



Building Community Capacity: Exploring Voice Assistants to Support Older Adults in an Independent Living Community

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ABSTRACT

Voice assistants (VAs) such as Siri or Amazon Alexa can benefit older adults by offering accessible and convenient information options and aiding living independently. Therefore, researchers have considered how VAs might support older adults. Yet, few studies have explored opportunities for VAs to support communities and the implications of this integration. This study investigates older adults' perceptions of VAs and the potential to extend VA capabilities to support an independent living community. We invited independent living residents to virtual community forums and interviews to discuss their experiences with VAs, expectations, and concerns for VA integration to support information exchange, wellness, and social connections in their community. We found that residents desired additional VA capabilities to address unique community needs, including building on existing community capacities to support VA adoption and use. We discuss VA design implications for independent living communities and recommendations to support VA sustainability in a community environment.

CCS CONCEPTS

• **Human-centered Computing** → Human computer interaction (HCI); Empirical studies in HCI; • **Social and professional topics** → User characteristics; Age; Seniors.

KEYWORDS

older adults, voice assistants, independent living, capacity building, assets

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1 INTRODUCTION

The growing ubiquity of voice assistants (VAs) such as Siri or Amazon Alexa has led to new opportunities to support older adults with completing tasks and obtaining information in their homes. Many studies [5, 6, 12, 27, 35, 47, 53, 54, 62] suggest that older adults generally see potential value in adopting VA devices in their homes for convenience, accessibility, or to support daily tasks. With this rise in VA popularity, senior organizations have also begun to explore how VAs might support older adult communities. Independent living (IL) communities such as senior apartments, retirement communities, or IL communities that are part of continuing care retirement communities (CCRCs) and life plan communities (LPCs) [36] often help older adults age-in-place while providing access to care and onsite support (e.g., amenities, maintenance, healthcare). In recent years, several senior independent living organizations have explored how VA integration in senior communities can help reduce social isolation among older adults by providing companionship, especially to those that live alone [31, 61, 63]. Other studies [9, 21, 27, 62, 67] have recruited from older adult communities; however, like other VA research, the focus has primarily been limited to exploring individual uses in individual homes.

In contrast to explorations of individual VA use, complementary studies of VA use in families [9], caregiving dyads [27], and even among older adult residents [62] suggest that users' needs and expectations for VAs change in group contexts. For instance, Trajkova and Martin-Hammond [62] studied individual commercial VA use in an older adult community and found that many residents found existing VA features useful but "*trivial*" and desired future applications that could support continued independent living. While the study focused on understanding individual use and non-use, one of the findings suggested a need to further explore "*essential*" use cases of VAs as tools to support connections within the community. Similarly, Corbett and colleagues found that dyads of older adults and caregivers saw commercial VAs as useful for tasks such as entertainment and reminders, but they felt that current applications were limited and desired features that could better support collaborative care tasks [27]. This prior work establishes older adults' desires and needs for different VA features and interactions in group settings to support collaborative and community tasks. However, limited prior work focuses on uncovering potential VA uses in community settings to support participation and a sense of community among members, specifically among older adults. Further, prior work has noted challenges with older adults' adopting and accepting VA technologies or their interest waning over time [21, 53, 62]. Therefore,

while older adult communities may provide a potentially rich environment for deploying VA applications, designing for a community environment also introduces complexities. Thus far, we have also not fully explored factors that might help lead to the successful integration and sustainability of VAs within communities of people.

This study investigates older adults' perceptions of VA capabilities and the potential to extend these capabilities to an older adult independent living community. We use Chaskin's framework of community capacity building [19, 20], which centers understanding community assets as essential to developing, deploying, and sustaining community-based initiatives, to purposefully explore opportunities for VAs to extend existing community assets and uncover new needed capacities to support VA adoption and sustainability within an independent living community. We engaged 38 independent living residents in four virtual community forums and 24 participants in semi-structured interviews to discuss their experiences with VAs and their expectations and concerns for VA integration within their community. We found that residents' individual use of VAs aligned with common use cases. However, at the community level, participants desired to leverage VA capabilities to address unique community needs to build on existing community capacities, such as enhancing access to information and resources within the community. Participants also expressed the need for coordinated efforts to build additional capacities that support adoption and use among the broader community of residents. Our study represents a first step in addressing the gap in knowledge of how VAs might be used to support older adults' participation in community by acting as an intermediary to connect them with community information, resources, and services and by helping them connect with other community members. Based on our findings, we offer three main contributions.

- First, we contribute insights into the existing community capacities shared by participants and their needs for additional support. We discuss how voice assistant technologies can support older adults' communal needs beyond individual use cases and can be leveraged to further build community capacity.
- Second, we contribute scenarios of use that may be beneficial for supporting older adults in an independent living community, providing new insights on potential VA uses in community environments and guidelines for communal VA application design.
- Third, we identify and discuss potential barriers to VA integration and sustainability in an independent senior living environment. Identifying strategies for increasing the sustainability of community-focused designs is an ongoing challenge in HCI research, and much of the existing VA research focuses on integration in individual homes. Therefore, there is currently little understanding of approaches that may support community-level integration efforts. Based on our findings, we contribute considerations for capacity building that may support better community-level diffusion and sustainability.

2 CAPACITY BUILDING AND TECHNOLOGY ADOPTION IN COMMUNITIES

The concept of community-capacity building stems from literature outside of Human-Computer Interaction (HCI) that aims to build and define principles that can guide the development of sustainable community-based initiatives aligned with the communities' priorities [19]. Chaskin defines community capacity as "*the interaction of human, organizational, and social capital existing within a given community that can be leveraged to solve collective problems and improve or maintain the well-being of a given community. It may operate through informal social processes and/or organized efforts by individuals, organizations, and the networks of association among them and between them and the broader systems of which the community is a part*" [20]. Community-based initiatives are often characterized by a broad set of principles opposed to a "*well-specified intervention model*"; however, emerging frameworks highlight the necessary components for successfully launching an initiative into the community. Chaskin [19] found that examining community capacity often includes exploring four fundamental characteristics: (1) a sense of community, (2) commitment from community members, (3) problem-solving abilities, and (4) access to resources. A sense of community refers to the degree of connectedness among members and a recognition of mutual circumstances [19]. Sense of community represents the level at which people in a community are connected to each other due to instrumental factors such as circumstance (living in a housing complex) or shared use of resources (neighborhood park). Community commitment is the responsibility taken by individuals, groups, and organizations in what happens in the community environment. Problem-solving abilities refer to the community members' commitment to action and making decisions that impact others in the community. Access to resources refers to available resources within the community. Chaskin also found that a community's social agency, intent to engage, development of strategies, and mediating circumstances impact an initiative's outcome [19]. Thus, understanding these different factors can help those developing community initiatives to plan for more sustainable solutions.

Within HCI, researchers and practitioners have made similar arguments for designing technologies that are integrated into communities. For example, some researchers have examined participatory design (PD), a method that emphasizes democratizing the design process, as an approach to technology design in communities [16, 34] and within organizations [33]. Approaches to PD, such as the MUST method, were developed to address the unique needs and challenges that arise when engaging in PD with organizations [33]. Carroll posits that PD is well-suited for exploring technology integration in communities [16]. However, because community environments often have unique challenges and needs, the PD process must shift slightly from supporting inclusion to supporting the self-actualization of community members. Carroll contends that factors such as lack of resources or technology planning can impact technology integration efforts in a community environment. Yet, it is imperative that community members are involved in developing technologies that affect their activities and experiences [16]. Similarly, one of the tenants of conducting Action Research (AR) in HCI counters the idea that research with communities should

be generalizable [30]. Hayes discusses that those that engage intimately with communities understand the need to contextualize and localize findings [30]. As such, there should be transparency when developing solutions so that community members and other stakeholders can understand what aspects might be useful to replicate for their setting [30]. Another approach, assets-based design, has also been found to be useful for engaging in work with communities [25, 49, 65, 66]. Compared to other approaches, the assets-based approach starts by centering the design process on a community's strengths and focuses on building upon those strengths [25]. Because of the focus on strengths, as opposed to deficits, Dickinson and colleagues note that when designing in community settings, the role of the designer shifts from problem-solvers to "*facilitators who work with residents to understand their capacities and lend their expertise to design tools that support the communities' efforts in addressing local issues*" [25]. Therefore, leveraging an assets-based approach within communities can help position existing capacities as a central component of the design process [25, 49, 65, 66].

2.1 Voice Assistants to Support Older Adults

As consumer-based voice assistants such as Google Home and Siri have emerged, Human-Computer Interaction (HCI) researchers have investigated how different groups use VAs in different settings [41, 55, 57]. From this work, we have gained a better understanding of usage patterns [10, 53], needs, and challenges of VAs [23, 26, 44], but also the possibilities of these devices to support individuals with disabilities [2, 3, 14, 52], children [9], and those with varied mobility or abilities [2, 3, 12, 17, 56]. Older adults (55-60 years of age or older) have also been a population of great interest. For example, some suggest that voice assistants are among the most readily implementable emerging technologies to support older adults in the next 10-15 years [1]. Researchers are also investigating how VAs might advance opportunities to support older adults' independence by exploring their use of these devices and expectations for future applications [5, 6, 12, 27, 35, 47, 53, 54, 62].

Initial findings suggest that older adults desire to use VAs to aid them at home [5, 6, 46, 53, 59]. For instance, older adults perceive voice assistants as helpful in managing daily activities, particularly when living alone [6]. Older adults with low technical skills perceive VAs as helpful for their daily information needs [53], and those with lower incomes perceive VA technologies as potentially useful for making health information tasks more accessible [46]. Despite older adults' overall positive impressions of VAs, many studies suggest that older adults still express concerns about adopting VAs. Many of these concerns overlap with concerns raised by other groups of users. For example, privacy is often a top concern among VA users, regardless of age, including beliefs that VAs might be perpetually listening [28, 29, 32, 37, 38, 40] and broader concerns about data privacy [13, 26]. Some users find that VAs are not as accessible as they might seem [2, 39, 52] and that current VAs might not be as useful for certain situations [11, 41, 62]. Further, while speech recognition advances have improved interactions with voice-based devices, there are still open challenges for creating useable voice-enabled interactions [22, 40, 42, 51]. However, these interactions can be particularly challenging for older adults, sometimes making VAs more difficult to use than other devices [55, 62].

Among older adults, another challenge known to limit adoption and use of VAs is the need for more awareness of what the devices can do and finding appropriate use cases and capabilities that support their needs [5, 27, 62]. Some older adults view the existing capabilities of VAs as less essential to their daily needs and, therefore, desire more meaningful interactions that could support health, wellness, and connecting with others [62]. Older adults and caregivers also see the potential for current VAs to help them with daily care tasks [27, 67]. Still, open design issues with commercial devices can make adoption challenging [5, 6, 46, 53, 62]. Some suggest that more research is needed to understand barriers to use, desired interactions, and tradeoffs to advance VA adoption and use among older adults [55]. For example, Almujalli found that older adults appreciated VAs for tasks such as reminding them of medications but felt that current VAs had limited features for supporting care [5]. This paper extends prior work by exploring potential uses in independent living communities, potential challenges that might arise, and older adults' beliefs about what is needed to support VA integration and sustainability within a community environment.

2.2 Exploring Voice Assistants to Support Groups and Communities

In the United States, independent senior communities, also known as independent living communities (IL) or retirement communities, offer older adults a way to age independently with a community of peers [7]. Older adults residing in IL often benefit from shared community amenities and resources while continuing to pursue daily activities outside the community if desired. Therefore, while they live within an IL community, there are usually no restrictions placed on residents' schedules or movements outside the IL community. While the amenities an IL community provides can vary widely, some of the advantages of these types of communities are the opportunities for sustained social interactions, support through peers in a similar life stage, and reduced household responsibilities [7]. IL communities also provide opportunities for formal and informal support networks, which can assist some older adults in remaining independent longer [7].

In recent years, there has been increased interest in how VAs might support older adults living in these environments to aid social wellness by reducing social isolation. For example, while living in a senior community can lower risks of social isolation through organized social activities, feelings of loneliness and depression can exist even in these communities as seniors often still have complete autonomy over their daily schedule and coming and going [4]. In collaboration with the American Association for Retired Persons (AARP), a nonprofit serving older adults in the United States, a senior apartment complex deployed VA devices to its residents to reduce social isolation through companionship [61]. Other organizations have explored similar deployments focusing on social isolation [31, 63] or opportunities for VAs to aid care tasks [21] in older adult communities. For example, Chung and colleagues found that older adults in affordable housing found Google Home useful for everyday tasks and saw it as a potential tool to better support managing emergencies within their residential communities [21].

Despite growing interest in using VAs to support communities of people such as IL communities, much of the literature on VAs has focused on understanding how individuals use these devices in their homes to support day-to-day tasks [10, 53]. For instance, Bentley and colleagues provide insight into how commercial devices are being used in homes for tasks such as finding quick information or setting alarms but also found that users tended to use the same commands over and over and explore new commands less often [10]. Pradhan and colleagues found that older adults who were infrequent technology users made similar commands during initial explorations of a commercial voice assistant; however, over time the use of some commands lessened as participants tended to use the device as a means to find quick information [53]. Nevertheless, apart from studies to understand usage, emerging literature investigates VA use among groups of people to understand how interaction needs and expectations for features change in group contexts and how group dynamics might alter needs and use. Prior work on family VA use has explored how interactions might change in a family dynamic [9, 43]. Lovato and colleagues examined how families engage with VA devices in the home, emphasizing the understanding of children's interactions with VAs [43]. From this work, they identified a need to tailor answers to unique users and requirements for closer consideration and support for how children interact with VA devices. Beneteau and colleagues also focused on families but investigated how families learned to use their devices [9]. They suggest opportunities for VAs to improve repair when acting within dynamic family conversations. Similar explorations of VA group interactions have also focused on supporting older adult interactions. Several researchers have studied how VAs might support older adult–caregiver dyads [27, 59, 67]. For example, Corbett and colleagues found that older adults and caregivers saw VAs as useful for information, entertainment purposes, and reminders but desired more capabilities explicitly related to care [27]. Therefore, studies' findings have shown benefits for exploring VA use among groups of individuals. However, we still know little about integrating VAs in larger communities of people and how they might support community participation.

Given the potentially unique needs and assets of older adults living in senior communities, our work builds on prior work by contributing older adults' perspectives of how VAs might support them as members of an independent living community. Our work explicitly examines VAs as tools to aid individual participation in the community by leveraging and extending community assets. In addition, given the prior challenges of VA adoption among older adults, we take an assets-based approach to research and design [25, 49, 65], examining desired uses and the role of community capacity building and leveraging community assets for integrating VAs in a community setting. By exploring desired use and needs for community capacity building, we highlight potential approaches for overcoming known barriers to adopting VA applications by older adults and within community settings. We additionally examine existing community capacities to better understand aspects of the community environment that might affect integration and sustainability.

3 METHODS

The qualitative study was conducted in two phases. We conducted four virtual community forums (N=38) in partnership with residents and technical staff, followed by semi-structured interviews (N=24) with residents of a multi-site life plan community (LPC). The goal of the forums was to engage community members in semi-structured discussions of how voice assistant (VAs) technologies might be integrated to support their daily activities as independent living residents. Following the forums, we conducted semi-structured interviews with residents to explore common challenges community members raised in forums and potential opportunities for voice assistant technologies to support their community. Our research was guided by the following questions:

- RQ1: What benefits or concerns do residents have regarding VAs supporting an independent living community?
- RQ2: What, if any, potential future uses of VAs do participants desire to support participation in the independent living community?
- RQ3: What is needed to integrate VAs in an independent living community setting? What, if any, organizational concerns need to be considered?

All participants were recruited by email. The research team crafted a recruitment email for the organization's staff to share with residents, including those that had participated in a prior VA pilot program. For forums, the email included the dates and invited residents to an open discussion about adopting and using VA technologies within the community. Residents were encouraged to attend any date that fit their schedules. Residents were encouraged to reach out to researchers for interviews to coordinate a meeting time.

3.1 Research Ethics

Our study, its documents, and procedures were reviewed and approved by the Institutional Review Board (IRB) at our university. Participants were informed about the study goals, procedures, benefits, and risks during the recruitment process and our intention to record and publish findings anonymously from the forum discussions and interviews. A study information sheet was sent along with the recruitment emails so that participants could make an informed decision of whether they wished to participate. At the beginning of each forum and interview session, we again shared information about the study and obtained permission to record discussions. Participants were also notified of the potential risks to privacy and confidentiality, efforts we put in place to reduce risks to privacy and confidentiality, and their right to leave the forum or interview at any time.

3.2 Study Environment and Context

We partnered with three independent living community sites that were part of a multi-site Life Plan Community (LPC) for this study. In the United States, an LPC is a type of senior living community providing continuing care services ranging from independent living to assistive and nursing care in one location [36]. For this study, we partnered with an independent living community, which includes private homes with shared amenities and community resources; however, residents remain independent in their movements.

Table 1: Number and VA Experience of Participants in Community Forums

Forum	Number of Participants	Voice-Assistant Experience
Forum #1	9	Past participants of VA pilot
Forum #2	9	Past participants of VA pilot
Forum #3	5	Past participants of VA pilot
Forum #4	15	Residents interested in VA technologies

The three different community sites we partnered with were located at different locations in the northeastern United States. The community's staff and residents were actively exploring "smart technologies," including voice assistants and other voice-activated technologies to support residents throughout the different locations with information access and accessibility. Our partnership with this community was strategic in that we were aware of the organization's efforts to formally integrate "smart technologies," specifically voice assistants, into the community. In addition, the community members (residents) were highly involved in exploring VA technologies which outwardly reflected two of the four components (sense of community and commitment from community members) defined by Chaskin [19] as necessary to build community capacity for an initiative. We explore these components along with the others in this paper. Therefore, our partnership aligned with our research goal of understanding how voice assistant technologies might support older adults as residents of a shared community.

3.3 Community Forums

Four virtual community forums were conducted, each including members from the research team, technical staff leadership who acted as an ally to the residents and the research team, and residents with interest or concerns about integrating VA technologies in the community. Our decision to host a forum was inspired by prior HCI work examining civic technologies' use in communities [25, 48]. We thus chose a community forum in the first phase of research to build trust among the community members and build confidence that their feedback would also be heard by those who could make changes within the local community (i.e., the technical staff). Thirty-eight residents attended across the four forums.

All residents were 65 years of age or older, as required for joining the community. Most participants (N~23) in the forums were involved in an ongoing community pilot program that provided residents with voice-only Amazon Echo devices supported onsite by the technical staff for use in their homes (Table 1). At the time of the study, these residents had been a part of the program for at least two years. Some of the residents involved in the pilot were also actively involved in testing a new Alexa application developed for the community that allowed them to look up events happening in the organization. However, at the time of the study, the application was not available to the wider community of residents. The application was only available at two locations and was still in the testing and feedback phase. Therefore, the application had open issues that caused the organization to pause its development after one year. The fourth forum included a mix of residents, including other residents interested in VA technologies that were not a part of the pilot program.

As part of the ongoing work with this community, all four forums began with a 10-minute presentation where the research team reported results from a prior study focused on how residents used their Alexa during the pilot. This presentation focused on reporting individual generic uses (e.g., playing music, jokes, reminders) of Alexa by pilot participants in their homes. Following the 10-minute presentation, we transitioned into open discussion, where we asked participants to share their experiences using VAs and thoughts about how one might successfully introduce VAs or other voice-activated devices to support the independent living environment. We used an open-forum format where participants could freely express concerns, make comments, engage with technical staff representatives, or raise new questions; therefore, participants were encouraged to participate as they saw fit. However, we did take a semi-structured approach to guide discussions. We used a set of questions to prompt discussions as needed during the forum if a discussion did not arise naturally to ensure coverage of topics. The question topics focused on understanding current uses of VAs, desires for VA support within the community, and concerns/questions about VA integration in the community. All participants had an opportunity to respond to questions and make comments (e.g., express agreement, disagreement, raise new questions) in the forums verbally or through chat. However, as in any forum, some participants did not actively participate through either mechanism, and we cannot confirm or deny agreement with other participants' responses.

To provide more context about the number of participants actively participating in discussions, we examined the number of verbal responses from different participants across focus groups. We found that we had high participation (~93%) among those that engaged verbally in discussions, with 28 of the 38 participants providing verbal responses or comments during sessions. However, aligned with other studies that have used forums as a method of data collection [25, 48], we report participation as those that attended and voluntarily chose to engage in the forum as community members, whether verbally or non-verbally. Staff also participated as needed during the forum, responding to resident questions, and providing comments related to the feasibility of requests at the organizational level and their needs as far as being able to advance the shared vision of integrating VAs in the community. Part of the goal of the forums was to encourage open dialog between technical staff (who would be responsible for maintaining any new system) and the residents who would be primary users. However, for our study, we did not interview staff directly as they were interested in learning about what residents may want from voice technologies so that they could address expectations about the maintenance and feasibility of a system. Each forum lasted about one hour.

Table 2: Semi-structured Interview Participants

ID(Gender)	Age	Education	Disabilities	# Years Using Voice	VA Speaker	VA Mobile	Voice Search	Smart Home
P1(F)	> 90	Postgraduate	Blind	2		X	X	
P2(F)	> 90	Some college		1.5	X			X
P3(F)	85-89	Some college	Mobility	2-5	X	X		
P4(F)	75-79	Postgraduate		< 1		X		X
P5(F)	85-89	Postgraduate		Unsure	X			
P6(M)	75-79	Postgraduate		2-5	X	X	X	X
P7(F)	80-84	Postgraduate	Deaf	2-5	X	X		
P8(F)	> 90	Postgraduate	Deaf	> 10		X	X	X
P9(M)	85-89	Postgraduate	Legally Blind	1.5	X	X	X	
P10(F)	70-74	Postgraduate		2	X			X
P11(M)	> 90	Postgraduate	Blind, Mobility	< 1	X	X		X
P12(F)	80-84	Some college		< 1		X		
P13(F)	85-89	Postgraduate		Unsure				
P14(F)	75-79	Postgraduate	Mobility	< 1	X			X
P16(M)	80-84	Postgraduate		2-5	X	X	X	X
P17(F)	80-84	Doctorate		Unsure		X		
P18(F)	75-79	Prof. Degree		Unsure		X	X	
P19(M)	75-79	Doctorate		2-5		X	X	X
P20(F)	80-84	Prof. Degree		2-5	X	X		
P21(F)	75-79	4-Yr. College		2-5		X	X	X
P22(M)	75-79	Doctorate		2-5	X	X	X	
P23(M)	75-79	4-Yr College		> 10	X	X	X	X

3.4 Semi-Structured Interviews

Following forums, we conducted semi-structured interviews. Interviews were conducted to complement forums to gain additional insight into potential uses, to understand the existing capacities available in the community, and to understand residents' opinions on VA integration. Interview topics focused on understanding what residents saw as strengths (available capacities) related to three themes that emerged as potentials for VA integration in their community: finding information, accessing services, and connecting with others in their community. Interviews were opened to the broader community of residents. All interview sessions lasted about one hour.

We interviewed 24 residents across the three sites. Interview participants were primarily female (68.2%) and White/Caucasian (91%). Participants had at least some college and were familiar with different types of voice technologies (Table 2). Twenty-four participants completed interviews, but two, P15 and P24, did not provide demographics. Interview participants were provided with a \$20 gift card for their time.

3.5 Data Collection and Analysis

All forum and interview sessions were recorded and later transcribed. For analysis, we used thematic analysis [24]. The analysis was conducted in two phases. For forums and interviews, two research team members independently read each forum and interview transcript, adding memos, and assigning an initial set of inductive codes to transcripts. The team then met several times to discuss and iteratively reconcile codes to create a codebook. After coming to a

consensus, one team member, guided by the codebook, coded each of the forum transcripts. The themes that emerged from forum data were used to inform the direction of the interviews. The analysis of the forum data resulted in 22 sub-codes, five codes, and three themes (Figure 1).

The themes emerging from interview data were similar to those from forums except for adding a new theme (existing community capacities). Using Chaskin's [20] framework for examining community capacity, we explored the foundations already in place to support voice assistant technology integration related to the use cases that emerged from forums. Additional themes focused on 1) existing **sense of community**, 2) existing **access to community resources**, 3) **commitment from community members** in the forms of existing VA use and interest, and 4) existing attempts to **problem solve**. We deductively applied these codes to transcripts to draw out quotes related to existing community capacity. Interview codes regarding envisioned VA uses for independent living were similar to forums; however, through interviews, we gained more insight into how participants thought these tools should function within the community.

4 FINDINGS

We first report the existing capacities in the community that were available to community members tied to desired VA uses. We then discuss themes that emerged from our data related to residents' initial beliefs about how VAs could support them as members of an independent living community. Finally, we report findings related

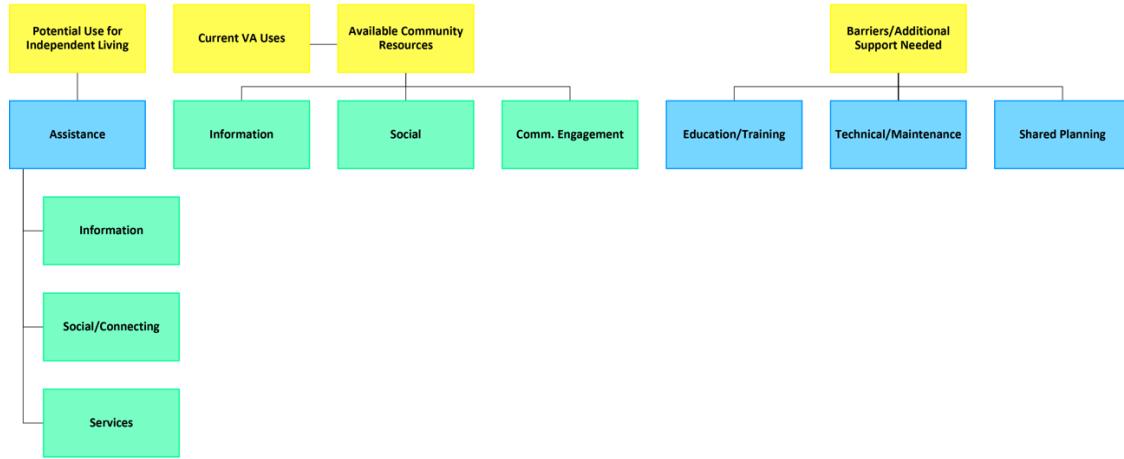


Figure 1: Examples of themes and codes used to characterize forum transcript data.

to potential barriers that would need to be overcome to support more widespread VA adoption and sustainability.

4.1 Existing Community Capacities

We found that the sense of community among residents was relatively high, and as a result, many of the social activities provided in the community were organized by residents or were resident-led. As such, participants shared many ways they were involved in the community, including serving on civic committees, regular participation in community activities, coordinating and managing social events, and serving on the resident council and other task forces. For example, P23 shared, “Well, I try to get involved as much as possible, I’m probably more physically able to move around than [my wife]. I swim in the pool two to three times a week. I get involved in some of the activities. There’s a singing group I’ve re-signed up for I’ve signed up for this play reading group. We play cards once a week to play Bridge...And when [the community] offers trips and events, we generally take them up on it...And I’m on the movie committee and other committees.” Many of the residents we talked with shared a sense of pride in being involved in their community and being able to contribute actively.

Residents also noted that the community already had access to a myriad of resources, including services provided by the community and many others that were resident-led efforts to share information and bring people together. For example, the community had established various communication and information mechanisms to keep residents informed. Resources included a weekly newsletter, internal website, community calendars, shelf-notice (paper notices placed in mailboxes), a dedicated TV channel, digital message boards, and community boards and listservs. Participants felt the community did a fairly good job communicating information about things happening. P7 shared that a dedicated resident committee led a lot of the communication about events and activities, which was one of the reasons the communication was reasonably good. However, P7 also noted, “They had a committee a couple of years ago, chaired by a friend of mine, a communications committee to increase communications. And I know as many times as we sometimes

publicize things, people, you know, a lot of it goes over because we have so much communication.”

Residents also shared that the community had various opportunities for residents to connect with one another. The community hosted shared entertainment activities and other organized social events and included information about resident interests through bios and a directory on their internal website. Residents also led many organized social activities and were involved in civic work and virtual meetings to meet others in the community. However, one of the most mentioned ways of meeting people was through organized meals. Several residents discussed that they would meet and sit with new people at meals or coordinate meals with people they would like to get to know to meet their neighbors and make new friends. P22 shared, “But well, let me add that the primary way in which people on a regular basis get together here is at mealtime; we’re required to take one meal a day, and that’s dinner at the facility, and that’s the time when people traditionally have gotten together and made new friends and met people and so on. There also are a variety of social clubs, whether it’s playing cards or getting together to read plays, or to write poetry or to or book groups there, there are lots of those kinds of things, which during the pandemic couldn’t meet because we couldn’t meet face to face.”

Yet, despite the many positives in the community, residents shared some challenges with accessing information and connecting with others. For example, P9, who self-identified as blind, shared that it could also be challenging to access information at times. They explained, “It’s not always consistently provided [information], you know, all the residents get a ledge notice because it’s dropped at their apartment... And that’s the one foolproof way of getting the information out. Of course, the other end of it is that my wife, fortunately, sees so she can read it to me. But for those of us that may be handicap, using vision as an example, they can’t read it themselves and sometimes that becomes a problem unless they can’t find somebody to read it for them... I guess what I’m saying is the communication is not comprehensive enough on a consistent basis to cover all the different disciplines and modes of communication needed in our community which numbers over 500 people now.” Therefore, many participants

shared that they wanted better ways to easily access information and coordinate connections with other residents, including more options to make information and connecting more inclusive. They saw VAs as a possible way to extend access to information, services, and resources already available in the community.

4.2 Extending Community Capacities Through Voice Assistant Integration

Aligned with prior work [5, 6, 53, 62], we found that many of the older adults that participated in our studies were using VAs in their individual residences to support everyday tasks such as setting reminders, music, and checking time. While the community was actively looking at ways to leverage VA technologies to improve communications and inclusion, the community's vision of VAs to support communications had yet to be fully realized at the time of the study. Nevertheless, we found that a common opinion among residents was that they felt that the options available in commercial VAs did not go far enough for community use. P2, F1, who self-identified as blind, shared:

"I think if this, Alexa, is not going to have a meaningful place in our day-to-day environment in communication and keeping us up to speed as to what's going on in [the community] and what we need to know, it is not going to be very useful. It's just a generic thing. I could go out and hire some other company or whatever it is to provide that. So, I think if you really want to be useful in terms of adapting to the needs of an independent living support facility with seniors in it, you're going to have to be broader and more in-depth and directly related to our environment here as to answering questions that relate to our day-to-day needs and fulfillment of our requirements to help us."

Other residents also expressed that if voice technologies were to be integrated at the community level, there should be more coordinated efforts to leverage VA technology to enhance the existing capacities in the community - supporting access to information and resources and extending existing capacities for community building. Participants shared three ways that they envisioned VA applications could support them further: (1) improving information delivery and access, (2) enhancing existing services, and (3) facilitating connections. *'Providing assistance'* was also mentioned, but the main driver behind participants' suggestions were still to improve access to existing community capacities to promote more equitable access for those with disabilities or no computer access.

4.2.1 Improving Information Delivery and Access. Participants felt that utilizing VAs could make accessing information within the community more convenient and inclusive. In terms of improving information access, participants were particularly interested in the capabilities of voice systems for reducing the amount of effort needed to gather and manage information, lessening some of the challenges they experienced coordinating among the different information sources provided by the community. P4, F4 shared, *"We had asked [the organization] and are still looking forward to a time when we can ask Alexa about our dining and events of the day and so forth ... I think that that will be wonderful once we can get that."*

It's occurring to me something in addition, right now, it would be great if we could ask Alexa what are the community rules about the COVID issue. To be able to say, 'Alexa, am I allowed to have a visitor on campus?' And it would answer, 'Yes if you call so-and-so.' That kind of thing. Other participants shared that they envisioned that VAs could help them conveniently keep up with daily community activities.

Participants discussed that an important component of the VA design that would increase usefulness would be to have the information be personalized to their specific community, which could, in addition, provide another potentially more accessible way for residents to access information. An interview participant, P3, commented, *"Well, you know, you can personalize it to [the community]. I mean, that'd be nice. Maybe you can improve on that technology, of being able to ask Alexa more things about what's going on today [in the community]. Especially if you haven't, or if you can't read the [newsletter], you don't have a tele century machine."* While some participants felt the community provided a good variety of communication mediums for its residents, some participants felt that VAs could help to improve access to information, promoting better inclusion for the diverse body of residents within the community by providing alternative options. One participant, FG1, P2 shared, *"The more methodologies that we have for communicating, the better. There's not just one system that's going to do it all. And there's some of us that have incapacities, disabilities, physical, mental challenges, and things of that nature, that we can't use all of those things [that are currently available]. And, of course, with a senior community, redundancy helps because we tend to forget things of that nature, so it's a bitter reminder... So, I know there's a lot out there, but the more, the merrier, I guess the point I'm making and looking at it from a broad accessibility standpoint... we need something that's more accessible."*

4.2.2 Enhancing Existing Services. Forum and interview participants also expressed interest in using VAs to enhance existing services provided by the independent living community. Early studies investigating older adults' reasons for moving to independent living communities find that most do so to anticipate future needs as they age, reducing the amount of upkeep and maintenance they need to do and the desire to live independently without "burdening" others [36]. Many residents we talked to shared similar reasons for joining their community. However, they also discussed that sometimes accessing the services could be challenging. Therefore, they believed that VAs could help them better connect with community services and amenities that would support remaining independent.

Participants suggested that VAs could help them access services provided by the organization, such as signing up for trips to the grocery store, picking up mail, making maintenance requests, and tracking dining options. P3, F2 shared, *"When we began this [participating in the VA pilot] there was kind of a feeling that it would be connected somehow to the [communities'] information. And so, I would try to say things like, 'Alexa, sign me up for the trip to Safeway,' and it could't do it. And the other day, I didn't want to walk down to just get the mail if it wasn't finished yet. So, I said, 'Alexa, is the mail in at [organization]?' And it said, 'I don't know that.'"* We saw similar suggestions in interviews adding ideas to enhance access to safety services. For example, P15 explained, *"Well, one thing that's*

occurred to me would be nice if someone had an accident in their apartment or fell down, for example, someone with mobility issues who might have trouble reaching a telephone to be able to just issue a voice command but something like Alexa to either call a security service that would be good." Similar to ideas for improving information access, residents felt that using voice could make accessing community services more convenient and accessible to many living in the community.

4.2.3 Facilitating Connections. Participants also felt that VAs could help facilitate connecting with people and groups in the community. While independent living residents often come and go as they choose, one of the benefits of living in an independent living community is being able to live independently together as a group [36]. Residents in independent living communities often enjoy the benefits of living independently, with opportunities to connect with other older adults for social purposes. Many residents suggested that their hope for the initial VAs integration efforts was to support their ability to better connect with other residents in the community. While many residents enjoyed connecting directly with others, some were excited about VAs' potential to facilitate some of those interactions, especially as the community grew larger over the years. For example, some forum participants mentioned ways VAs might support "*finding information about other residents*" and finding relevant "*social events using their voice*", especially those that found it challenging to use other mediums. P22 shared the following vision:

"In the same way that computers do, and I think that, you know, the, we will eventually probably have in every apartment, some kind of a system that enables both voice and visual communication between among ourselves [residents] and between ourselves and concierge is or other parts of the community ... You just talk to the box and the box does what you've asked it to do ... I could also imagine the time when that becomes standard equipment in the apartments that you have this thing that sits on the counter, in the, in the center of the facility, it probably would be like the kitchen counter, or in the bedroom. ... And that's how you communicate. You don't do it at a keyboard. You don't have to do it with a telephone call. You just talk to the voice, and the voice takes care of things."

One of the challenges experienced by some residents was learning about others in the community with common interests and experiences that they may like to meet. Overall, residents suggested a preference for being able to connect face-to-face but felt VAs could potentially help them find people to connect with and events related to their interests. P15 shared that integrating a VA could help facilitate people being able to connect with others easily. He stated, "*For example, like, the, there is a, you know, resident directory here, you can look in, but I, it would be nice ... to be able to say please read me the biography of [a resident] or please call Joe. I don't want to have to log in, and you know ...*" Therefore, participants discussed ideas for VAs to make it easier to coordinate or facilitate connecting with other people in the community.

On the other hand, some participants discussed that some residents were not connected to the community at all. They felt VAs could also potentially help those residents engage more socially. For instance, P19 shared that they knew of people that were not connected, "*You know, we've [my friends and I] established social systems that work and so part of our challenge is to be open to new people ... but the people I worry about here are several categories, and one is people who have gotten older and who have more trouble connecting either because they've lost a spouse or when they came in here single they didn't establish a close group of contacts, or those close group of contacts are no longer alive. So, I think there's people here who were in their apartments, not coming out a lot.*" The residents suggested that VAs could be used in some ways to motivate others to become more socially engaged.

4.3 Addressing Barriers and Building Additional Capacities Through Collective Knowledge

In part, the goals of the forums were to open the dialog between residents and technical staff so that technical staff could better understand residents' concerns about integrating VA technologies in the community. S1 noted in the forums:

"What we [the staff] are trying to do is trying to help with [community] specific items that we have control over. There are some generic tools that may or may not work. And we don't have much influence in that. We invested in some devices in developing a skill but did not see usage as much as we expected. ... We are trying to now understand what else would you want any voice recognition [to do], is Alexa the right tool to use that? Do we have Google users with Google Home and these things?"

Therefore, in forums and interviews, residents discussed what they felt might be barriers to the broader adoption of VA technologies within the community. While participants felt that VAs could be valuable tools to integrate into an independent living environment, additional themes emerged from our data regarding challenges and concerns from residents and staff for integrating VAs as a tool to support the community. We learned that one main barrier participants felt needed to be addressed was rethinking VA integration efforts in a community environment to build assets to support sustainable use.

Sustainability (e.g., an initiative's ability to be maintained) has long been a concern when introducing technological interventions into communities leading to the study of several approaches that support long-term community sustainable design [16, 30, 33, 49, 66]. One approach that residents discussed for potentially addressing the immediate needs of the resident body centered on finding ways to leverage residents' collective knowledge to build additional capacity for VA integration among community members. Residents believed that the community could benefit from leveraging the knowledge and skills that individuals had gained over their lifetime and were eager to share as a way to help educate the broader population of residents about VAs and what they can do. They also discussed using this approach to explore VA limitations, and how VAs might address the needs of the collective. Participants suggested that residents and staff come together to develop a set of

community assets that all residents looking to adopt these types of technologies could access, including opportunities for training, extended technical support and maintenance, and shared integration plans. These discussions stemmed from forums where participants noted that some residents might not be aware of what existing systems can do, which might, in-turn, limit VA integration and sustainability efforts in the community. P3, F4 shared that providing instructional opportunities for residents could help them find and learn about beneficial use cases. They stated, *“information that might be available only by some direct question to some authority within [the organization], who could answer some of the kinds of questions that [Participant 2] was offering as examples. And that entails not only the technical means to do that but also some instructional opportunity... There are probably people present at this meeting [forum] who, if I could consult, would answer my question. But in some more systematic way, how could information about ‘how to use’ Echo be distributed.”* Another participant mentioned that the residents at one of the campuses attempted to start an interest group for Echo users and shared that it might be a way to meet residents where they were to help facilitate examples of use cases. P5, F4 shared, *“We conducted a class... on an introduction to Alexa, where we teach a lot of these skills starting from how you get it set up and everything and then the basic things it can do for you. We probably are more limited in our ability to use Alexa to get information about our community than you guys because we don’t utilize some of the [website] attributes like the event scheduling and so on that the other two communities use. Hopefully, we’re going to be moving in that direction, and that’ll give us a little bit more.”* Interview participants agreed that providing educational and training opportunities would be essential to ensuring that integration efforts were sustainable in the community. P17 shared, *“I think it would be mandatory [training], you know when I say mandatory, but in a nice way. Everybody needs to know how to use it [VAs]. And they would have to figure out how to make that training accessible to people who also have disabilities and don’t move as freely as some of the rest of us.”* Therefore, capitalizing on the collective knowledge of residents and staff to build a community of practice would allow knowledge sharing to help develop appropriate use cases for others.

Another key consideration for integrating VA at the community level was creating sustainable organizational support that could help residents with technical challenges and aid planning for the long-term maintenance of any community-focused applications. This planning would include ensuring everyone has access to a device but also further exploring relevant use cases that might be beneficial to the broader community and the support needed to sustain those use cases in the long term. Some participants felt that for successful VA integration at the community level, careful consideration would need to be made about prior awareness and perceptions of VAs within the community, as well as efforts to present cases that residents might find valuable. P1, F3, *“Somehow, I think you have to whet people’s appetite to tell them about something that in some sense fills their needs. So, it has to be announced and introduced in a way that makes people interested. My experience is I talked to people about Alexa, ‘Do you know Alexa?’ And they said, ‘No.’”* Participants also mentioned that any plan for integration would require not only dedicated technical and maintenance

support from staff but also ways to help residents understand integration plans. P4 noted that they felt sharing *“information on what they [the organization] plan to do, and how they plan to do it”* would be essential to helping residents understand plans moving forward. P2, F3 shared that also, while integrating, *“It is important that you [the organization] don’t overpromise. Because all of these things have a backside. To have things on Alexa that are community oriented, have to be accurate. And if you can’t keep it up to date because you don’t have the manpower to do that and to follow up, then it ought not to be there. So, part of the thing is not to sell something that’s beyond what it’s really going to do.”* Accordingly, participants discussed that apart from residents’ potential expectations for organizational and staff support, understanding the feasibility and any additional person-hours required should also be considered in community integration efforts.

5 DISCUSSION

Our research examined older adults’ perceptions of voice assistant (VA) technologies for supporting and enhancing an independent living community environment. We engaged 38 older adults in community forum discussions followed by 24 individual interviews to better understand their perceptions of integrating VA technologies within their independent living community. The study’s goal was to understand what older adult residents perceived as the potential benefits and barriers of VA technologies at a community level, identify use cases they value, and uncover potential factors that might impact integration efforts within the community. While other studies have examined older adults’ use of VA technologies in the home [5, 6, 53, 62], older adults often find existing technologies limited for providing desired features in specific group contexts, such as in caregiving dyads [27] or support for continued independent living [62]. Trajkova and Martin-Hammond found a need to distinguish between essential and casual use cases when designing VA applications for older adults [62]. Therefore, complementing prior work focused on individual use of VAs by older adults, our study and its findings purposefully focus on uncovering opportunities and *essential* use cases for VAs to support a community of older adults, and the potential barriers to community-level integration that might hinder adoption.

Aligned with prior findings [27, 62], we found that residents felt that existing VA applications needed to go further to address the needs and interests of those living in an independent community setting. They shared their beliefs that existing VA applications were limited in addressing community-level needs. Participants also felt that for the integration of voice-based technologies to be successful at the community level, the organization and community would need to establish additional community capacities to aid adoption and sustainability, and to support the inclusion of all residents in the community. Based on our findings, we leverage Chaskin’s definition and characterization [19, 20] of community capacity building to discuss opportunities and potential barriers to integrating VA technologies in a community of older adults to support participation and foster a sense of community. Our study contributes to existing literature by exploring community-level VA integration and providing insights into the needs of older adults in an independent senior living community to inform the design

of voice technologies that further build community capacity. We additionally contribute scenarios of VA use residents identified as potentially beneficial to supporting a senior independent living community. These findings add to the existing literature by identifying essential use cases [62] that might aid adoption among older adults. We reflect on these scenarios to provide guidelines for designing communal VA applications more broadly. Finally, we offer new insights into barriers to VA integration and sustainability in an independent senior living environment. Based on these findings, we contribute considerations for designers, community organizers, organizations, and other stakeholders when approaching VA integration efforts to support community-level adoption, diffusion, and sustainability among a community of people.

5.1 Designing Communal Voice Assistant Applications Requires Focus on Community Needs

Much of the prior work on VA use among older adults has focused on individual uses in the home [5, 6, 10, 35, 53, 62]. While some studies such as [9, 21, 27, 62, 67] have recruited older adults living in community settings (e.g., apartment communities, Life Plan Communities), still much of the focus of this work has centered on exploring the potential use or perception of existing applications to support tasks within individual homes [5, 6, 10, 35, 53, 62]. Yet, several recent studies have highlighted a need for a deeper exploration of useful collaborative voice applications for older adults in group contexts [21, 27, 62, 67], often noting mismatches in expectations for VA applications coupled with a lack of knowledge of appropriate and non-trivial use cases can be a significant barrier to adoption for older adults [55, 62]. Our study intentionally examined the context of supporting participation in senior living, an area that has yet to be explored deeply in prior work. Similar to findings by [27, 62], our participants noted that existing VA applications were limited for supporting a group of older adults in independent living. They suggested that for VA technologies to be useful at the community level, they need to be designed to address the unique challenges in the specific community. Therefore, offering a different perspective than prior studies, our study revealed the need for communal VA applications that build community capacity [19] and address unmet needs related to participation in the community. Below, we elaborate on the use cases proposed by participants and discuss potential guidelines to support the forms of communal VA design discussed in the use cases. We acknowledge that communities are diverse and dynamic but share our insights with the goal that they might transfer [24] to other communities with similar characteristics.

5.1.1 Communal Uses Cases. Our study reveals three communal use cases for VAs to support older adults in an independent living community environment: (1) **improving communal information access delivery**, (2) **enhancing community services**, and (3) **facilitating community connections**. Participants wanted VAs to support them in more easily accessing community-based information, such as information about events or finding residents and staff. They also discussed how VAs might enhance community services already available such as online maintenance requests and cafeteria dinner reservations.

Finally, they discussed that they envisioned VAs could help better support connections between themselves and other residents by making the process of connecting easier. Informed by our findings, we provide examples of potential communal voice agent interactions that align with the examples participants shared in the forums and interviews. The three cases tie directly to the concept of community capacity building defined by Chaskin [19, 20] and focus on opportunities for VAs to support communal activities to further build a **sense of community**. Therefore, most discussions revolved around creating customized VA applications that leveraged internal data or tied to existing systems (e.g., an internal website) to provide information and assistance more conveniently and efficiently.

Table 3 provides examples of how designers might leverage existing VA capabilities to build on existing community capacities to make it easier for community members to access available assets. For example, creating custom VA applications that can help a user find and register for community events, submit maintenance requests using voice, or find information about others in the community. The vast majority of VA applications can already provide simple informational and transactional interactions [45], such as returning predetermined information or setting up event reminders. Therefore, these applications could likely leverage existing VA technologies (e.g., Alexa, Siri) which could also aid in widening access among community members.

Some participants also suggested enhanced interactions that go beyond the existing, command-based conversational model commonly used in existing VAs. In the current model, the user typically initiates a question, and the system answers [45]. Table 4 provides examples of how enhanced VA capabilities and features might provide even more support to build existing community capacities to make it easier for members to access community assets. For example, participants discussed applications they could “*talk to*” to “*help them identify*” relevant events that were going on in the community or to “*automatically notify*” and help them sign-up for communal trips to the grocery store. Therefore, instead of VA applications that support older adults as a passive actor, participants discussed that VA technologies might assume the role of a collaborator or “*true*” assistant and actively engage them to make the processes easier.

5.1.2 Implications for Voice Assistant Design. We provide several recommendations for designing VA applications that may serve communal needs based on the example use cases. While the focus of our study was on understanding opportunities for VA applications, these guidelines likely also apply to the design of any community-based intelligent technologies that leverage automation and are designed to support community needs. Our first recommendation aligns directly with the goals of our study. Our findings indicate merit in **including communities as partners in the VA design process**. By engaging community members directly, even in the exploratory phase, we uncovered use cases they value, which helped to identify several “*essential*” use cases that prior work notes can be a barrier to adoption among older adults [62].

One newer interaction approach mentioned by participants also suggests the need for **leveraging proactive engagement**. With this approach, instead of the user engaging the agent, the agent would engage the user [18, 64] to initiate interactions. These types of interactions are currently being studied, and early findings have

Table 3: Examples of communal VA interactions informed by findings that can be supported by existing VA applications.

Community Asset	Use Case	Example Voice Agent Interactions
Listing Events	1, 2, 3	<p>U: Hey [agent], what are today's events?</p> <p>A: Here are today's events. At 9:30 a.m. there is Group Yoga in Room 119. At 9:30 a.m. there is morning prayer in the Chapel. At 10:00 a.m. there is an art class in Room 230 ...</p>
Providing Information	1	<p>U: Hey [agent], is the mail in?</p> <p>A: The mail is not in.</p>
Maintenance Requests	2	<p>U: Hey [agent], I need to submit a maintenance request.</p> <p>A: Sure, what is the problem.</p> <p>U: My sink is leaking.</p> <p>A: What is your apartment/house number?</p> <p>U: 12345</p> <p>A: I submitted a maintenance request for [sink is leaking] for apartment/house number [12345]. Maintenance requests usually require a 7 day turn around. If you do not receive any follow up by [date], please call the maintenance department at 123-4567.</p>
Dinner Reservations	2, 3	<p>U: Hey [agent], I would like to make a dinner reservation for today.</p> <p>A: Sure, what is your name.</p> <p>U: My name is Ruth Greenwood.</p> <p>A: Ruth, how many people will be attending?</p> <p>U: Six</p> <p>A: I have made a dinner reservation in the cafeteria for today for six people. Check with the front when you arrive for table directions.</p>
Residents and Staff Information	1, 3	<p>U: Hey [agent], what is Vert McFadden's contact information?</p> <p>A: Vert McFadden, lives in apartment 180. Their number is 123-4567. Their email is vbert@gmail.com. Would you like to hear Vert's profile information?</p> <p>U: Yes</p> <p>A: Vert is from Mississippi. Vert likes gardening and travel. Vert is an Air Force veteran.</p>

suggested a need to further explore when and where such interactions might be appropriate [18, 64]. Cha and colleagues' study of proactive interactions with smart speakers found that opportune moments for context-aware smart speaker reminders often vary based on several contextual factors [18]. Our findings suggest that such interactions may be useful in enhancing community-based information access by not only providing timely information but also notifying members of information such as events that might be of interest to them. Therefore, proactive interactions could make becoming involved in the community easier. This could be helpful not only for those community members that may experience access barriers, such as the older adults with vision disabilities that participated in our study, but also others such as those that find using a computer challenging or that simply find the current process cumbersome. By making it easier to become involved in the community, VAs could support the goals of building a sense of community which could further build community assets [19, 20]. However, given research suggesting that some older adults find unexpected proactive communications unsettling [13], more work will be needed to understand how to design such interactions.

Related to the suggestion from participants that the voice assistant "*simply talk*" and their expectations that finding information, engaging with services, and connecting with others become easier, our findings also suggest the need for **including more reasoning abilities in VA application design**. To better reason about the users of the system, our findings suggest the need for VAs to be

able to **learn about participants' interests** and, using that information, be able to **provide personalized recommendations**. One of the potential advantages of community-level VA integration is the possibility of leveraging existing systems and processes to make reasoning and personalization more feasible. For example, the community we partnered with already provides access to other residents' information through internal services such as a website, resident directory, and profile. Because these systems and resources are already established, they could be leveraged to match people to community resources, opportunities, and others. Further, while privacy and trust concerns were not discussed among our participants, they have been shown as a barrier to adoption among older adults [13, 15, 62]. Since these existing internal systems have already been vetted by the organization, leveraging them could potentially ease some user's privacy concerns.

Related to increasing inclusion in the community, some studies, particularly those focused on accessibility and technology access, suggest VAs can potentially increase access to information for people with disabilities [2, 52] and older adults that may find it challenging to use technology [53]. Participants in our study also saw the potential for VAs to improve access and accessibility for those with disabilities and low technical knowledge. However, our findings additionally suggest that at the community-level VA, design requires an emphasis on building community capacity by improving access to community assets that are already available.

Table 4: Examples of communal VA interactions informed by findings that can be supported by enhanced VA capabilities and features.

Community Asset	Enhanced Features	Example Enhanced Voice Agent Interactions
Listing Community Events (User Sets a Daily Event Reminder for 9:00 a.m.)	- Proactive Engagement - Reasoning (Learns Interests, Personalized Recommendations, Refining Automated Transactions)	<p>A: Good morning, Ruth, there are some events happening today that might interest you. U: Great, what are they?</p> <p>A: [knows about Ruth's interest in art] At 10:00 a.m. there is an art class in Room 230. There are two spots available. There is a trip to the art museum scheduled for Friday, August 3 at 1:00 p.m. It was just posted. Would you like for me to sign you up for any of these events?</p> <p>U: Yes, sign me up for both.</p> <p>A: Okay. I have signed you up for the art class in Room 230 and the trip to the art museum.</p>
Connecting with Residents and Staff (Dinner reservations includes an option to meet and pair new people)	- Reasoning (Learns Interests, Personalized Recommendations, Refining Automated Transactions)	<p>U: Hey [agent], I would like to make a dinner reservation. A: Sure, Ruth, what date? U: Today A: How many people will be attending? U: One, just me. A: Would you like to meet someone new at dinner? U: Sure.</p> <p>A: There are three people with reservations that are interested in meeting others for dinner and have overlapping interests. All have reservations at 5:30 p.m. Vert McFadden likes gardening and travel. John Toussaint is from your home state. Pat Neely attends the same art class that you do on Tuesdays. Would you like to meet with any of these residents for dinner?</p> <p>U: Yes, I would like to have dinner with Pat.</p> <p>A: Sure. I have made a reservation at 5:30 p.m. for you and Pat. I will notify Pat and confirm.</p>

Doing so could aid in **supporting inclusion by increasing equitable access to community assets** (e.g., independently accessing community information and services) and **facilitating a sense of community through improved connections**. Several participants, with and without disabilities, emphasized the importance of VA applications for communities to focus on what is needed by the community instead of “generic” information access and services. Therefore, while prior studies have suggested that VAs can make information access and computing task more convenient, our study suggests that at the community-level the type of information and resources that are being supported by voice technologies are just as important to promoting adoption as the availability of voice to support independence or convenience.

5.2 Supporting Voice Assistant Diffusion and Sustainability within Communities Requires Leveraging Existing Community Assets

Learning about voice assistants, what they can do, and suitable use cases is a significant barrier to VA adoption [8, 27, 62]. For example, while primarily focused on VA use among families using generic features, Corbett and colleagues found that their participants struggled with learning to use VAs and wanted more assistance to learn

how to capitalize on the capabilities [27]. Among our participants, even those who used VAs daily for personal uses, some expressed a lack of awareness of what existing VAs can do, which they discussed would likely be a significant barrier to adoption at the community level. Staff raised similar concerns and stated it was one of the reasons they were interested in learning more about community interests, noting a lack of uptake of VA devices in a prior pilot program. Both staff and residents agreed that adding a new tool without identifying potential strategies to promote use and sustainability could likely cause more challenges for residents interested in capitalizing on VAs as a tool to access information and resources in the community. Therefore, our findings suggest a need to identify different technology diffusion strategies [8] when considering sustainable community VA integration.

Beneteau and colleagues introduced and explored the concept of VA diffusion [8] in their study, highlighting the necessity of understanding the dissemination and diffusion of learning of VA technologies among families. In their work, Beneteau and colleagues identify the strategy of a “near-peer” model that leverages the knowledge of others (family and friends) or “near-peers” to influence learning about VA technologies in family homes [8]. They propose a framework that leverages the social environment within the home that surrounds the user with learning influencers (i.e., the VA – Echo Dot and outside influencers - family and friends) and helps a family

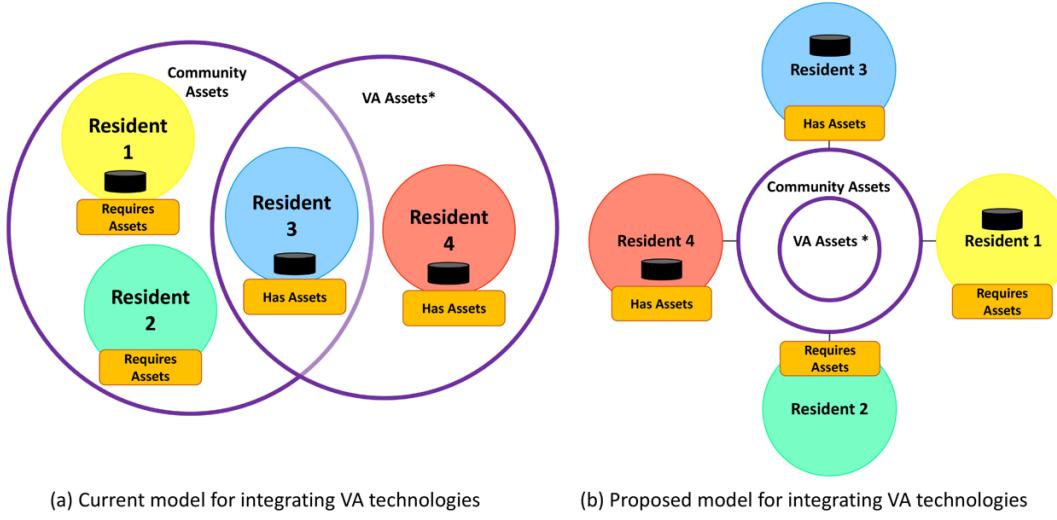


Figure 2: Current (a) and proposed (b) models for approaching the integration of voice assistant technologies in the community.
 *VA Assets = Information and Resources for learning and using VAs.

member learn about the VA technology. Our participants similarly noted that one of the advantages of living in a community is the potential to leverage the existing capacities or assets within the community, including human assets such as collective knowledge of other residents and staff to support the diffusion of learning efforts. Several participants shared efforts to create spaces such as interest and learning groups that could help more residents learn about VA technologies. Therefore, our work suggests that leveraging the expertise of others in near proximity could also benefit the adoption of VAs in community settings.

Our findings additionally suggest a need to fundamentally rethink community-level VA integration focusing efforts on leveraging existing community assets not only as part of the design process but also as a viable approach to supporting the diffusion and sustainability of VA designs within the community environment. Many existing studies show that VA learnability is a significant barrier to adoption and sustained use [8, 27, 62]. Within HCI, building sustainable community-based design is an ongoing challenge that has led to a focus on identifying approaches to building sustainable designs within the community and organizational contexts [25, 33, 60], including assets-based design [49, 66].

One of the tenants of the asset-based design is a design process that focuses on identifying existing capacities to support long-term sustainability and the impact of technologies within the community it supports [49, 66]. For instance, Dickinson and colleagues found that in the design of civic technologies, community residents felt any integration efforts should leverage existing community assets and connections between those assets to make it successful [25]. In Human-Computer Interaction (HCI), our study of assets as a method for sustainable design within communities aligns directly with Chaskin's examination of community capacities [19]. We found that the community we partnered with already had assets

built-in the environment that residents felt could be leveraged to advance integration efforts within the organization. However, from their perspective, one of the main challenges of integration was not necessarily related to the organization providing access to technology as they already had done but instead building additional community awareness (i.e., building new assets) that could sustain long-term adoption, maintenance, and training of VA technologies among residents.

In their work, Beneteau and colleagues contribute a model for re-thinking VA diffusion of learning within families. Based on our findings, we similarly propose a model for rethinking or shifting community-centered VA integration efforts from a “device” integration-focused model to a model that leverages the human assets within the community and centers them in the design process (Figure 2).

In the current model (Figure 2a), some residents have VA assets (e.g., individual skills, resources, and other supports) that could support the diffusion of learning and use of VAs to others in the community. However, often because of the ad hoc nature of the “device integration” approach, some residents may not be able to take advantage of those assets that could allow them to capitalize on the device’s capabilities (Figure 2a). For example, Resident 3 and Resident 4 may have individual assets (e.g., installation help, knowledge about useful skills) that could be leveraged to help others learn about VA technologies they already own (Resident 1) or may be looking to adopt (Resident 2). These individual assets could add to the overall availability of community assets. Yet, while there may be some overlap (e.g., Resident 3 offers occasional help to those they know), others, such as Resident 4, may be disconnected and want to help but have no avenue to do so.

To pivot to a community-focused approach (Figure 2b), we propose a model where community and individual VA assets are repositioned at the center of design and integration activities. In this model, VA assets are purposefully explored and included as part of the community assets already available to members. As our findings suggest, participants felt one of the advantages of living in a community is the ability to leverage the community's collective knowledge to address potential barriers to VA adoption, which ultimately would limit the device's usefulness to the overall community. With this new approach, the community and each resident would be able to pool assets in support of the larger community (e.g., creating workshops, small learning groups). Pivoting to a focus on leveraging assets might better support both individual and community VA adoption efforts, help identify the potential benefits and limitations of introducing a device for community purposes, as well as help uncover appropriate design cases for the community. In the proposed model, individual members of the community could leverage the assets or capacities of other humans (e.g., neighbors, friends, committees, staff) available to them as members of the community. Doing so could promote more equitable access to broader community information and resources that could aid community adoption of not only VAs but any technology that supports the community. This approach is aligned with other participatory methods that focus on partnership with communities and understanding the community as a first step to sustainable design [16, 30, 49, 66]. We acknowledge that the success of this approach will depend on several community characteristics. Yet, in a community such as the one studied with a high level of community capacity, this community-centered approach to integration might lead to better adoption and sustainability efforts within the community over time.

5.3 Limitations and Future Work

Most of our study participants were actively interested in using VA devices and self-selected to participate based on that interest. However, we acknowledge that certain voices, such as reticent users, may be excluded due to this self-selection. The uses and ideas about capacity building may vary for those with less knowledge about VAs, different experiences, or other opinions about VA integration within a community environment. Similarly, while we provide context about the community of focus during the study, opinions of VAs may also vary depending on different community characteristics. Aligned with the goals of similar types of research, while we anticipate that our findings may translate to other communities of older adults [24], our findings are contextualized to the particular communities involved [30, 50] and, therefore, may not be generalizable.

Our study leverages community forums to engage potential users, staff, and researchers in dialog about VA integration in the community. While other HCI researchers have used this method [25, 48] and demonstrated its effectiveness for democratizing the design process and engaging communities in design, the approach has its limitations. We attempted to compensate for potential limitations by recruiting from a group interested in community-level VA integration, providing additional mechanisms for participation (e.g., chat, non-verbal agreement-disagreement in Zoom) during virtual forums, and complementing early findings from forums with

interviews. However, hosting a community forum leads to larger groups than traditional focus group sessions. Yet, like focus groups [58], some participants may not elect to participate verbally for various reasons (e.g., personality, silent agreement, comfort), and we may have encountered this in our study.

Additionally, some potential use cases residents suggested also required organizational policy considerations. For example, including VAs at the community level in settings such as organized IL communities to support independence might violate the Health Insurance Portability and Accountability Act (HIPPA) which has requirements for the confidential exchange of personal health information. VAs for fall safety would need to align with in-house policies for fall support. There is also the question of who sustains the data needed to keep these systems up to date, which our participants felt would be essential to promote continued use. In addition to community-based capacities, systematic approaches to identifying organizational capacities, including potential limitations, are needed when considering the sustainability of VAs in a community setting. While staff were involved in our study, their main goal at the time was to learn about residents' perspectives and concerns. Therefore, our study provides limited insights into broader organizational challenges that may arise due to privacy or maintenance. Future work should focus on understanding concerns beyond those of community members that may affect integration efforts to address potential sustainability challenges more broadly.

In the future, we plan to continue working with the community, residents, and staff to explore broader sustainability issues, including those related to organizational privacy requirements and maintenance. We have also explored strategies for transferring and implementing some of the use cases feasible with existing VA technologies to develop community-focused applications. Our broader research goal is to continue to explore the use cases identified in this study, including enhanced conversational approaches that can support older adults living in community environments to better participate and take advantage of available assets.

6 CONCLUSIONS

We investigated older adults' perceptions of voice assistant technologies to support and enhance interactions in an independent living (IL) community. Findings suggest that IL residents used devices for individual needs in their homes. However, IL residents desired different types of VA support at the community level, including tailored applications relevant to the needs and challenges in their local community and consideration of capacity building needed to support integration efforts and adoption throughout the community. We discuss considerations and recommendations for designing communal VAs and integrating VAs in independent living environments. Our work contributes to research examining VA use in groups suggesting that at the community level, there is also a need for further concentrated studies to uncover how community dynamics may change VA use and requirements, including approaches to integration. We also discuss the potential for leveraging community capacities and assets as a springboard for strengthening the diffusion and sustainability of VAs within a community once integrated. Our work contributes to a better understanding of older adults' opinions about VA use at the community

level in independent living. We also contribute considerations for community-level VA integration.

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