Design of PharmAssistant: A Digital Assistant For Medication Reviews

Research Paper

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Abstract. Polypharmacy's prevalence and challenges, like medication non-adherence, drug-related problems, and increased healthcare costs, are becoming significant issues. One approach to address that problem is conducting medication reviews to analyze patients' medications to detect drug-related problems and provide recommendations. However, these reviews are time-intensive and necessitate strategies to support them. Meanwhile, digital assistants are being utilized in healthcare to facilitate practitioners' work and support patients. Therefore, this study is grounded in a Design Science Research (DSR) approach, presenting a digital assistant aimed at supporting pharmacists by gathering essential patient data for medication reviews. In line with DSR principles, the problem space was initially informed by an exploratory literature search and interviews with practicing pharmacists, which helped identify practical needs and define requirements for the artifact. Following the development of a first prototype, the assistant was evaluated in two focus groups with pharmacy students, generating insights that informed refinements to the design.

Keywords: *Pharmacy, Medication Reviews, Digital Assistants, Design Science.*

1 Introduction

Polypharmacy, commonly understood as the use of five or more medications by an individual, is a significant and growing global healthcare concern among older people. Excessive medication use can lead to negative outcomes, such as drug-related problems (DRPs), inappropriate medication usage, increased hospitalization rates, higher morbidity and mortality, and elevated healthcare costs (Maher *et al.*, 2014; Masnoon *et al.*, 2017; Payne and Avery, 2011; World Health Organization, 2019).

Among essential interventions for addressing polypharmacy are medication reviews (World Health Organization 2019; Griese-Mammen et al. 2018; Payne and Avery 2011; Blenkinsopp et al. 2012), which are evaluations of patients' medicines, to detect DRPs and recommend interventions (Griese-Mammen *et al.*, 2018). Medication reviews can be economically and clinically beneficial if they are planned and carried out properly (Brulhart and Wermeille, 2011; Sorensen *et al.*, 2004; Zermansky *et al.*, 2001).

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In this regard, patient-focused services like medication review and management are key roles of community pharmacists. So far, medication reviews have not been widely incorporated into everyday practice, due to several obstacles that have been preventing community pharmacists from doing so, including time and funding, poor use of staff, or lack of facilities (Bryant *et al.*, 2010). While medication reviews vary from country to country, numerous studies confirm that pharmacists find medication reviews too time-consuming, which appears to be the main reason medication reviews are not that widespread (Bitter *et al.*, 2019; Bradley *et al.*, 2008; Lee *et al.*, 2009; Niquille *et al.*, 2010). This is why, implementing a pre-collection tool that allows patients to report their medications ahead of consultations could streamline the medication review process. Such a system would primarily target older people, a group that often approaches technology - particularly in healthcare contexts - with caution and anxiety (Meng *et al.*, 2022). This underscores the importance of designing interfaces that are intuitive and accessible. Additionally, older individuals tend to place high value on social connection and personal interaction in their healthcare experiences (Marcinowicz *et al.*, 2014). In this regard, digital assistants, systems designed to interact with humans through natural language (McTear *et al.*, 2016), are well-suited, as they offer a more natural and engaging interaction mode by simulating human-like communication (Seeger et al., 2021). Research has also shown that older adults tend to prefer digital assistants over conventional interfaces for medication-related discussions (Olafsson et al., 2021), and they generally find data collection through such assistants to be both enjoyable and cognitively undemanding (Wilczewski et al., 2023).

Therefore, this study explores the idea of leveraging advances in digital assistants to support medication reviews, by pre-gathering data needed from the patients. This can save pharmacists' time for the initial consultation, as gathering the patient data takes up a significant amount of time. Thus, we pursue the following research question: *How to design a digital assistant to collect information for conducting medication reviews?*

Our research contributes insights gained from interviews with pharmacists. Based on the interviews, we derived essential requirements for the digital assistant and designed it accordingly. Finally, we evaluated the prototype in focus groups with pharmacy students, which helped to confirm and refine our proposed design for the digital assistant. Thus, the goal of this study is to broaden the problem space surrounding medication reviews, identify user requirements for digital support and develop a prototype digital assistant. Doing so, we seek not only to explore the feasibility of technical solutions, but also to inform the digital health literature with empirically grounded insights into how such tools can better align with older users' needs.

2 Conceptual Foundations and Related Work

2.1 Medication Reviews

Medication review terminology has often been ambiguous, encompassing a broad range of service models. To clarify this, the Pharmaceutical Care Network Europe proposed a structured definition: "a structured evaluation of a patient's medicines with the aim

of optimizing medicines use and improving health outcomes. This entails detecting DRPs and recommending interventions." (Griese-Mammen *et al.*, 2018, p. 1205). DRPs can be defined as "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes" (van Mil *et al.*, 2004, p. 862).

The definition of medication review allows for different types based on available information sources. According to Griese-Mammen et al. (2018), these include the simple medication review (type 1), which is performed only with the patient's medication history. In the intermediate medication review (type 2a or 2b), type 2a includes the medication history and a patient interview and type 2b includes the history and clinical data, but no interview. The advanced medication review (type 3) is based on all three sources of information, medication history, patient interview, and clinical data. Our study focuses on type 2a reviews, common in many countries, where pharmacists lack prior access to medication records and must rely on direct consultation (McCahon *et al.*, 2021; Rose *et al.*, 2020). Otherwise, no pre-gathering tool would be needed. Accordingly, it follows the German Federal Chamber of Pharmacists' guidelines, which provide interview questions to collect medication information (Bundesapothekerkammer, 2023). In this process, patients bring all medications to the consultation. Pharmacists then assess potential and actual DRPs, propose solutions, and, with consent, may contact physicians. The goal is to reduce risks and improve treatment outcomes. To support this, we explore how to gather key patient data before the consultation.

2.2 Digital Assistants

Systems capable of engaging in human-like dialogs with individuals have long existed and gained significant attention. Various terms, such as "chatbots", "conversational agents" or "virtual assistants", have been employed to describe these systems (Dale, 2016) and we define those dialog systems as "digital assistants" (Maedche, Legner, *et al.*, 2019). Especially since 2016, advancements in AI technology have led to the emergence of digital assistants across various sectors, including healthcare (Adamopoulou and Moussiades, 2020). In healthcare, these assistants are promising tools for accessing and delivering services. For instance, to support diagnosis by checking users' symptoms, for prevention purposes, by tracking and building awareness of users' health, or by providing therapeutic support (Jovanovic *et al.*, 2021).

2.3 Computer-Assisted Research on Medication Use-Cases

This section presents an overview of the researched tools and systems that support healthcare practitioners in conducting medication reviews and discusses various digital assistants used in similar scenarios.

Several systems have been proposed to identify DRPs. For instance, Wauters et al. (2021) proposed an electronic tool to recognize inappropriate medications and generate side-effect lists. The most time-intensive task was mentioned to be the symptom observation, which required talking to the nursing home residents. Furthermore, Ulfvarson et al. (2010) explored a DRP detection system that provided warnings and explanations

of interactions. Clinical Decision Support Systems (CDSS) also aid medication reviews. For example, Rieckert et al. (2018) evaluated a CDSS providing comprehensive medication reviews to help make clinical decisions. Despite time-consuming data gathering with the patients, it provided valuable insights. Furthermore, Meulendijk et al. (2015) developed a CDSS for primary care, generating guideline-based recommendations. There is various research on the use of systems to assist medication reviews, also especially to help with the medication analysis, but still the data-gathering remains underexplored. The study by Sandbæk et al. (2022) tested a paper-based questionnaire to gather patient data for medication reviews before the consultation. The study found that the questionnaire supported the patients in taking a more active role in the consultation and improved communication about the medication with the pharmacist. Since the analysis of potential drug interactions has been extensively covered in previous research, this study focuses on the preceding step: the collection of patient information using a digital assistant.

The rationale for using such an assistant is outlined in the following through a review of related work, including research on digital assistants designed for medication management and health data collection. For instance, Tschanz et al. (2017) introduced a medication management assistant, which integrates patients' medication plans from their electronic patient dossiers. The assistant offers essential functions such as medication interaction checks with food, medication reminders, or information about the patient's medication. However, as mentioned, the system assumes that electronic patient records are available or that a medication plan is available, which is not always true. Similarly, Ahmad et al. (2018) proposed an assistant providing tailored medication recommendations for specific illnesses.

Besides that, Olafsson et al. (2021) conducted a study to ascertain the factors influencing users' preference for a conversational agent over a conventional user interface for medication adherence counseling. The findings revealed that participants with low smartphone literacy and older users were more inclined to choose the agent. The agent was favored for its interactive and enjoyable approach to tasks. Moreover, research has shown the utility of digital assistants in health data collection. One study has found that data gathering with digital assistants could be perceived as enjoyable for older people with a low required cognitive load (Wilczewski *et al.*, 2023). Similarly, that those assistants are preferred over simple forms is shown in a study, where participants reported that it is more usable and that they are more likely to recommend it as a data collection tool (Soni et al., 2022). The work of Biduski et al. (2020) also showed the benefits of using an assistant to gather health data, demonstrating its appreciation among users.

2.4 Research Gap

Medication reviews are important tools for managing polypharmacy, identifying DRPs, and optimizing medication use. Nevertheless, medication reviews are not widely implemented in practice. One of the primary barriers is their time-consuming nature. This is illustrated by a study in England, which revealed that pharmacists faced time constraints in conducting medication reviews (Bradley *et al.*, 2008). Similarly, medication reviews in Germany are not widely implemented as a pharmaceutical service due to the

perception of them being too time-intensive (Bitter *et al.*, 2019; Schindler *et al.*, 2020; Waltering *et al.*, 2022). Levivien et al. (2022) likewise highlighted that medication reviews are time-consuming and not exhaustive in French hospitals. A survey from Switzerland also mentioned the lack of time to be one of the barriers to medication reviews led by community pharmacists (Niquille *et al.*, 2010). Further studies, such as Geurts et al. (2016) in the Netherlands and another study in New Zealand (Lee *et al.*, 2009) reported initial consultation times ranging from 30 to 60 minutes and averaging about 57 minutes, respectively, which is too time-consuming. Moreover, as outlined previously, various technologies can assist in conducting medication reviews, particularly in analyzing medication and resolving DRPs, which are essential components of these reviews. However, there is limited research on pre-gathering patient data to facilitate medication reviews. Digital assistants, already used for medication management, could streamline the data-gathering process for medication reviews. Despite their demonstrated utility in related areas, digital assistants have not been explored for facilitating medication reviews, especially in gathering necessary patient data. Thus, this research paper aims to address this gap by investigating the use of digital assistants to pre-gather patient data for medication reviews. This approach can potentially alleviate time constraints currently hindering the widespread implementation of these reviews.

3 Designing PharmAssistant

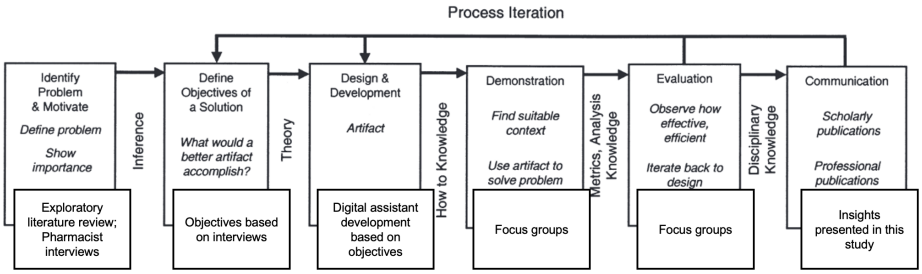

Figure 1: Design Science Research Methodology adapted from Peffers et al. (2007)

We applied the design science research methodology proposed by Peffers et al. (2007), as shown in Figure 1. This approach is employed to create and evaluate artifacts. The methodology was applied as follows: (1) problem identification and motivation were informed by an exploratory literature review, results are discussed in Chapter 2, and further refined and confirmed through interviews with pharmacists; (2) the definition of objectives for a solution was based on insights gathered from the interviews; (3) the design and development of the digital were carried out based on the identified objectives and requirements from the interviews; (4) demonstration and (5) evaluation of the assistant took place through focus groups with pharmacy students, whose feedback helped assess the artifact's usability and relevance; and (6) communication of the outcomes and the design knowledge generated is presented in this paper to contribute to

both academic research and practical development of digital health tools. Future research includes additional design and evaluation iterations, incorporating feedback from focus groups and involving older adults to further refine and validate the assistant.

3.1 Problem Identification and Objectives

The problem identification revolved around an exploratory literature search and interviews with pharmacists performing medication reviews. The definition of objectives for the artifact was also discussed in the interviews with the pharmacists. Drawing upon the problem space conceptual model from Maedche, Gregor, et al. (2019), we defined the following concepts: patients and pharmacists constitute the stakeholders. The need is a solution that can streamline the execution of medication reviews due to their time-intensive nature. To address this need, we defined initial high-level goals: to reduce the time required for medication reviews, improve task efficiency, and support wider adoption. While these goals are intentionally broad at this stage, they provided a foundation for targeted expert interviews. In these interviews, we gathered domain-specific requirements for the system supposed to streamline the process. Building on this framework, we formulated questions for experts in the field, aiming to further expand the problem space and identify requirements.

Our interview questions thus were focused on several key ideas. Firstly, we aimed to understand the experts' perspectives on the challenges associated with medication reviews. Then, we asked about what they would find useful to simplify the process. Furthermore, we wanted to see if they would find our idea of a digital assistant useful for gathering patient data. We asked them what requirements and functionalities they would find important for such an assistant. We interviewed four pharmacists in Germany who execute medication reviews, and with their consent, we recorded, transcribed, and analyzed the interviews and extracted key points for our research.

The pharmacists agreed that although medication reviews are essential for healthcare, they are unfortunately not that widespread. This is primarily due to the lack of staff, resulting in time constraints in general. In addition, medication reviews tend to be lengthy, which is problematic, especially given the fixed remuneration of 80 euros per medication review, regardless of its duration. On average, a medication review takes two to three hours, encompassing various tasks. Furthermore, expensive software to support the medication review and the lack of cooperation and acceptance from doctors are also hindering the process. Another issue that was stated is the limited demand from patients, which they stated may come from their lack of trust in pharmacists in contrast to their doctors. Generally, the pharmacists aren't satisfied with the current situation and would wish for some kind of change or assistance. One important aspect is that the pharmacists agreed that the initial consultation is very important and cannot be omitted. The consultation lets them understand the patient's medication usage and gather essential information. For instance, it enables them to see how the patients administer their medication or get details they might be hesitant to share otherwise.

The opinions varied regarding whether the interviewees would find a digital assistant useful for preparing medication reviews. The first interviewee supported the idea, noting that it could streamline the process by enabling them to prepare the consultation

beforehand. However, the second and third interviewees were less convinced. The second emphasized the importance of consultation and patient contact, considering medication too personal to share with a digital assistant. They also mentioned concerns about the older individual's ability to adapt to new technology, which they perceived as a potential obstacle. Similarly, the third interviewee expressed reservations about the older target group's ability to use such technology effectively, citing potential risks of them entering wrong data or lacking necessary information. Still, they agreed that relatives or caregivers could help. They also emphasized the importance of asking questions during the consultation, as patients may not always be aware of the relevance of certain types of medication for the review. Despite these concerns, they emphasized the necessity for patients to bring their medication to the consultation to demonstrate how they administer them, such as eye drops. In contrast, the fourth interviewee found the idea of the digital assistant to seem helpful, as it could relieve pharmacists' workload by leaving room for preparation before the consultation. They also suggested that it could encourage patients to participate in medication reviews by lowering their initial barrier or hurdle. Additionally, they thought it would be sufficient to have only an overview of the medication plan and the different medication names for their preparation.

The interview also covered the requirements for the digital assistant, with key insights, design principles, and features summarized in Table 1.

Table 1. Problem-Requirement-Principle-Feature mapping

Problem insights	Design requirements	Design principles	Implemented features
The main target group: older people, who may struggle with technology	DR1: System should be user-friendly and simple for older users	DP1: Minimize cognitive load DP2: Use empathetic and clear communication	DF1: Short system; non-overwhelming interactions DF2: Patient-adjusted language: avoid judgment, approach patients slowly, have empathy, and provide clear explanations DF3: Design adjustments: large fonts, buttons, suggested answers, allow speech entry, and image upload of the medication
The data gathered from the assistant should allow to prepare for the review	DR2: Gather all necessary data for the review	DP3: Ensure the relevant data is gathered DP4: Support data review and correction by users	Beyond standard data (like indication and dosage) given in the guideline for type 2a medication reviews, certain context-specific information are also essential to prepare effectively: DF4: Ask about the patient's expectations, medication storage, expiration dates DF5: Add reminder to not bring cooled medications to consultation DF6: Upload discharge/doctor's letter, if given DF7: Add a way for patients to review their data
Pharmacists have limited time and low remuneration for the medication reviews	DR3: Cost-effectiveness and time-saving	DP5: Automation of data collection to reduce preparation	DF8: Forwarding of data to the pharmacy, in the best-case direct integration into their system (future research)
Counseling is essential and cannot be omitted; the assistant should supplement it, not replace it	DR4: Support the consultation, not replace it	DP6: Preserve human judgment and interaction for complex analysis	No new feature implemented, but the assistant is intentionally limited to data gathering, with decision-making left to pharmacists
Other	DR5: Ensure future extensibility of the	DP7: Plan for modularity and scala-	DF9: Planned support for multilingual interaction and data protection measures (future research)

	system to accommodate evolving user and technical needs.	bility to support integration and feature expansion	

3.2 Design of the Digital Assistant

The structure of the digital assistant was derived from the preceding chapter's requirements, the guideline for type 2a medication reviews, and input from pharmacy students as part of their mandatory elective internship at a chair for clinical pharmacy. The assistant is divided into various parts: an introductory message explaining the assistant and its process, followed by a query to respond truthfully, and a query regarding language preference - formal or informal. Subsequently, the assistant asks about the patient's motivation for undertaking the medication review. Moreover, general data such as age, gender, date of birth, and contact information are queried. This is followed by a prompt for users to upload their medication plan, if possible, and related inquiries. Afterwards, the taken medication is queried, starting with prescribed medications and then self-medication. In this step, users are offered the convenience of taking a picture of the PZN (abbreviation for "Pharmazentralnummer", a standardized identification code for medicines in Germany) barcode of medications, which outputs the name of the medication (see Figure 2). This way, the user doesn't need to enter the name of the medication, minimizing data entry errors. Different important information about the medication is asked, like the indication, the intake time, the dose and so on. Then, the user is asked to upload laboratory results or a discharge letter, if available and possible. Users were also allowed to review or edit their entered data through a form after each section, enhancing data accuracy, as shown in Figure 2. The design enhancements, such as font enlargement and color adjustments from Table 1, can also be seen in Figure 2.

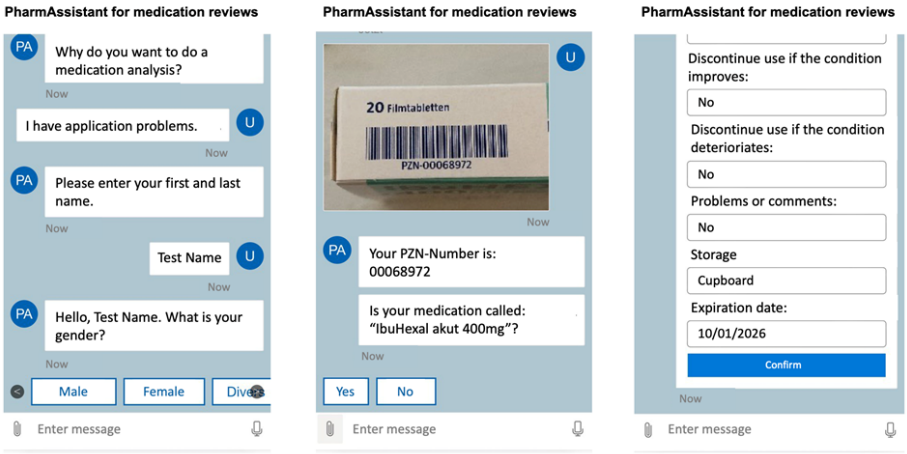

Figure 2. User interface of the digital assistant (translated)

3.3 Evaluation and Results

To evaluate the digital assistant, we conducted focus groups with pharmacy students. This group was chosen primarily for practical reasons and their foundational education in pharmacotherapy. Although not all participants are likely to engage in medication reviews in their future professional roles, their academic training equips them to provide informed feedback on the system's usability and content. Moreover, their input offered a valuable supplementary perspective on system functionality and areas for potential improvement. Two focus groups were organized, compromising three and four students, respectively. During the sessions, participants were introduced to the motivation behind the project, the requirements, and the result of the digital assistant. They then should discuss the digital assistant in the form of a Strength-Weaknesses-Opportunities-Threats (SWOT) analysis to bring them to interact with each other in a structured manner. Overall, the feedback from the participants was positive, viewing the assistant as a useful tool.

The results from the discussions are summarized in Table 2. In general, the feedback provided valuable insights into the further development of the assistant, highlighting several areas for improvement.

Table 2. Results of the SWOT-analysis

Strengths	**Weaknesses**
• Pre-defined answers facilitate the operation, especially for older people • Asks a lot of important information, goes into detail • Medication can be photographed (PZN-number) • Time savings on the data gathering and less time spent in the pharmacy itself	• Maybe not accessible enough for older people • Hurdle with personal data sharing on the Internet, especially for older people • It may not always be possible for older patients to understand all the questions and answer them fully, no opportunity for them to ask questions (no integration of AI) • May be too small, e.g., the arrow of predefined answers is not so visible • Time expenditure for patients
Opportunities	**Threats**
• Expand to include questions such as lifestyle • Combination with drug therapy checks • Older people are also increasingly able to use technology • Availability in other languages, which could also support the oral consultation • Coupling with the electronic patient file • Definition or explanations of certain terms • Allow to save the intermediate status	• Protection of sensitive patient data • Wrong or missing data entries due to ignorance or uncertainty of patients • Older adults may refuse to use it

Participants highlighted several strengths of the digital assistant, including predefined answers that reduce errors and the ability to scan PZN numbers, which simplifies data entry and avoids typing difficulties. They also valued its potential to save pharmacists time by collecting patient data in advance. However, concerns included accessibility for older users, data privacy, and the inability to ask follow-up questions, suggesting the need for AI integration. Participants also noted that patients may lack certain information (e.g., reasons for medication use), and discussed whether shifting time burdens to patients is fair. Opportunities for improvement included adding lifestyle and dietary questions, integrating drug interaction checks and electronic health records, and

offering multilingual support. Participants also recommended including explanations of medical terms, allowing users to save progress, and recognized that future generations may be more comfortable with such technology. These insights offer clear directions for making the digital assistant more effective, inclusive, and user-friendly.

4 Discussion

This research explores the complex issue of medication reviews, which are essential for managing polypharmacy but often require substantial support to be effectively implemented. We proposed a novel solution: a digital assistant to pre-gather the necessary data for these reviews, presumably easing pharmacists' workload.

4.1 Implications

The interviews with pharmacists revealed several challenges in the practice of medication reviews in Germany. For instance, medication reviews are infrequently practiced due to their time-intensive nature, and pharmacists struggle to allocate sufficient time. A study in the United Kingdom confirms these findings (Duncan *et al.*, 2019), which interviewed general practitioners and pharmacists and discovered that time and resource constraints hinder thorough medication reviews, leading to less comprehensive assessments with few pharmacists routinely involved. Similarly, Bryant et al. (2010) explored the perceptions of New Zealand community pharmacists and found that medication reviews were often conducted outside of regular working hours, highlighting the difficulty of integrating these reviews into standard pharmacy practice. More insights from our interviews highlighted additional barriers such as the high cost of software required for the reviews, lack of patient demand due to a preference for trusting doctors over pharmacists, and the resistance from doctors reluctant to allow pharmacists to modify patient medications. These challenges indicate a need for better promotion of medication reviews to patients, efforts to build patient trust, and strategies to gain doctors' acceptance. Interviews revealed mixed opinions among pharmacists on digital assistants. Half saw benefits in workload reduction, while others worried about older patients' usability and the need for consultations. Key requirements included user-friendliness, conciseness, empathetic language, and multiple data entry options. These insights shaped our solution.

Pharmacy students suggested improvements like clarifying medical terms and allowing progress saving, though concerns about older adults' usability remained. While literature highlights positive outcomes, such as Wilczewski et al. (2023) finding digital assistants easy and useful for older users, concerns about privacy, lack of clarifications, and lengthy interactions persist. Similarly, Ponathil et al. (2020) found older users often preferred digital assistants for reduced workload and better guidance.

Our research contributes to design principles for digital assistants, complementing Jovanovic et al. (2021) who emphasized design aspects relevant to healthcare digital assistants. These aspects firstly include the conversational style of the assistant, which should be sociable and empathetic, use understandable medical terminology, and exhibit proactive behavior. Secondly, user understanding is crucial, e.g., using natural

language capabilities. It was found that in diagnostic or data collection tasks, users are typically guided through questions rather than being able to narrate their condition freely. Providing effective error recovery strategies is also critical, yet often inadequately implemented. Thirdly, the accountability of the assistant is essential; users should be able to understand the decisions made by the assistant and have transparency regarding data collection. These aspects are often underrepresented, highlighting the need to explain why and how data is collected and clarify relevant decisions. Lastly, regarding healthcare provision, the collaboration facilitated by the digital assistant and the continuity of service delivery are included. Most sessions are one-time interactions with little to no information shared across sessions. Collaboration is uncommon, with the assistants focusing on individual users without involving other stakeholders.

While our study focuses specifically on medication reviews for older patients, similar design principles apply. Such as the need for the assistant to be empathetic and explain medical terms. We achieve this by adjusting the language to be patient-friendly, avoiding judgment, approaching patients gradually, and providing clear explanations. Our digital assistant is also proactive, initiating questions in every interaction. Another design requirement is simplicity and brevity to avoid overwhelming the patient. Furthermore, as our assistant is designed with older patients in mind, incorporating features such as larger fonts, suggested answer options as buttons, and the ability to input information via speech or by taking pictures of their medication was found to facilitate the process. Regarding user understanding, while our assistant does not currently support this, feedback from focus groups suggested it would be a valuable addition. As for error recovery, a form is provided for users to review their data. In terms of accountability, the assistant explains its purpose and details about what data will be collected and why. However, our assistant cannot share sessions with others or continue the conversation later, a feature also noted by the focus group as desirable. This could include integrating with electronic patient files and allowing users to save their progress.

4.2 Limitations and Future Research

This study comes with limitations. Firstly, the small sample size of four pharmacists limits the generalizability of our findings. More extensive interviews with a larger group could provide a broader perspective on the challenges and assistances for medication reviews. Additionally, the requirements extracted from the study are not fundamentally based on design know-how, as pharmacists don't have expertise in designing digital systems, and their feedback may not align with usability practices. Moreover, the use of pharmacy students - who are not yet practicing professionals - presents limitations regarding the generalizability of our findings to real-world clinical settings. This group was selected primarily for pragmatic reasons and their foundational knowledge of pharmacotherapy.

This leads to the limitation of the absence of insights from actual users, particularly older patients. Involving them in the evaluation process is crucial to learn about their needs, refine the assistant's design, address potential issues, and improve its overall quality while fostering a greater sense of participation (Fischer *et al.*, 2020). Furthermore, the study does not adequately address the potential challenges older patients may

face with visual, hearing, cognitive, or motor impairments when using technology (Kuerbis *et al.*, 2017). Such impairments may hinder some patients' ability to use digital assistants effectively, necessitating support from staff or relatives.

Another constraint was varying requirements, making it challenging to consolidate them into a unified framework. Additionally, the developed artifact is highly tailored to the specific context in which it was designed. This specificity might restrict its applicability to different use cases.

Future research should focus on enhancing the digital assistant's features based on the evaluation. From a design perspective, conducting a comprehensive literature review on existing medication-related digital assistants to extract valuable design knowledge and best practices could be beneficial. This review should identify successful design strategies that can be integrated into the refinement of the digital assistant to enhance its functionality and effectiveness.

Additionally, engaging with the intended user group and testing the prototype is crucial. These trials would provide essential insights into the assistant's practical application and usability in real-world settings. They should address various challenges, such as ensuring the system is intuitive and accessible for users with different levels of technological proficiency. Future studies could explore strategies to promote medication reviews among patients and build their trust in pharmacists and digital assistants. These could include promoting the digital assistant in pharmacies and developing trust-building features such as secure data handling and transparent processes.

Moreover, future work should examine the long-term impact of digital assistants in medication reviews. This includes their integration into healthcare systems and potential to save pharmacists' time. Additionally, incorporating a medication pre-analysis feature for pharmacist review could be explored.

5 Conclusion

This study investigates the challenge of conducting medication reviews, which are essential for managing polypharmacy. It proposes a digital assistant as a novel solution to streamline the data-gathering process and alleviate pharmacists' workload. Interviews with pharmacists were conducted to reveal insights into the current practices and challenges of medication reviews in Germany. These insights highlight the time demands of medication reviews, low patient interest, and physician resistance - underscoring the need for supportive systems and better communication of their benefits. The mixed opinions on the digital assistant's utility from the pharmacists reflect the potential benefits and concerns regarding its implementation, particularly for older users. The developed digital assistant, informed by healthcare professionals' and pharmacy students' requirements and feedback, aims to be intuitive, empathetic, and accessible. Despite its promising features, the study's limitations, including the small sample size and the absence of direct user perspectives, indicate the need for further research to refine the digital assistant and ensure its practical applicability. Addressing the identified challenges, such as data privacy, usability, and integration into existing healthcare workflows, will be crucial for successfully adopting digital assistants in medication reviews.

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