Adoption of Integrated Voice Assistants in Health Care – Requirements and Design Guidelines

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Abstract. Integrated voice assistants (IVA) receive more and more attention and are widespread for entertainment use cases, such as radio hearing or web searches. At the same time, the health care segment suffers in process inefficiency and missing staff, whereas the usage of IVA has the potential to improve caring processes and patient satisfaction. By applying a design science approach and based on a qualitative study, we identify IVA requirements, barriers and design guidelines for the health care sector. The results reveal three important IVA functions: the ability to set appointments with care service staff, the documentation of health history and the communication with service staff. Integration, system stability and volume control are the most important non-functional requirements. Based on the interview results and project experiences, six design and implementation guidelines are derived.

Keywords: integrated voice assistant, speech recognition, human computer interaction, health care

1 Introduction

Integrated voice assistants (IVA) receive more and more attention in our society. According to a study of the German digital association Bitkom, seven out of ten respondents over 14 years know IVA. Four out of ten respondents can imagine to use voice assistants regularly [1]. Large tech giants, such as Google, Amazon and Apple, provide own voice assistant platforms, out of which Amazon's platform Alexa is the most popular one [2].

At the same time, the health care sector is confronted with several challenges, such as a strong lack in employees. According to the Federal German Employment Agency, an position in health care is on average vacant for 183 days, which is 63 % above average [3]. Information systems for health care have the potential to support integrated care [4] and increase process efficiency. Meister et al. already discussed the usage of IVA in health care and recommend its further investigation [5]. However, several challenges, such as the digital divide [6] and skill inequalities of elderly users [7], might hinder its usage in health care. These challenges require a comprehensive investigation of IVA in health care. So far, no substantial studies are available that provide insights into the requirements and barriers of voice assistants in health care.

15th International Conference on Wirtschaftsinformatik,
March 08-11, 2020, Potsdam, Germany

https://doi.org/10.30844/wi_2020_k2-eggert

By exploring both requirements and adoption barriers of IVA in health care, the paper at hand aims at closing this research gap. Therefore, we apply the design science research paradigm [8] and provide research contributions of level one (situated implementation of an artifact) and two (operational principles) [9]. We develop an IVA prototype based on elicited requirements from health care experts and refine this prototype in two more iterations. Finally, we additionally demonstrate the prototype at elderly test persons in order to receive their feedback. Thereby, all interviews are systematically analyzed by applying a content analysis [10].

The research contribution of this paper is threefold. First, we provide insights into prototype-based perceptions of health care experts regarding the application of IVA in the health care domain. Second, we systematically identify functional and non-functional requirements for the usage of IVA in health care, which sets up a basis for further design science projects. Third, based on elicited adoption barriers and project experiences, we provide design guidelines for health care IVA development projects.

The remainder of this paper is structured as follows. Section 2 briefly describes the related literature of IVA, digitalization of the health care service sector as well as design science foundations. Section 3 comprises the research design. All elicited functional and non-function requirements, as well as the barriers and design guidelines, are presented in Section 4. Finally, Section 5 discusses the results.

2 Related Literature

2.1 Integrated Voice Assistants

Otoo and Salam define IVA as "voice-based Artificial Intelligence (AI) personal agents, programmed to act like humans in performing automated tasks" [11]. They point out that the goal of artificial intelligence is the realization of a natural dialogue situation between the human being and the machine [11]. Technologies of dialogue systems are used by numerous companies to implement innovative personal assistants [12]. Currently, a large number of IVA are available on the market [13]. In addition to the well-known language assistants from Apple (Siri), Amazon (Alexa), Samsung (S Voice) and the Google assistant, there exist also less common assistants, such as Cortana from Microsoft and Facebook's M [14].

IVA platforms apply speech recognition as input interface of their speech assistants [15]. This involves direct human-machine communication, which triggers a defined action by sending a command to the speech assistant [16]. According to Jiang et al. [12], an IVA has three core functions: The function of the *device dialog* implements the use of voice commands. This core function enables access to the functions of the device as well as the execution of commands for further tasks via the interaction in dialog style. By using the *web search* function, one may conduct voice-supported Internet search queries. Furthermore, requests, which cannot be identified and recorded by the voice assistant, are forwarded to a web search engine. Finally, each IVA has a *chat function* that allows contacting the IVA. For this function, the voice assistants have predefined answers that are generated by the provider [12].

https://doi.org/10.30844/wi_2020_k2-eggert

2.2 Digitalization in Health Care

The health care sector is divided into inpatient and ambulant health care. According to the German Social Code, ambulant care facilities are "independently operating facilities that provide home care services to persons in need of nursing care in their apartments under the constant responsibility of a trained nurse" (§ 71, SGB XI). An inpatient health care facility is an independent facility, "in which persons in need of nursing care are cared for [and] under the constant responsibility of a trained nurse [in part-time or all-day]" (§ 71, § 72, SGB XI). Healthcare organizations constantly invest in the digitization of processes in order to optimize patient care quality [17]. The introduction of IT in health care facilities is intended to reduce operating costs [19], but also requires investments. For example, an IVA implementation in larger health care facilities costs around 250,000 $ [18].

Current research on health care digitalization is manifold. According to Hillestad et al., the implementation of the electronic patient record for the ambulant care sector is a core element of the digital change in health care services [20]. Besides the increased efficiency, one major advantage is the reduction of “adverse drug events” [20]. Several studies investigate the positive effects of IT on costs of inpatient care [21–23].

An extensive literature review on the usage of voice assistance for electronic health records revealed that using IVA for patient records is a much regarded research field [18]. Two major issues in applying IVA in health care is the misunderstanding of words [e.g., 24, 25] and the reduced understandability in noisy environments [26].

In summary, the use of IT in health care has become a core research topic for information systems research [27]. Due to the high investment costs of IT and the need to improve process efficiency, quality and safety, further research, that investigates the effects and requirements of IT on the existing structures of nursing facilities and patient care, is required [19].

2.3 Design Science Research

Design science strives to expand the boundaries of human beings by developing innovative artefacts, which are the basis for gaining knowledge and the understanding of problems and their solutions [8]. Furthermore, design science is a solution-based approach, which investigates human-made phenomena [28]. The goal of design science is to develop and evaluate IT artifacts that require the conscious recombination of resources. In this way, the limits of existing IT applications are extended by addressing significant problems that previously could not be solved by IT [29].

According to March and Smith [30], there are two design processes (design and evaluation) and four design artifacts (construct, model, method and instance), which may be constituted as principles, guidelines, software and patents [9]. The evaluation of the artifact is based on feedback obtained during the evaluation [31]. In order to gain a better understanding of the problem, the loop of the construction and evaluation process is typically run through several times before the final artifact is

https://doi.org/10.30844/wi_2020_k2-eggert

developed [32]. We apply the design science approach in order to develop and evaluate an IVA prototype for health care. The following Section contains the concrete research design.

3 Research Design

In this section, we describe our research methodology that is based on a design science approach [8, 9]. In total, the research process comprises four phases (cp. Figure 1). Phase one aims at developing an interview question guideline. Phase two (data collection) and phase 3 (IVA prototype development) are intertwined. We collect requirements for an IVA prototype and take over the most important and feasible requirements. By that, we develop a new version of the prototype, which we again demonstrate to receive feedback from respondents. The data analysis phase aims at transcribing the collected interview data and analyzing the respondent´s feedback.

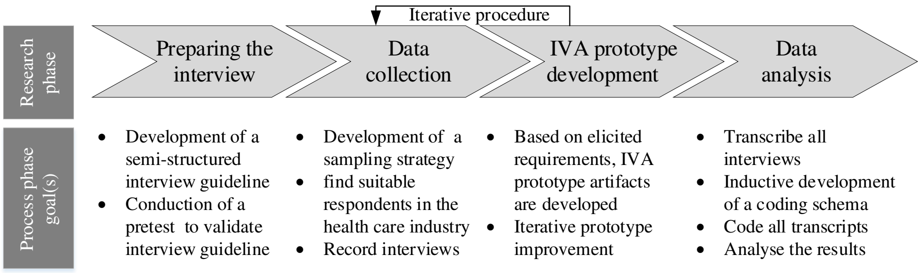

Figure 1. Research design

3.1 Preparing the Interview

We conduct semi-structured interviews [10] in order to elicit the functional and non-functional requirements, as well as common barriers of IVA usage. Besides the perspective from health care service providers, we also want to gain insights into the perceptions of elderly people, which we perceive as potential IVA users.

Table 1. Interview guideline

Function and non-functional requirements	
1.	Which application areas do you see for voice assistants in healthcare?
2.	What added value do you think voice assistants can bring to care providers?
3.	Are there any concerns about data protection or other reasons against introducing voice assistants in healthcare?
4.	Which non-functional requirements have to be guaranteed in order to use voice assistants efficiently?
Prototype feedback	
5.	Please provide feedback for each functional part.

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6.	What has to be changed in order to apply the presented function in your institution?
7.	Do you have any further requests regarding changes and/or feedback?
Barriers / Opportunities	
8.	What opportunities do you see for the usage in inpatient/ambulant care?
9.	In which areas of your institution could you imagine the use of voice assistants?
10.	Which aspects do you consider critical for such a language assistant?
11.	For what target groups in the care sector is such a language assistant suitable?

In total, we develop 11 questions that we structure into three question areas (see Table 1). Questions in the area 1 elicit the functional- and non-functional requirements for IVA in health care. This question block was solely part of the first interview session with health care experts. In the following two interview sessions, we only asked questions from areas two and three, because we want to elicit solely the prototype feedback and potential barriers. Area 2 contains questions to receive feedback about the developed prototype. Question area 3 contains questions to elicit barriers for IVA in health care. The development of the interview guideline comprises direct questions (e.g., "Which application areas do you see for Alexa in healthcare?") and probing questions (e.g., "Do you have any further change requests and feedback?") [10]. All question areas and the belonging questions are provided in Table 1. The question guideline was pretested by two test persons in order to check and increase the questions understandability.

3.2 Data Collection

We follow the sampling suggestions of Vogelsang et al. [33] and choose two different stakeholder groups. First, we conducted three interview sessions with professional experts from health care. Health care service providers need to provide either impatient or ambulant care being part of a valid group of respondents. All respondents are located in North Rhine-Westphalia, Germany. Second, we conducted four interviews with elderly people who might use IVA in the future.

Table 2. Health care service providers (respondent group 1)

Respondent	*Gender*	*facility*	*Additional information*	*1. interview session*	*2. interview session*	*3. interview session*
P1 (head of the nursing home)	f	1	Ambulant care, 100 beds, elderly people, high staff costs	✓	✓	✓
P2 (head nurse)	f	2	Hospital, 450 beds	X	✓	X
P3 (HR)	f	3	Ambulant care, founded 1996, 300 in need of care, <100 employees	✓	✓	✓
P4 (IT)	f	3		✓	✓	✓
P5 (roster coordination)	m	3		✓	X	✓
P6 (director)	m	3		X	✓	X
P7 (nurse)	f	4	Hospital, 7000 employees, 2000 beds	✓^	✓^	✓^
P8 (nurse)	f	5	Hospital, 500-600 employees, 600 beds	✓^	✓^	✓^

✓ participation, X no participation, ^ phone call interview

https://doi.org/10.30844/wi_2020_k2-eggert

Table 3. Elderly test persons (respondent group 2)

Respondent	*Gender*	*Living situation*	*Age*	*IT-affinity*
T1	f	Retirement home	80	Owns smart phone & laptop
T2	m	Residential home, with option for assisted living	83	Owns a smart phone (however hardly used)
T3	m	Retirement home	79	Owns emergency call button
T4	m	Retirement home	81	Owns a tablet

All interviews took place between November 2018 and February 2019. In total, 12 respondents attended at the study. Eight respondents are health care experts (respondent group 1, cp. Table 2). Four respondents are elderly people (respondent group 2, cp. Table 3). All respondents from facility 3 have been interviewed together in one session because they did not want to be interviewed separately. Thus, we conducted 17 separate interview sessions (10 sessions with P1, P2, P7 and P8, 3 sessions with P3-P6, 4 sessions with T1-T4). Each interview is recorded with a sound recorder. The produced sound file is transcribed and coded by applying a content analysis [10].

3.3 IVA Prototype Development

The Design Science Research approach [9] encourages the development of a prototype. In order to follow the guideline "design as an artifact" [8], we iteratively develop and improve a viable prototype of an IVA that fulfills requirements of health care facilities. In total, the prototype development comprises two iterations. Interview session one provides the requirements for the first prototype development iteration. The requirements are prioritized according to their relevance (number of mentions in the interviews). Each ongoing interview session begins with the demonstration of the developed prototype, followed by the elicitation of respondent's feedback.

The IVA prototype operates on Amazon Alexa. We apply the Amazon Alexa developer console (https://developer.amazon.com) in order to prepare an interaction model for the frontend communication process. The backend function, which processes the answers of the user and prepares the responses, is deployed with Amazon Lambda, written in the programming language Python. After each development iteration, we tested the prototype by using the elicited requirements. Finally, we provide the IVA skill on an Amazon Echo device and demonstrate it in the interview sessions. The final prototype is additionally evaluated by elderly test users (respondent group 2).

3.4 Data Analysis

The analysis of the interviews follows the methodological guidelines of Ryan and Ber-nard [34]. We regard the sum of all interview transcripts (respondent group 1 and 2) as input for a qualitative content analysis. All statements that can be categorized as either functional requirements, non-functional requirements or as IVA barriers in health care are analyzed. Therefore, we use an interview-based content analysis approach, according to [10], which aims at eliciting what the respondents experienced [10]. The content analysis is based on the counting of mentioned terms, which is

called frequency. It is assumed that “categories with a high interview-frequency matter more” [33].
In order to achieve reliability and validity, the coding results need to be cross-checked by a second coder [35]. As a measure of reliability and validity, a certain percentage level of agreement between the coders is suggested [34]. According to Kappa statistics, moderate results are expected at a match level between 41 to 60 % [36]. Thus, we solely accept coding results with an intercoder-reliability of above 41 %.
The coding procedure is as follows. In a first step, thematic blocks and individual categories are formed on the basis of the idioms of the interviews, as described by [10]. We systematically note the corresponding text sections for each thematic block. We then iteratively analyze the transcripts in order to refine the results. After the first coder finishes the analysis, a second independent coder, who repeats the coding independently from the first one, has analyzed the transcripts. Besides the number of identically coded elements, we also provide the relative number of identically coded elements, whereby we divide through the total number of coded elements. Finally, all coding results are filtered among the most important constructs, whereas *relative importance* is calculated by identically coded elements divided by the total number of coded elements. Therefore, we only accept constructs that are mentioned at least six times by two or more different respondents.

4 Analysis Results

4.1 Functional Requirements

Table 4 provides the functional requirements. In total, they are mentioned 62 times by different facilities (Frequency, Fre.). We extract and encode 163 text passages (Content relevance, Rel.). 135 of them are equally assigned by both coders. The percentage column provides the intercoder-reliability (identical coding divided by content relevance). The last column provides the rank of the requirements, based on the equally coded elements. As stated in Section 3.3, we apply a filter to select the most relevant requirements, which causes a difference in the total number and the sum of the single values. In the following, we present indirect or direct statements and refer to the respondents IDs of Table 2 and 3.

Table 4. Functional requirements

	Fre.	*Rel.*	*Ide.*	*In %*	*Imp.*
Total[1]	62	163	135	82	
Arrangement of appointment	4	23	18	78	13,33
Documentation	2	16	13	81	9,63
Communication with staff	4	12	9	75	6,67
Electronic patient record	4	11	8	73	5,93
Extendable interaction model	3	10	8	80	5,93
Translation functions	4	7	6	86	4,44
Admission & Discharge Mgt.	4	7	6	86	4,44
Patient surveys & evaluation	4	7	6	86	4,44
Meal planning	4	8	6	75	4,44

https://doi.org/10.30844/wi_2020_k2-eggert

Safety & legal verifiability	3	8	6	75	4,44

Fre.: Interview frequency; Rel.: Content relevance; Ide.: Identical coding; Imp.: Relative importance
[1] Total numbers regarding all coded constructs, including the less relevant ones.

The most important requirement is the *arrangement of appointments* between the patient and the care facility. The IVA should provide a function that coordinates the appointments and informs patients and staff (P2). Additionally, communicating appointment changes would also be a great benefit (P1, P2). P7 would like to use an IVA to "inform the patient in advance about his appointments, e.g. for x-rays." (P7).
The request for *documentation* is the second most important requirement. IVA-supported documentation of nursing activities is perceived as valuable (P2). In particular, in rooms with single occupancy, the nurse "could say, for example, wound care or special wound care" to document special treatments (P1). Furthermore, IVA should enable the recording of conversations with the patient in order to document agreed treatment measures (P3-P6). In addition, an analysis of recorded documentation should be possible (P8).
In order to simplify the processes in a nursing facility, a *communication with staff* function would be very effective (P1). By forwarding the personal needs of the patients, the voice assistant might inform the nursing staff in real time (P2). "Nursing staff could then directly bring along the things that are needed and would save themselves a trip." (P8). Additionally, the communication channel must provide a request confirmation (P1) and a function to contact family members (T1).

According to P2, another requirement is the real time availability of an *electronic patient record*. "If I could inquire locally, whether Mrs. Müller has an allergy to medication x, that would be absolutely advantageous." (P2). Therefore, access to the patient record data must be provided to the nurses in real time, so that the data always represents the latest medical state (P3-P6). Notifications of an update of the patient's medical record would enable an updated knowledge of the current medical state. P8 states that it is necessary that the IVA notifies the nurse in case of updated data. In addition, the data stored in the electronic patient record must be accurate and verified to avoid misinformation (P1).

Due to the large number of digital aids, the IVA should provide an *extendable interaction model* (P2, P3-P6). P3-P6 state that model "extensions should always be possible". For a large-scale deployment in the health care segment, IVA should get a broad communication model that enables a user-friendly patient flow (P3-P6).

Overcoming language barriers represents a significant problem in the everyday life of many care facilities (P2, P8). To overcome these barriers, IVA might be equipped with a *translation function* (P2). For example, with a language translation service "compliance frauds could be minimized if the patient has to be informed" about certain treatment risks (P8). Such a function would be beneficial for a nursing facility in both the ambulant and inpatient segment (P2).

IVA might also support the *admission and discharge management*. In the admission procedure, the IVA must support the input of patients' data so that it can be stored in the internal system of the hospital (P2). "That would be faster than entering the data" (P3-P6). Furthermore, the employees of the caring facility should access room and bed occupancy information in real time (P8). In combination with an access

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to the electronic patient record, medical examinations are more independent of medical staff. Therefore, a short briefing by a voice assistant at the beginning of the treatment is useful (P7).

Patient surveys & evaluation could also be supported by an IVA (P1, P2, P8). The voice assistant must then elicit survey data and make it available for periodical evaluations (P1). For this function, "a structured questionnaire with possible answers needs to be stored" (P2). This might lead to an accelerated evaluation because the data does not need to be entered manually into the system (P8).

A voice assistant can also support the *meal planning* process by recording and saving patients' menu requests. For user-friendly operation, a list of selectable menu options must be provided, which can be repeated and changed if necessary (P7, T4). The voice assistant should register and forward possible changes to the patient's menu preferences (P3-P6). P8 states: "I find it a good idea. A patient might decide that tomorrow he would like to have menu 1, 2 or 3".

Applying IVA in a care facility implies to follow *safety & legal verifiability* requirements. For this purpose, numerous tests must be carried out to check the stability of the processes (P2, P8). The guarantee of security is just as important as the guarantee of verifiability. Regarding the control of medication, P3-P6 state: "If we only prepare medication for patients, they themselves are responsible for taking the medication. But if we also administer the medication, then we must be locally present".

4.2 Non-functional requirements

According to the coding results, which we provide in Table 5, *system stability* of IVA is the most important non-functional requirement category. Respondent P1 mentions that "the hospital's own processes must be adapted internally to the new conditions so that patients receive the support they need as quickly as possible".

Table 5. Non-functional requirements

	Fre.	*Rel.*	*Ide.*	*In %*	*Imp.*
Total[1]	63	174	130	75	
System stability	4	17	12	71	8,89
Volume control	4	13	11	85	8,15
Ability to speak	4	12	9	75	6,67
Area-wide WLAN	6	14	8	57	5,93
Target user group selection	4	10	8	80	5,93
Theft protection / security	3	6	6	100	4,44
Water resistance	2	6	6	100	4,44
Internal process digitization	4	10	6	60	4,44
Authorization	2	9	6	67	4,44
Financing model	2	6	6	100	4,44
Test	4	12	6	50	4,44
Technical affinity of patients	5	8	6	75	4,44
Legal requirements	3	6	4	67	2,96

Fre.: Interview frequency ; Rel.: Content relevance; Ide.: Identical coding; Imp.: Relative importance
[1] Total numbers regarding all coded constructs, including the less relevant ones.

https://doi.org/10.30844/wi_2020_k2-eggert

The second most important requirement is the *volume control.* Respondents mention that the volume of the speech assistant must be adaptable to the environment and the individual user of the system. In addition, regardless of the prevailing ambient noise, an error-free recognition of the user's linguistic input is required (P3-P6, P8). "This is especially important for us in the hospital, because the [buildings] construction makes noises even louder" (P2).

Whereas the usage of IVA in business environments always assumes that the user has the *ability to speak*, its application in health care does not always fulfill this basic prerequisite because some patients might not be even able to speak anymore. Thus, the user needs the ability to speak and express himself clearly (P2). In turn, the IVA must be able to recognize even hardly understandable commands.

The care facility needs to be equipped with a comprehensive and *area-wide WLAN*, which is particularly elementary for a trouble-free operation of the application (P2). It is important that "the wireless network is sufficiently implemented, so that the voice assistant can function without objections" (P3-P6). In addition to the range of the wireless network, its stability and connection speed are also of great importance (P8).

"Before such an application can be used, the exact target group must be determined" (P1). The level of demanded care provides a sufficient basis for IVA *target user group selection*. Officials assess and classify each patient based on a point-scaled system. In addition to cognitive abilities, that system also considers the patient's life situation (P3-P6). However, the definition of the possible target users must consist of many aspects, so that the degree of care can be treated as one out of many factors (P3-P6, P7).

IVA in nursing facilities may be installed in freely accessible areas, which demands a *theft protection and security* mechanism to protect the device against the possible consequences of theft, such as data misuse (P2) or software hacking (P7). In addition, the *water resistance* of the device must ensure that the application runs smoothly. Due to its use in patient rooms and facility areas, the device must have a splash water protection (P2, P8). "The devices should be sufficiently protected so that their functionality is not impaired" (P2).

In order to optimize care and treatment procedures, the internal processes need to be adapted to the new conditions. P8 states that "application areas [of an IVA] must comply with the regulations and requirements of the hospital". Thus, *internal process digitization* is a significant prerequisite for IVA in health care. Therefore, the implementation of an electronic patient record is an essential prerequisite (P2).

IVA usage in healthcare requires a role-specific *authorization*. The authorizations should correspond to the organization chart of the care provider (P3-P6). So far, IVA platforms do not support user specific access rights. P5 requests a voice recognition by the device, which protects the application from abuse.

Due to the cost-intensive devices and its integration, cost absorption by health insurances is essential (P3-P6). Each facility must have a choice between different *financing models*, depending on its financial situation (P3-P6). "Basic technical and financial prerequisites for such a deployment" need to be fulfilled in advance, P8 said.

In health care, a language assistant can only find an accepted nationwide deployment if it has been sufficiently *tested*. P8 said, "every innovation needs test

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phases, studies and people who deal with its potential application". The test phases must also include patient tests in order to consider feedback into the IVA optimization (P7).

When applying an IVA, the key aspect for the patient is a secure feeling when dealing with the voice assistant (P8). Therefore, and in addition to the definition of the target user group and the aspects of the degree of care, aspects of *technical affinity* and readiness for use must also be considered (P2, P3-P6). T1 and T2 additionally state that users with a lack of technical routine most likely choose common communication devices, instead of using the IVA. Finally, the IVA must meet *legal requirements*. P8 states that IVA in health care "has to implement requirements […] also the legal ones in Germany".

4.3 Adoption Barriers

Several barriers hamper the adoption of IVA in health care. In Table 6, we provide the most important barriers according to our analysis results. The most important barrier is *trust in the IVA provider* in terms of its compliance with the data protection regulation (P2). "A new provider, which is specialized in care and which could implement the requirements, also the legal ones in Germany, would be desirable." (P3-P6). Explicitly in inpatient care, where patients share rooms, it is a challenge to comply with such regulations.

Table 6. Adoption barriers

	Fre.	*Rel.*	*Ide.*	*In %*	*Imp.*
Total	54	213	169	79	
Trust in IVA provider / Data protection	6	72	57	79	42,22
Deficit of interpersonal needs	5	21	18	86	13,33
Insufficient communication channels	4	23	18	78	13,33
Integration of IVA in system landscape	3	20	16	80	11,85
Target group oriented communication model	4	12	7	58	5,19
Risk in emergency case	3	10	7	70	5,19
Voluntary Usage	3	6	6	100	4,44
Lacking routine	3	9	6	67	4,44

Fre.: Interview frequency; Rel.: Content relevance; Ide.: Identical coding; Imp.: Relative importance
[1] Total numbers regarding all coded constructs, including the less relevant ones.

For socially accepted usage of IVA, the system must address *interpersonal needs*. P3 – P6 perceive the loss of interpersonal relationships in communication with an IVA as problematic and raise ethical questions. "Especially for older people, this could cause confusion if the employee suddenly talks to someone and an answer comes out of nowhere." (P3 – P6). Important medical issues must continue to be discussed with qualified medical personnel (P8). T2 and T4 additionally mention that digital support for people in need of help must consider the value of dignified interactions.

Insufficient communication channels of the IVA hinder its adoption (P3-P6, P8). In this context, the respondents perceive the inadequate communication channels for all sub-areas of the prototype as the third most relevant adoption barrier. "Receiving an e-mail, notifying me that in room 5 is an emergency, is not adequate" (P3 –P6). The

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IVA must guarantee that all responsible employees receive new patient requests quickly (P8). The *integration of IVA in the system landscape* and corresponding challenges to exchange data with other IS of the facility is also perceived as a barrier (P3 – P6).

Additionally, the IVA needs to support a *target group oriented communication* and has to be adaptable to the medical condition of patients (P3 – P6). “Before such an application can be used, the exact target group would have to be determined” (P1). During their stays in the institution, the patients go through different phases of their physical and mental condition, which leads to different requirements for the IVA (P7).

Respondents P7 and P8 mention the *risk in emergency cases*. They state, an IVA cannot exist isolated, particularly in emergency management (P7, P8). However, an IVA in addition to the emergency button would be acceptable (T1). Accordingly, the voice assistant is rather perceived as a service instrument in health care (P3 – P6).

The *lack of routine* of elderly users in dealing with IVA also hinders its adoption in health care. “I'm just thinking about how it would work to get such a message out of nowhere, if I can't find my way in the here and now anymore” (P1). P2 and P8 suggest using IVA in consultation with the patient and on a voluntary basis.

4.4 Design and Implementation Guidelines

Based on the elicited barriers, requirements and own experiences during the prototype development, we extract six design and implementation guidelines for further IVA development projects. Therefore, we take-over the health care providers perspective, since the implementation of IVA is demanded and managed by this target group rather than by the persons to be cared for.

1. *Clarify IVA provider acceptance before beginning with the development.*
   The acceptance of the IVA provider is the most important barrier for accepting IVA in health care, since voice data is mostly stored in distributed systems. In turn, this implies perceived data privacy risks. Thus, we suggest to carefully choosing the IVA provider together with the health care facility.
2. *Develop a sensible humanoid IVA interaction model.*
   The interaction model that contains all possible questions and responses must regard the replacement of human interactions. We suggest, analyzing speech patterns of potential users first. These speech patterns should be integrated into the interaction model of the IVA system. In addition, you should clarify that the expected efficiency increase leads to more free time for interpersonal relationships.

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3. *Create an API landscape diagram, containing all relevant interfaces and types.* The early planning of connections to existent interfaces is meaningful, since health care service providers most likely already apply information systems, such as meal planning systems. Thus, we recommend to firstly create an API system landscape diagram that contains all relevant systems and its APIs. Based on the landscape diagram, we suggest developing an integration architecture.
4. *Prepare different IVA Skills for different target groups.* Health inpatient, ambulant care service providers and treated patients are different user groups. As mentioned by the respondents and according to the digital divide [6], we suggest to handle the different user groups separately, for example by developing a distinct interaction model for each user group.
5. *Create and provide a risk impact probability analysis.* Respondents mention several risks when they think about the implementation of an IVA system in health care. For example, respondents often mention regulatory risks or the risk of technical reliability in case of an emergency call. To address this obstacle, we suggest conducting a risk analysis and classifying all identified risks in a risk impact and probability matrix in order to prevent its occurrence.
6. *Provide training courses, particularly for elderly users.* Since elderly users have no routine in handling an IVA, we suggest developing an extensive training concept that trains the usage of IVA. In order to train the general use of IVA and to break the ice, we suggest training cases that rather handle entertainment topics, such as radio handling or web searches.

5 Discussion and Outlook

The paper at hand presents the results of a design science project that aims at developing an IVA prototype for inpatient and ambulant health care service providers. In order to elicit requirements as well as prototype feedback, we conducted 17 interview sessions with health care professionals and elderly test users. Based on the interview results, we iteratively develop and refine an IVA prototype for health care. Thereby, we found out that the three most important functions are the ability to set appointments with care service staff, the documentation of health history and the communication with service staff. Our results confirm the demand for health record support via IVA [e.g., 24, 25]. In addition, the results confirm the requirement for speech recognition in a noisy background [26]. Integration, system stability and volume control requirements are the most important non-functional requirements, according to the respondents. Finally, we provided a catalog of six design and implementation guidelines for the development of IVA in health care, which we derived from elicited barriers. Researchers already work on the implementation of prototypes for IVA in home care. For example, Dojchinovski et al. implemented IVA supported electrocardiogram readings, appointment scheduling, therapy record and doctor's correspondence [37].

The implications for research are threefold. First, we provide ranked functional and non-functional requirements for IVA usage in health care, which fills a current

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research gap. Second, we provide barriers for the usage of IVA in health care. The elicited barriers are a starting point for the development of theoretical models for IVA acceptance in health care. Third, the introduced design guidelines for IVA development are applicable for validation and further prototype extension. Practitioners benefit from the study at hand in two ways. First, the catalogs of functional and non-functional requirements provide a basis for the development of a commercialized voice assistant for health care service providers. Second, developers may follow the design guidelines in order to prevent common development mistakes and increase IVA acceptance.

The small group of different health care service providers and test persons limit the expressiveness of the study at hand. In addition, the test persons have a gender and regional bias, which potentially influences the results. Finally, the demonstrated prototype does not implement all elicited functions. Thus, the effects of not demonstrated functions could not be tested yet.

Further research is needed to replicate the study in other regions. In addition, the prototype development should be extended in order to implement other important functions, such as the translation service or the access to an electronic patient record. Finally, based on the elicited barriers and mediating effects of IVA [11], a model for the adoption of IVA in health care needs to be developed and evaluated.

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