) that immediately comes to my mind, how they should deal with the systems"* (IP12, Pos. 8).

The competence to operate the technology is also important because *"there are always those who can handle it and those who cannot"* (IP 2, Pos. 10). One interviewee pointed out that many older adults may struggle with the increasing complexity of everyday technologies: *"[...] the red button, everyone can manage that, almost everyone can do that, but many already have difficulties when it comes to things like the television, where everything is actually on the screen, where you just have to press a button. That is already a change for many. Or how does it work with the phone card"* (IP 9, Pos. 16). Additionally, the technology acceptance of the patients plays a role: *"Can they operate it, or are they perhaps afraid of this device or don't dare to touch it"* (IP 5, Pos. 21).

An interviewed person mentioned biographical events as a factor to consider. *"Especially with older individuals who may not be cognitively impaired but have experienced a lot in the wars, I would say if Robbie* [nickname for the robot] *comes by at 12 midnight with his nice flashing light on, it could become a bit unpleasant"* (IP12, Pos. 18).

3.4 Clinic-Specific Requirements

The participants discussed various requirements that should be considered by the clinic in the development and integration of robotic assistance systems. Generally, *"[...] the technical conditions would need to be updated or fundamentally given"* (IP9, Pos. 26). In addition to adapting to existing technology, expanding the clinic's internal IT infrastructure was mentioned: *"The only problem I see here (...) is our IT system and everything"* (IP 10, Pos. 2) and *"[...] then simply the network utilization and the possibilities of digitization in our house"* (IP2, Pos. 38).

In addition, compliance with hygienic guidelines is crucial: *"It* [the robotic assistance system] *was on the patient* [in contact with the patient] *(...) that means I would have to do a post-cleaning after every patient because I sent the device from A to B to C, and it basically distributes germs - not necessarily assuming COVID, but normal germs"* (IP11, Pos. 6).

Robotic assistance systems should be tailored to the needs of different departments and tested in real-world practical scenarios. *"I believe it will be quite difficult to implement this universally across multiple stations because it varies from station to station, depending on what you need"* (IP3, Pos. 38), and *"[...] that you try and say, okay, it works in this unit, it doesn't work in another unit. (...) It has to be looked at individually, I cannot say it works or it doesn't work"* (IP2, Pos. 28).

For a sustained implementation of robotic systems in a clinic, participants pointed out the need for a continuous point of contact. *"There should always be a contact person available if the technology doesn't work or if there are issues, even on weekends. (...) So, it needs to be somewhat secured, that in case of problems, there is a contact person available"* (IP6, Pos. 22).

3.5 Technology-Specific Requirements

For the participants, it was important that the technical functionality is ensured. This has an impact on motivation because *"[...] if something doesn't work or there is some technical issue, that one can quickly find solutions (...) exactly. That's the only thing, that when something new is introduced, often the technology doesn't work initially, and then, of course, frustration sets in"* (IP6, Pos. 14). Regarding technical functionality, the ease of use of robotic systems is crucial: *"In principle, they should be easy to use, as easy as possible (...) so that you don't struggle too much to get into the topic, especially people who are not so technically adept"* (IP9, Pos. 22).

Important technical features mentioned include obstacle detection, acoustic signals, driving speed, voice control, and speech output. *"Because it can't speak, i think that's still a thing: Now this thing is coming, but it doesn't speak to me. I do get my needs fulfilled through it, but I don't get anything back. (...) I don't know if in the future somehow you can still incorporate a bit of voice control, just certain phrases like: Here is your newspaper, here is your water"* (IP5, Pos. 31).

In addition to functional aspects, ensuring safety was mentioned. For individuals with visual or hearing impairments, an autonomously driving assistance system can pose a safety risk. In the case of urgent patient transport during an emergency, such as a resuscitation, corridors must be quickly cleared of objects. *"If you then have an emergency CT or a new patient arrives on the ward and you have to resuscitate there, however. I don't think it can get out of my way quickly, and then I would just have it more as ballast somewhere in the way"* (IP5, Pos.19). Therefore, it is crucial *"[...] that it can be quickly moved out of the way"* (IP1, Pos. 78).

Additionally, questions have arisen regarding the location of the robot on the ward, power supply, and battery capacity: *"Do they have backup power generators, what is the charging time? [...] How do they even get their power? Are they then parked somewhere overnight? [...] Accordingly, I believe it also depends on how long the battery life is, how effectively I can use it on the ward, and how long it takes to charge?"* (IP5, Pos. 23–25).

4 Discussion

4.1 Summary of Key Findings

This section provides a brief summary of the main findings. The identified application possibilities for robotic assistance systems can be categorized into four domains: fetching and delivery tasks, nursing and patient-related interventions, organizational activities, and documentation and information processes. Robots were also seen as useful for service-oriented tasks in routine hospital operations, beyond direct nursing support. Various departments—such as oncology and gynaecology—were identified as potential application areas, while use in intermediate or intensive care units was viewed more critically.

These findings illustrate the diversity, complexity, and creativity of possible applications for robotic systems in clinical settings. The described use cases offer a portfolio of ideas that may guide the development of concrete implementation scenarios. Requirements for development and integration were identified on four levels: spatial, personal, organizational, and technological. These results highlight the importance of user- and benefit-oriented development processes grounded in clinical reality.

The results form part of a broader, multifaceted development and implementation process. Early user involvement helped identify relevant use cases and reveal expectations and requirements for successful implementation in hospital care. In retrospect, the qualitative approach proved effective for generating these insights.

4.2 Application Areas for Robotic Assistance Systems

The findings of this study highlight the diverse potential of robotic assistance systems in clinical care. Participants described a wide range of applications that go beyond simple task delegation and reflect the complexity of everyday care. These use cases vary depending on clinical setting, task type, and the roles of those involved. The next section discusses these application areas in more detail, focusing on practical relevance, contextual factors, and user expectations.

The identified application scenarios can be classified—similar to Maalouf et al. [7]—according to their practical benefits and technical functions. Most described use cases fall into the category of partially or fully automated service robotics, as defined in current literature [34].

Several of the reported applications align with existing evidence. These include logistical tasks like transporting meals, drinks, medications, and lab samples, as well as vital sign monitoring and nursing support such as mobilization [8, 34, 35]. The findings from Horstmannshoff et al. [16] further suggest that selected applications may be transferable across different care settings [16]. In both acute and long-term inpatient care, potential users envisioned robotic systems supporting mobility, transporting items, or serving meals and drinks [8, 16, 34, 35].

Nonetheless, the potential for transferability should be viewed critically. Bedaf et al. [36] and Maibaum et al.

[33] argue that the requirements for robotic systems vary significantly depending on the specific context of use. Forcing mechanized care concepts onto practice can lead to poor system design. This is especially true when adapting systems originally developed for home care to hospital environments, where the needs of individuals must be reconciled with the expectations of larger user groups [33, 36].

Notably, participants mentioned isolation wards as a potential field of application for robotic systems—particularly in situations requiring reduced direct contact. Although pandemic contexts were not explicitly referenced, these considerations resonate with findings from Bartosiak et al. [13], which show that robotic systems can improve communication between healthcare professionals and patients in such scenarios, while also enhancing perceived safety by reducing exposure risks. This highlights the potential value of robotic assistance in exceptional care settings, particularly when it comes to supporting communication and information flow under constrained conditions [13].

Furthermore, entertainment-related functions have thus far been primarily associated with socially assistive systems in home care settings. These include features such as games, music, or interactive activities aimed at supporting emotional well-being [37–39]. Although not mentioned in this study, such features could help reduce monotony and promote psychosocial support in hospital settings.

Finally, while existing literature emphasizes the general applicability of robotic assistance systems in clinical, long-term, and outpatient care settings [37–41], this study is among the first to explicitly identify critical or unsuitable application areas. Participants voiced reservations regarding the use of such systems in intermediate care, intensive care units, and emergency departments—citing patient acuity, time pressure, and safety concerns as limiting factors. These perspectives add important nuance to the broader discourse on the integration of robotic systems in clinical environments.

Based on these differentiated perspectives, the study also contributed to developing a practical use case in the REsPonSe project. Informed by user perspectives and contextual conditions, a scenario was designed for a radiation therapy ward, focusing on logistical support and communication processes. The results further contributed to adapting a service robot originally developed for the hospitality sector and integrating it into a real-world clinical environment—aligning its technical features with the practical needs of nursing care [17, 42].

4.3 Implementation Requirements and Contextual Factors

The successful implementation of robotic assistance systems in clinical nursing care depends on a wide range of technical, organizational, individual, and emotional factors. The present findings add to existing research by clarifying key requirements and conditions for developing and integrating robotic systems from the user perspective.

A core prerequisite for integration is the technical reliability and safety of the systems. Christoforou et al. [5] point out that technologies used for detection, localization, and navigation in industrial contexts cannot be readily transferred to dynamic environments such as hospitals or private households. Particularly in clinical settings, autonomous robotic behavior poses challenges, as existing safety concepts from industrial environments must be adapted to the complexity and unpredictability of care processes [5]. These challenges became particularly evident in relation to structural conditions: participants mentioned narrow corridors, missing automatic doors, and limited space as obstacles to implementation. In addition, hygiene standards and fire protection regulations were mentioned as central requirements for a realistic and safe integration.

A key factor for user acceptance is the perceived usefulness of the system. When its functions are experienced as helpful and workload-reducing, motivation for use increases—especially if it contributes to improved care quality or streamlines routine tasks. In contrast, unclear responsibilities, technical problems, or overly complex operation can cause frustration, uncertainty, and rejection [41, 43]. The findings of this study further highlight the importance of targeted training and clear, comprehensible information. Frennert et al. [44] additionally point out that uncertainty and perceived lack of competence in dealing with technology remain recurring challenges. Successful implementation therefore requires not only initial training, but also ongoing support, peer exchange, and accessible learning opportunities [44].

Another crucial aspect of successful implementation is the usability of robotic systems and their adaptation to the individual needs of users. Prior studies emphasize that both the design and the perceived friendliness of human-robot interaction play a key role in shaping acceptance. Physical, sensory, and cognitive limitations—as well as varying degrees of technological affinity and prior experience—must be taken into account. Addressing these individual factors can support the development, application, and long-term integration of robotic systems in diverse care settings [38, 40]. These findings support earlier research and add a new perspective: individual factors such as technology biography, age, and health status strongly influence how robotic systems are perceived and accepted. Notably, technology use was not described solely as an individual task. Participants viewed technology use as socially embedded, reporting experiences of peer learning, mutual support, and informal exchange within teams and with patients. The data thus point to socially situated dynamics of learning and appropriation in the context of technological systems. These assumptions are further supported by a study by Hwang et al. [45], which illustrates that the process of technology appropriation—for example, among people with dementia and their relatives—is a collaborative and multifaceted endeavor. In this context, practical competence, empathy, and a supportive social environment all play an essential role. The study shows that successful technology adoption is a complex process that requires more than one-time training and must be embedded in social interaction [45].

Emotional factors also play a crucial role in how people engage with new technologies. In this study, emotional responses already emerged during the anticipated use of robotic systems: positive emotions such as curiosity, trust, and enthusiasm fostered a willingness to engage, whereas unclear processes or difficult-to-understand functions led some participants to express irritation, uncertainty, or rejection. As shown by Bartosiak et al. [13] and Franke et al. [41], emotional responses are not peripheral but central to technology acceptance. For this reason, they must be actively addressed in the design and implementation process [13, 41].

The discussion underlines the need for co-creative and participatory development approaches. Stegner et al. [20] argue that the early involvement of users—particularly through qualitative methods and real-world testing—can foster trust and improve the adaptability of technical systems [20]. The findings of this study support this perspective: participants described their involvement in the development of specific use cases as practice-oriented and valuable. However, it should be noted that the present study does not follow a participatory research design in the strict sense. Although these users were systematically involved through interviews during the development phase, their direct participation in later project stages remained limited. During the later phases of the project—particularly within the pilot phase on the radiation therapy ward—user perspectives were actively incorporated into the further development and adaptation of the system. This highlights the importance of embedding participation not only at the beginning, but throughout the full course of technology implementation [46, 47].

4.4 Limitations

One methodological limitation of this study is the potential for non-responder bias [48]: individuals with a generally positive attitude toward innovative technologies are more likely to participate in related research. This was also evident in the present study: most participants already expressed strong interest in the topic before joining the study, while some individuals with more critical views actively declined to take part. As a result, it is possible that sceptical perspectives on robotic systems were not captured in sufficient depth—an aspect that should be taken into account when interpreting the findings. Future studies should actively include participants with critical views to capture a broader range of perspectives and reduce bias.

Only participants from large tertiary care hospitals were interviewed; individuals from smaller clinics were not included. Nevertheless, the sampling strategy was designed to include participants from a variety of departments and roles. The selected analysis method enabled both deductive and inductive approaches. Reconstructive methods could also help explore relationships between categories while considering context and interaction complexity.

4.5 Recommendations

Based on the study's findings, the following recommendations are derived for future research and practice:

1. Early Involvement of Potential Users and non-clinical Robotics in Healthcare Robotic systems originally developed for non-clinical or service-oriented environments can offer valuable potential in healthcare settings. However, successful adaptation depends on early and ongoing involvement of users. Their perspectives contribute to the development of relevant and context-sensitive use cases and help to identify practical barriers to implementation.

2. Addressing both Applications and Conditions for Development and Integration The development and integration of robotic assistance systems are multifaceted processes that extend well beyond technical considerations. It is essential to consider person-specific factors as well as spatial, institutional, and organizational conditions. Development and integration should be seen as interconnected phases to ensure that systems can be embedded effectively into real care settings.

3. Integration of Theoretical and Methodological Frameworks This study highlights that the development and implementation of robotic assistance systems in nursing care constitutes a complex undertaking, encompassing interrelated technical, organizational, and social dimensions. As such, these processes require a structured, theory-informed, and context-sensitive approach. We recommend that interdisciplinary research teams engage early and consistently with appropriate frameworks, such as Care-Centered Value-Sensitive Design (CCVSD) [49] or the Nonadoption, Abandonment, and Challenges to the Scale-up, Spread, and Sustainability (NASSS) framework [50], to systematically identify both conceptual, practical, and ethical barriers and enablers throughout the entire research and development process.

We also encourage a critical reflection on nursing theories to explore the core of nursing and the characteristics of good nursing practice in light of current technological innovations. This reflection is essential to ensure that technological developments align with core care values and goals, and that nursing not only adapts to innovation but plays an active role in shaping it.

5 Conclusion

Robotic assistance systems represent a complex and evolving field of research and development that requires interdisciplinary collaboration and a deep contextual understanding. Interdisciplinary teams must develop a shared language and a practice-oriented, sensitive approach to nursing realities and those involved.

This study demonstrates how qualitative methods can provide meaningful insights into user needs and support co-creative technology development. Such methods help to identify relevant application areas, define requirements, and uncover potential barriers to implementation. Crucially, robotic systems must be tested and evaluated under real-life conditions to ensure they are aligned with the realities of daily nursing practice. Only then can usability, functionality, and relevance be assessed in line with real care processes.

Future research should therefore focus more strongly on situational and interactive care practices and integrate real-world testing as a core element of technology development. Additionally, the perspective of informal caregivers and relatives—who often play a central role in the care process—should be more systematically included.

Forward-looking robotics in nursing must be more than technological advancement—it must be designed with social responsibility in mind, grounded in practical relevance, and developed to support both care delivery and the people at its centre.

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Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Ethical Approval The study was reviewed and approved by the ethics committee of the LMU Hospital Munich, Germany (20–0954).

Consent to Participate This study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of LMU Hospital, Munich, Germany. All participants were informed by written informed consent. The consent was given by signing the form. The participation was voluntary and could be withdrawn at any time without giving reasons.

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article. The companies who provided the technologies were part of the research projects but were not involved in study designs or analyses.

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