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Needs-based selection and prioritization of Technologies to Aid and Assist Nursing Staff in Inpatient Care of Elderly

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Abstract: Inpatient care facilities globally are facing a critical shortage of staff, posing significant challenges to resident well-being and care quality. This issue is further compounded by demographic shifts and increasing care demands. While technological advancements offer promise in alleviating nursing staff burdens, their effective integration remains complex, with nursing staff acceptance playing a pivotal role. This paper describes a systematic approach designed to streamline the process of identifying, categorizing, and prioritizing suitable technologies in inpatient care settings. By taking into account the specific needs and requirements of nursing staff, this approach, validated through a comprehensive case study, aims to facilitate targeted technology adoption, thereby contributing to the successful digitization of this occupational domain.

Keywords: inpatient care, nursing staff, technology, technological solutions, technology selection, categorization, prioritization

1 Motivation

One of the biggest social challenges of upcoming fifteen years will be to ensure that people in nursing and elderly homes will continue to receive professional care in the future. Due to well-known demographic reasons professional nursing staff is cur-

rently the scarcest resource, as the number of elderly people in need of care will increase in the near future while the number of available nursing professionals cannot be increased in the same ratio [1]. The overarching goal of the “Pflege 2030” project [2] is to address these staffing shortages and ensure continuous professional care in nursing and elderly homes. This involves several sub-projects, including the realization of a novel personnel assessment procedure (sub-project A) and the implementation of suitable technologies in a retirement and nursing home (Haus Curanum Karlsfeld, Germany) to reduce the workload of nursing staff (sub-project B). However, while it cannot be assumed that the shortage of professional nursing staff will be completely mitigated by technological advancements, it is still plausible that the availability and seamless integration of appropriate technologies could alleviate or redistribute the workload of nursing staff [3].

The specific goal of this paper, within the context of sub-project B, is to describe the approach of identifying suitable technologies for a care facility that are tailored to the needs of the nursing staff. This process of technology selection, categorization and prioritization was performed in the first phase of the project, based on team interviews, a novel categorization scheme [4], and the use of an online prioritization tool.

2 Methods

A user-centred, needs-oriented selection process was designed based on findings from technology acceptance research [5]. Following an initial screening of available technologies (Section 2.1) with the potential to support and alleviate the workload of nursing staff in their daily tasks, a requirement analysis was conducted (Section 2.2), followed by a categorization (Section 2.3) and prioritization (Section 2.4) of the identified technologies.

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2.1 Available technologies

The first step involved screening available technologies based on their potential to alleviate the workload of nursing staff while enhancing the quality of care provided to elderly residents. The available technologies for aiding and assisting nursing staff in inpatient care of the elderly were identified through a comprehensive review process. This included a combination of literature review, consultations with technology experts and assessments of existing technological solutions in similar care-giving settings.

2.2 Requirements

A requirement analysis was conducted by a user-centred workshop involving $n = 23$ participants of the nursing staff at *Haus Curanum Karlsfeld*. Participants were asked to identify their daily workflow challenges based on a table addressing the following care function areas: physical tasks, social & emotional tasks, monitoring, documentation, work organization & communication. Furthermore, they were requested to highlight technologies that they found "interesting" as well as "helpful". The employees' requirements for potential technologies to support and alleviate their workload were also addressed.

2.3 Categorization

Within a recent report [4] a scheme for categorization has been proposed. Specifically, the categorization is based on a technology matrix, wherein relevant technologies are categorized on one axis according to the care function areas (physical tasks, social & emotional tasks, monitoring, documentation, work organization & communication), and on the second axis on technology types (information & communication, sensor, and automation (robotic) technologies) [4]. Following the initial requirement analysis, this scheme was used to match the identified challenging workflows in various care function areas with the technology needs of the nursing staff.

2.4 Prioritization

Based on the identified catalogue of technologies and the categorization scheme (Section 2.3), an evaluation and selection process was carried out by panel consisting of ($n = 9$) representatives and staff from the care facility (*Haus Curanum Karlsfeld*), as well as technology experts and researchers, in order to ensure a comprehensive and balanced assessment. Each member of the panel was given sufficient information

about the technologies to be evaluated (technical specifications, potential use scenarios) and individually assessed them on the established criteria [4] derived from the requirements workshop. These criteria encompassed various aspects across the levels of "technology" (such as functionality, usability, interoperability, reliability & maintenance, data privacy, costs), "socio-ethics" (ethical & moral standards, accessibility, ethnic & cultural sensitivity), as well as "organization" (alignment with the facility's goals, relief for nursing staff, conditions of facility, acceptance & support of the stakeholders).

The evaluation was conducted using a 6-point scoring system ranging from 1 = 'strongly disagree' to 6 = 'strongly agree'. Hence, in the overall assessment each technology could attain a minimum of 13 and a maximum of 78 points. In order to establish which technologies should be prioritized, a threshold of $\theta = 59$ points (equivalent to 75% of the maximum achievable score) was defined. Using these measures an overall scoring and ranking was created.

3 Results

As depicted in Figure 1, in our case study, the highest overall ratings were given to (1) 'mobile documentation' (74 points) and (2) 'speech-based documentation' (69 points) (both part of the 'documentation' category) as well as (3) 'digital medication management' (71 points) (from the 'work organization & communication' category). Also, representatives of the other categories were selected, namely (4) fall detection (68 points), (5) night light sensors (66 Points), (6) digital planning & communication tool (66 points), (7) digital wound documentation (64 points), (8) digital games for mental activation (64 points), (9) digital incontinence products (63 points), (10) a cleaning robot (61 points) and (11) movable toilets (60 points).

3.1 Identified Technologies

As – with the sole exception of the movable toilet – none of the identified technologies are able to function without the support of a high-fidelity Wi-Fi system (and such wireless possibilities were also identified as a communication bottleneck during the recently passed Covid-19 pandemic), such a Wi-Fi system has been added as core technology (see Figure 2, left). In the following, each of the identified and selected technologies will be described briefly.

1. Mobile documentation using mobile devices such as smartphones or tablets and specialized apps allows the nursing staff to record patient information at the point of care (as e.g.

	Technologies considered important by 1-2 groups (in the requirements workshop)										Technologies considered important by all groups									
1 = strongly disagree 6 = strongly agree	height adjustable toilet	voice assistant	tablets for communication with relatives	night light sensor	teleconsultation	digital information of weather for residents	cleaning robot	smart incontinence products	robot for entertainment	digital activity games	digital wound documentation	voice-based documentation	digital care documentation via Tablet	digital collaboration & task organization	digital medication management					
	service robot					fall detector														
functionality	4	4	3	3	5	4	5	3	4	5	3	4	5	6	6	6				
usability	4	5	5	5	6	5	6	5	6	5	4	6	5	6	5	6				
interoperability	5	2	4	4	5	3	4	5	5	4	6	5	5	5	4	5				
reliability/maintenance	3	5	4	4	5	4	5	5	5	5	3	5	5	5	5	5				
data privacy	4	6	2	5	5	5	5	5	4	5	4	5	5	6	6	6				
costs	3	3	3	3	4	5	4	4	5	5	4	4	4	5	5	5				
ethical and moral standards	4	5	4	4	6	5	6	5	5	5	3	6	4	6	6	6				
accessibility	4	6	5	5	6	4	6	4	5	5	4	5	5	5	5	6				
ethnic and cultural sensitivity	5	6	4	5	6	5	6	6	6	6	5	5	4	6	5	6				
alignment with the care facility's goals	3	4	3	4	3	4	6	3	5	5	3	5	5	6	6	6				
relief for caregivers	4	6	2	2	4	5	4	2	2	4	4	4	6	6	6	6				
conditions of the care facility	3	3	5	5	4	4	5	5	4	5	4	5	5	6	6	5				
acceptance and support of the stakeholders	4	5	5	5	6	4	6	5	5	5	4	5	5	6	6	5				
Sum	50	60	49	55	66	56	68	58	61	63	51	64	64	69	74	71				

Fig. 1: Rating and prioritization of technologies considered important by 1-2 groups (left), and considered important by all groups (right)

directly at the bedside), update medical records, and communicate with colleagues efficiently, thereby streamlining documentation processes and improving overall workflow [6].

2. Speech-based documentation involves the use of voice recognition technology to transcribe spoken words into written text [7]. This technology allows nursing staff to verbally dictate patient notes, care plans, and other documentation, eliminating the need for manual typing and potentially saving time during documentation tasks.

3. Digital medication management integrates care facilities with local pharmacies and the attending physicians of residents, simplifying the prescription ordering process [8]. These systems enable faster prescription processing and expediting medication delivery.

4. Fall detection systems utilize sensors, cameras, or wearable devices to detect when an individual has fallen or is at risk of falling. These systems can automatically alert nursing staff or emergency services, enabling prompt assistance and reducing the likelihood of serious injury resulting from falls, especially among elderly residents.

5. Night light sensors are devices that automatically activate ambient lighting in response to low light conditions, such as during nighttime or in dimly lit areas. In elderly care facilities, night light sensors can help residents navigate their surroundings safely during night-time hours, reducing the risk of falls or accidents.

6. The Digital planning and communication is a software designed to facilitate care planning, scheduling, and communication among caregiving team members. These tools include features such as task assignment, calendar integration, messaging, and real-time updates, enabling better coordination and collaboration among nursing staff.

7. Digital wound documentation systems utilize imaging technology, such as cameras or specialized scanners, to capture high-resolution images of wounds [9]. These images are then stored digitally within electronic health records (EHR) systems, allowing for accurate documentation, tracking, and monitoring of wound healing progress over time.

8. Digital games for residents are designed specifically for mental activation and cognitive stimulation among elderly individuals. These games often incorporate puzzles, memory exercises, and other interactive activities aimed at maintaining or improving cognitive function, memory, and overall mental well-being in elderly residents.

9. Digital incontinence products are innovative solutions equipped with sensors to detect moisture or pressure changes, aiding individuals in managing urinary or fecal incontinence [10]. They alert nursing staff or wearers when a change is needed and may include remote monitoring capabilities for enhanced management.

10. Cleaning robots are autonomous or semi-autonomous robotic devices equipped with sensors, brushes, and suction mechanisms designed to clean floors, surfaces, and other areas within a facility [11] (see Figure 2, right). In elderly care settings, cleaning robots can help maintain cleanliness and hygiene standards, reducing the workload on nursing staff and minimizing the risk of infections.

11. A movable toilet refers to a toilet fixture that can be adjusted in height or moved to accommodate the needs of elderly or mobility-impaired individuals. These toilets feature adjustable seat heights, grab bars for support, and may be equipped with additional features such as bidet functionality or built-in sensors to monitor toilet usage.

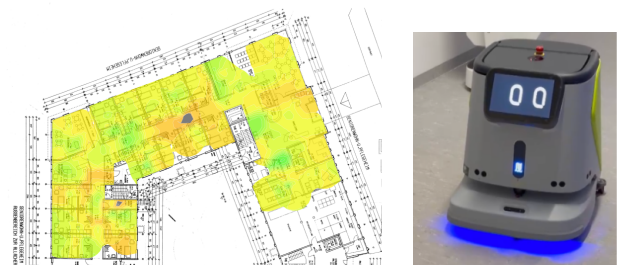


Fig. 2: Left: Wi-Fi illumination of one residential area at Haus Curanum Karlsfeld (Source: www.btd-service.de). Right: Cleaning robot installed for evaluation purposes at Haus Curanum Karlsfeld. With courtesy from Giobotics corp.

3.2 Order of Implementation

The planning of the technology implementation took into account the care function areas that were rated as particularly challenging by the nursing staff. This brings us back full circle to the requirements workshop (see Section 2.2). In all three groups of nursing staff, the majority of examples of demanding workflow tasks were cited in the documentation domain. Following this, examples from the care function areas of physical tasks and work organization and communication were cited in all three groups. Only two out of three groups mentioned examples of challenging workflow tasks from the care function areas of monitoring and social-emotional tasks. Based on this, the following implementation order was suggested: Technologies for documentation should be introduced first (mobile devices for documentation, speech-based documentation, digital wound documentation) followed by those for physical tasks (cleaning robot, movable toilet), work organization and communication (digital planning & communication tool, digital medication management), monitoring (fall detection, night light sensor, digital incontinence products), and finally social-emotional tasks (digital games for mental activation).

4. Conclusion and next steps

Within the initial phase of the research project [3] technologies aimed at assisting nursing staff in elderly inpatient care have been successfully identified, categorized and prioritized. The proposed approach is suitable to select the most appropriate technologies for assisting in elderly and nursing care, based on the specific needs and requirements in a certain facility [4] and to plan the implementation order of technologies according to the respective care function areas. Moving forward, potential providers and vendors of the identified technologies will be approached for further collaboration. Additionally, ongoing evaluation and feedback mechanisms will be established to ensure the efficacy and relevance of implemented technologies in addressing the evolving needs of both nursing staff and elderly residents. Parallel to the assessment of different technologies to potentially relieve the workload of the nursing staff, together with the Univ. Bremen, a change of the processes and staffing is implemented within the project [3], which might also influence the measured outcomes.

This iterative approach aligns with the overarching goal of the research project, which is to foster innovation and optimize caregiving practices in anticipation of future demographic

challenges.

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References

- [1] Bundesministerium für Gesundheit. Pflege in Deutschland: Pflegestatistik 2019. Verfügbar unter: <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Pflege/Publikationen/Downloads-Pflege/pflege-deutschlandergeb-nisse-5224001199004.html>.
- [2] Scharfenberg, Sassen, Rothgang, Wittenberg. Das Modellprojekt *Pflege 2030* - in Echtzeit. *Pflegez.* 76, 10-13, 2023
- [3] Rösler, Schmidt, Merda, Melzer. Digitalisierung in der Pflege. Wie intelligente Technologien die Arbeit professioneller Pfleger verändern. Initiative Neue Qualität der Arbeit INQA, Berlin; 2018.
- [4] Arndt, Simon, Schmitt-Rüth, Wittenberg: How to release the potential of technology for the future of work in inpatient care of elderly? – Validation of a new employee centered technology selection process. *Proc's RESER Conf.* 2023
- [5] Güsken, Frings, Zafar, Saltan, Fuchs-Frohnhofer, Bitter-Krahe. Einflussfaktoren auf die Nutzungsintention von Pflegekräften zur Verwendung digitaler Technologien in der ambulanten Pflege - Fallstudie zur Einführung eines Sen-sortextils. *Zeitschrift für Arbeitswissenschaft.* 2021;75(4):470-490.
- [6] Wilson, Small: Care Staff Perspectives on Using Mobile Technology to Support Communication in Long-Term Care: Mixed Methods Study *JMIR Nursing* 2020;3(1):e21881
- [7] Joseph, Moore, Patton et al. The impact of implementing speech recognition technology on the accuracy and efficiency (time to complete) clinical documentation by nurses: A systematic review. *J Clin Nurs.* 2020; 29: 2125–2137.
- [8] Patel, Ivo, Faisal, et al.: A Prospective Study of Usability and Workload of Electronic Medication Adherence Products by Older Adults, Caregivers, and Health Care Providers *J Med Internet Res* 2020;22(6):e18073
- [9] Shi, Dumville, Juwale, Moran, Atkinson: Evidence assessing the development, evaluation and implementation of digital health technologies in wound care: A rapid scoping review. *J. Tissue Viability* 31, 567–574, 2022.
- [10] Schmidt, Neumann, Muller. et al. Digital assistance systems in the field of incontinence care for individuals in need of long term care (EASY): study protocol of a stratified randomised controlled trial. *BMC Geriatr* 23, 409 (2023).
- [11] Graf & Klein. Robotik im Krankenhaus. In: Klauber et al. (Eds.) *Krankenhaus-Report 2023: Schwerpunkt: Personal.* Springer Berlin Heidelberg, pp. 179–195, 2023.