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Perspective

Perspectives on Wider Integration of the Health-Assistive Smart Home

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Abstract: Most older adults desire to be as independent as possible and remain living in their ancestral home as they age. Aging-in-place maximizes the independence of older adults, enhancing their wellbeing and quality of life while decreasing the financial burden of residential care costs. However, due to chronic disease, multimorbidity, and age-related changes, appropriate conditions are required to make aging-in-place possible. Remote monitoring with smart home technologies could provide the infrastructure that enables older adults to remain living independently in their own homes safely. The health-assistive smart home shows great promise, but there are challenges to integrating smart homes on a larger scale. The purpose of this discussion paper is to propose a Design Thinking (DT) process to improve the possibility of integrating a smart home for health monitoring more widely and making it more accessible to all older adults wishing to continue living independently in their ancestral homes. From a nursing perspective, we discuss the necessary stakeholder groups and describe how these stakeholders should engage to accelerate the integration of health smart homes into real-world settings.

Keywords: smart home; telemedicine; telehealth; health monitoring; aged; older adults; Internet of Things (IoT); gerontechnology; multidisciplinary; interdisciplinary

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1. Introduction

Health systems around the world are faced with challenges including an explosion in the number of older adults. The global population of persons aged 60 and older is expected to nearly double from 12% to 22% between 2015 and 2050 [1]. Older adults typically desire to remain living in their ancestral homes for as long as possible [2,3]. However, complex interacting challenges such as chronic disease, multimorbidity, and age-related changes necessitate a certain level of oversight of the health and wellness of the older adult who is aging-in-place [4,5]. Many older adults will require specialized care [6] to manage chronic conditions, and many older adults typically have one or more chronic conditions requiring ongoing medical management [4,5,7]. The Health Smart Home (HSH) could serve as the infrastructure that enables the convergence of independent living with health, wellness, and medical care. The HSH could be central to the development of new, innovative models of aged care with a focus on dignity, independence, autonomy, and the avoidance of institutionalization of older adults which could enable cost-effective quality health outcomes [8–11].

1.1. Health-Smart Home

Smart homes for health monitoring are made possible by the Internet of Things (IoT) which connects a variety of electronic devices to enable the collection of large amounts of sensor-collected data which is then stored and processed using machine learning algorithms without human intervention [12]. Smart home sensors are described in various ways in the extant literature. They usually involve continuous, unobtrusive, in-home sensor-based health monitoring of social, behavioral, physical, and biological (e.g., vital signs) monitoring that is represented in activities of daily living (ADLs) which have been described as everyday activities such as sleeping, eating, toileting, and cooking [13]. Bennett, Roka, and Chen (2017) [14] define smart health care in the home as:

"A home or dwelling with a set of networked sensors and devices that extend the functionality of the home. . . in the pursuit of improving the health and wellbeing of its occupants and assisting in the delivery of healthcare services" (p. 2). We will use the term HSH to refer to sensor technology that is embedded or deployed in the home environment (e.g., attached to ceilings, walls, furniture, appliances) to detect motion in persons living in private dwellings in the community or retirement villages with an emphasis on remotely monitoring the health and wellness of the occupant to detect changes to facilitate early intervention.

A primary goal for the HSH is forecasting and predicting potential changes in health because with this knowledge the clinical team can implement early interventions prior to a health crisis [15,16]. For example, studies have shown that smart home sensors can recognize clinically significant changes in ADLs, showing potential for the HSH to support pain management and monitor function, falls, and sleep [17–20]. Some smart home products that offer services to customers that provide alerts to family caregivers or medical service providers if changes in the baseline are detected are already available on the market [21]. Despite some smart home companies catering to the needs of the older adult end-user, the HSH is not currently designated as a medical device, and the full potential of artificial intelligence for precision health using this technology is yet to be realized and widely adopted by older adults and caregivers [21].

1.2. Accelerating the Integration of the Health Smart Home

The World Health Organizations Global Strategy on Digital Health 2020–2025 guiding principles state that successful digital health initiatives require an integrated strategy [22].

The HSH should be viewed as part of the digital health ecosystem that can address the wider health needs of aging older adults.

Accordingly, there needs to be both coordination and collaboration among different stakeholders. Although interdisciplinary and multidisciplinary collaboration are not new concepts in smart home research, nor in aging research, the fruits of this collaboration remain elusive. For example, the integration of the HSH as a standard intervention for older adults living at home with chronic disease and age-related changes is currently not evident. This could be because older adults may not be sufficiently informed of the possibilities of the HSH, but the gross lack of adoption reveals that there are larger issues [23]. Given the HSH's potential to support positive health outcomes and extended independence for older adults and its potential to support the healthcare system by providing data about patients' health during complex and unprecedented challenges like COVID-19, more widespread adoption would be expected. In addition, there is little evidence that new models of home care such as those provided by HSH systems are being introduced to frontline health professionals to prepare them for clinical practice settings where home monitoring technologies are used.

In response to this perplexing situation, we reached out to multiple stakeholders including nurses with home care expertise to elicit their thoughts on how our disciplines can work together to advance the use of HSH data and the wider adoption of the technology. With this paper, we aim to stimulate a discussion leading to meaningful advancement of the HSH's use for extending older adults' independence. We propose a Design Thinking (DT) process for specific stakeholder groups that we (as nurses) believe should be engaged to accelerate the integration of the HSH into real-world settings.

2. Design Thinking

There are many types of DT processes, models, and frameworks that can be used to develop products and solutions [24]. We prefer the DT framework used by the Hasso Plattner Institute of Design at Stanford which includes five design phases: empathize, define the problem, ideate, prototype, and test. According to Auernhammer and Roth (2021), DT is made possible because it is based on psychological theories which integrate creative and human values. DT has been described as a strategic big-idea process that results in a product that addresses or solves a problem [25]. DT includes gaining a deep understanding of the perspectives of end-users' requirements and needs. DT processes have not been used to the full extent possible in the development of smart homes [26]. Thus, we will propose a process.

Whilst user-centered design is important [27], it is futile if the HSH is not accessible to the population it was designed for or if it cannot be integrated into everyday clinical aged care. User-centered design models are the most widely accepted and may have, at least in part, led to the current low uptake environment. These designs have not holistically considered accessibility (financial, acquisition), wants versus needs, privacy concerns, and end-user support and maintenance [23,28,29]. These design models may not take into consideration that the end-user is likely not to be the primary barrier to wider integration [30].

It is noteworthy to mention that whilst there is potential for wider integration, to our knowledge the HSH is currently not in the tool kit of healthcare professionals or medical service providers (e.g., home-care, primary care clinics) for routine recommendations for older adults who have a chronic disease, multimorbidity, and decreased function—and live alone—nor has it become part of new models of home care post-hospitalization or used as a routine intervention in retirement apartments to ensure the health, wellness, and safety of its occupants. From a gerontologic nursing perspective, both wider accessibility and integration of the HSH into everyday clinical aged care are required for the HSH to be widely adopted. We hypothesize a lack of wide integration is likely due to certain stakeholder groups not being included in the design process *from the beginning*. We believe the stakeholders highlighted here should be involved in the design. However, practically speaking, it is impossible to get all stakeholders together (across disciplines, industries, and patient populations) at the same design table for every meeting at every phase.

In Figure 1, we exhibit a stakeholder-based DT process aimed at facilitating wider integration of the HSH so older adults can be supported in their quest for independent living in their ancestral home for as long as possible. As Auernhammer and Roth (2021) indicate, moving from product design to product integration requires fluency in thinking and flexible approaches. Product development requires the capabilities and dynamic innovative synergy of a variety of stakeholders and a robust design culture with the capabilities of removing hindrances or barriers from the team [24].

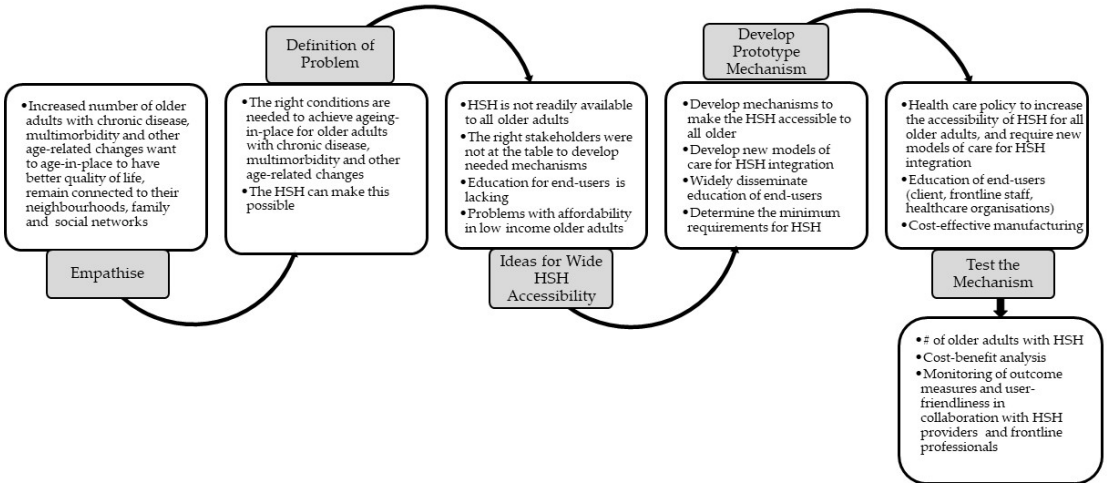

Figure 1. Design thinking process for integration of the HSH in the care of older adults.

3. Stakeholder Groups

It is well-known that a variety of disciplines and stakeholder groups must collaborate to provide quality care to older adults [31]. However, to facilitate the integration of HSHs in everyday clinical practice, wider groups of stakeholders must be included in the DT processes (Figure 1). From a nursing perspective, we believe that certain stakeholder groups are key to each design phase (Table 1). Stakeholders need to begin by *empathizing* with older adults living in poverty, suffering from chronic disease, multimorbidity, and natural age-related changes who wish to remain living in their ancestral home. This phase could be achieved using world-café methods to generate dialogue which should be thematically analyzed.

Table 1. Requirements and contribution for integration of health smart homes.

Stakeholder Group	Requirements for HSH Integration	Contribution to HSH Integration
	Microsystem	
Older adult & family caregivers (critical at each phase)	Knowledge of the HSH, benefits, and potential challenges How the HSH can meet the goals/needs of an older adult and family caregivers Funding mechanism that addresses initial HSH cost and ongoing service/maintenance fees Offering different levels of HSH that can change with the worsening of chronic conditions	Can be early adopters to test the user-friendliness of the HSH and to determine the aspects still needed to meet their needs
Frontline healthcare professionals (critical at idea generation, developing the prototype, testing the mechanism phases)	Education for older adults and their family caregivers Clinical workforce readiness to use HSH in care delivery	Trusted professions, prescribing/gatekeeping role Monitoring of health outcomes Contribute to workforce readiness
Social workers (critical at idea generation phase)	Opportunities to collaborate with governmental and non-governmental agencies, policies, or services Connect with HSH stakeholders to share knowledge that may impact the integration of the HSH	Determine the social complexities that impact aging-in-place of the older adult; connect older adult governmental and non-governmental agencies, policies, or services

Table 1. *Cont.*

Stakeholder Group	Requirements for HSH Integration	Contribution to HSH Integration
Multidisciplinary research teams (critical at each phase)	Funding and supportive academic and clinical environments to conduct research Studies that show clinical effectiveness and cost-effectiveness of the HSH Studies that show that the HSH is meeting the needs/expectations of older adults and family caregivers and clinicians	Findings from pragmatic clinical trials on the clinical effectiveness of the HSH The impact of HSH on older adults and family caregivers' needs/desires; and clinician end-user experiences/perceptions regarding the HSH and clinical decision-making Cost-benefit analysis
Academic or educator roles (critical at defining the problem, idea generation phases)	Increased digital literacy in health professional's education standards Increased educational materials developed for the public about HSH and how it can support older adults and family caregivers	Development of curriculum for allied health professions; educational material for older adults and family caregivers, and education on the HSH
	Mesosystem	
Health care organizations (critical at defining the problem, idea, and testing phases)	New models of care delivery using HSH Enable prescriptions for HSH Robust technology infrastructure and supports	Development of new models of care Clinical policies and procedures
Aged-care organizations (critical at defining the problem, idea generation, and testing phases)	Clinical workforce readiness to use HSH in care delivery Data visualizations that make sense for clinicians, and integration into existing electronic health record systems need a mechanism by which equitable access to the HSH is available to all older adults including low/lower income	Early adopters of HSH in retirement villages/apartments. Provides a platform to provide education to the public, older adults, and family caregivers Collaborate with the multidisciplinary research team
HSH Companies: Computer science & electrical engineering teams, entrepreneurs, start-ups, companies (critical at all phases)	Clinical significance of monitored health behavior to refine machine learning Data visualizations that make sense for clinicians, and integration into existing electronic health record systems Privacy/data security Business development and strategies for scaling up	Development of algorithms & artificial intelligent agent Clinician dashboard Sensor development and further innovation (e.g., gait analysis in the home, accommodating for pets) Formation of start-up companies to advance the practical manufacturing of HSH with minimal cost and clinical effectiveness and user-friendliness for older adults, families, and the clinical workforce
Master system integrator (MSI) (critical at developing the prototype, and testing phases)	Collaboration with technicians and building experts	Balances the depth and breadth of knowledge required to design and manage smart building systems on a short and long-term basis Connects the multidisciplinary team members with trade contractors and coordinates trade teams for effective design, implementation, and evaluation

Table 1. *Cont.*

Stakeholder Group	Requirements for HSH Integration	Contribution to HSH Integration
	Macrosystem	
Health care policymakers (critical at empathizing, defining a problem, testing phases)	Policies and standards for the HSH if covered by aged care packages public health funding Integration of HSH into aged care packages/ public funding Policies and standards developed for privacy and data management of HSH data	Development of health care policy with corresponding mechanisms for prescribers and payment, ensuring that all older adults have access to the HSH
Special interest groups/advocates (critical at Testing phase)	Knowledge and understanding of how the HSH can benefit	Advocacy, dissemination of education

Next, the stakeholders need to begin *defining the problem* and analyzing the associated root causes. This could be achieved through blended activities such as brainstorming, diagrammatic illustrations, and drawing on the expertise and knowledge of stakeholders. After ideas are generated using humanistic and creative processes, a multi-faceted set of solutions and accompanying mechanisms can be developed and approaches to testing can be determined. To facilitate the DT process, the relationship between all primary stakeholder groups needs to be transparent and collaborative (Figure 2). Members of the DT team should be aware that some stakeholder groups may be in closer proximity to the older adult and family caregiver at the microsystem level, whereas other stakeholders such as health care policymakers, whilst important, may be situated at the macrosystem level. The stakeholder group's role in the DT process should be commensurate with where in the system the stakeholder groups are situated, and their input and contribution may vary in intensity depending on the phase they are most critically needed for in the DT process.

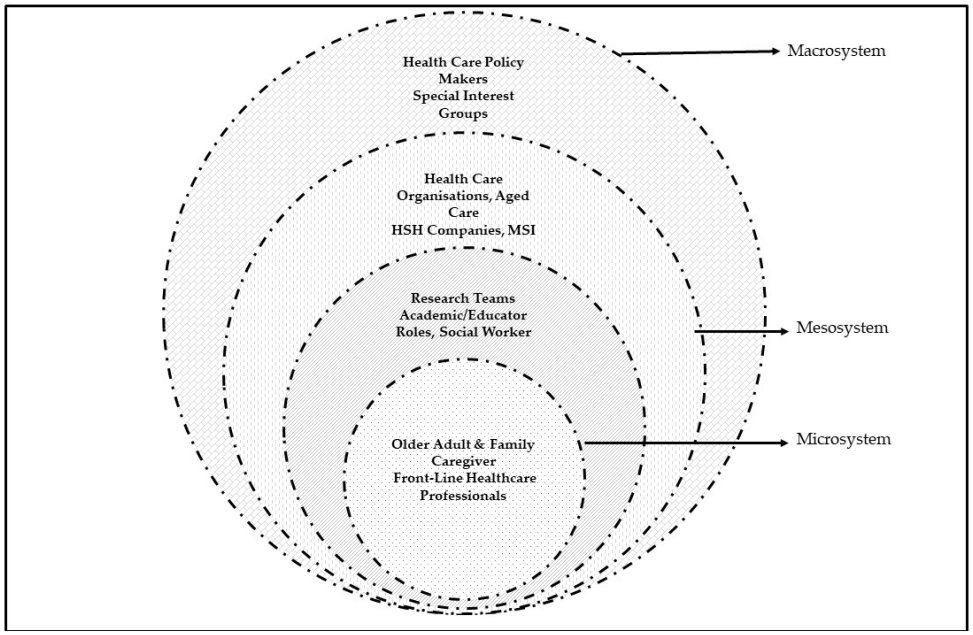

Figure 2. Relationships between primary stakeholder groups for design thinking.

3.1. Older Adult, Family Caregivers & Frontline Healthcare Professionals

As the older adult population increases and alternative aging-in-place solutions emerge, it is important that HSHs are designed for the unique needs of the older adult end-user [32]. The older generation may not be universally comfortable with technology

leading to varied perceptions about living with sensor-based monitoring [23]. Older adults and their family caregivers need to be more informed about how the HSH could support older adults to remain living independently, and HSHs should be designed to consider user preferences, add value, and not impinge on the quality of life or privacy [33]. Front-line health care professionals such as nurses, recognized as a trusted profession [34], are optimally positioned to provide education about the HSH to the older adults and family caregivers and to advocate for the implementation of the HSH [35]. Community-based nurses are familiar with a person's medical history, psychosocial context, desires, and needs and can use this holistic view to make recommendations for the HSH to doctors on behalf of the older adult. Subsequently, front-line health care professionals like nurses as well as older adults and family caregivers must become valued members at each phase of the DT process, with opportunities to participate in every DT phase [36].

The readiness of HSH adoption among older adults is questionable, and more studies are needed. Previous studies have reported that older adults have limited knowledge of how the HSH works and how it can be used to support them to age-in-place [23,29]. However, others suggest that whilst older adults also have concerns about maintaining privacy, they are willing to trade perceived loss of privacy for independence if they can remain living in their own home with the HSH [23,37–39]. The utilization of HSH technology to support family caregivers' roles in providing care for older adults is also important and could reduce the family caregiver burden [40].

However, more research involving both family caregivers and older adults is needed, because they may have different perceptions about the factors that may influence their readiness to adopt HSH [41]. In addition, family caregivers may be influential in supporting the adoption of the HSH. Accordingly, the lived experience and the desires and needs of both older adults and family caregivers and how HSH could support them is critical knowledge needed by the DT process to overcome the barriers impeding the adoption of HSHs and guide knowledge development and create pragmatic solutions to make the technology more acceptable, and adaptable.

3.2. Multidisciplinary Research and Academic or Educator Roles

Some healthcare professionals work in academic institutions to educate the next generation of healthcare professionals and conduct research, and some are educators in a variety of healthcare settings [42]. Whether the educator role is an academic role or a role in a health care setting, these professionals are optimally positioned to educate students, clients, and family caregivers about how the HSH works, the benefits, and how it can be accessed. This stakeholder group is positioned to develop a curriculum for the allied health professions and develop age-appropriate educational material for older adults and family caregivers which could support the integration of the HSH. The engagement of these stakeholder groups in *defining the problem* and *idea generation* is critical because the university environment is a natural and optimal place to explore novel solutions to real-world problems.

3.3. Social Workers

Because the home environment sets the stage for the older person's health and well-being, social workers could be instrumental in assessing the complex social needs of this population by ensuring social justice and social program access [43].

Therefore, social workers are critical at the *idea* phase as they can share insights about the pathways that can make the HSH accessible to older adults living in poverty. However, to our knowledge, no HSH development teams include social workers. These insights may be missed if this stakeholder group is not included. Social worker stakeholders should also collaborate with governmental and non-governmental agencies to develop policies or services which can support the creation of health care policies and the integration of the HSH.

3.4. Health Care Organizations

Health care organizations that provide home services and operate primary care clinics routinely care for older adults. Health care professionals that work for these providers follow the model of care required by the health care organization [44,45]. If the HSH is not integrated into the toolkit of health care professionals to be used in everyday practice, it is unlikely that a health care professional would recommend the HSH to their patients/clients. If the HSH is to be financially paid for by private or public insurance, medical doctors, nurse practitioners, and other allied health care professionals with prescribing ability may need to "prescribe" the HSH as a medical device. In addition, mechanisms to make the smart home data accessible to health care professionals to support care coordination would have to be created.

Whilst health care professionals could use the smart home data to identify changes in ADLs that may warrant early interventions, integration into the existing electronic medical record system and a dashboard to visualize that data with the healthcare professional in mind is still needed. Currently, health care professionals do not receive education on the use of smart home sensor data to augment clinical decision-making.

Accordingly, health care professionals need training and practical tools, work processes, and policies for the HSH to be integrated into in-home care services, primary care clinics, and similar settings that provide home services and telehealth to older adults. Many care costs are managed within healthcare organizations which makes these organizations a key partner in *defining the problem.* Cost-effective solutions will be more widely adopted and the systems (people within it) that manage those costs understand where solutions should be applied.

3.5. Aged Care Industry

The aged care industry provides a range of services and support to older adults wherever they live, including home care, aged care villages, long-term, and respite care. In 2018, more than 1.2 million people received aged care services in Australia alone, with most (77%) receiving support in their home or other community-based settings. Over 70% of older Australians live at home and will require clinical and supportive services at some point [11]. Insights on the global aged care market confirm that home-based care dominates the markets across not only Australia but also North America, Europe, Asia Pacific, Latin America, the Middle East, and Africa [46].

Importantly, many aged care organizations are early adopters of novel technologies as they can see the potential uses for their consumers. Despite its potential, the aged care sector has struggled to integrate innovative technologies into the aged-care system [47]. Whilst the aged care industry is a key stakeholder in the adoption of HSH technology across the aging spectrum, digital immaturity may inhibit some aged care providers from engaging with HSH technology. For example, one report found that cost, concerns about data privacy and security, and questions about the reliability and validity of the HSH technology are barriers to adoption among some aged care providers [48,49].

Partnering with these organizations to *define the problem* will be key to developing technology solutions that will be widely adopted. Likewise, these organizations are an optimal environment within which to *test prototype* solutions.

3.6. Computer Science & Electrical Engineering Teams

Researchers such as electrical engineers, computer scientists, start-ups, and big organizations (e.g., Google) are leading development and research in the smart home sensor technology space [15,50]. Although computer scientists use sophisticated computer-based modeling techniques and statistical analysis to understand sensor data of older adults in the home, they need health care professionals to provide real-world context about the meaning of the data. Without this context, it is difficult to produce reliable HSH monitoring and interventions [16]. Data visualization dashboards that make sense for health care professionals and can integrate with existing electronic health record systems are needed for

the HSH to be integrated into healthcare settings. The consistent engagement of electrical engineers and computer scientists with health care professional stakeholders will be useful for further innovation and machine learning [16,17]. Collaboration with start-up companies and collaboration with existing companies is needed to manufacture and market the most effective and user-friendly HSH system with the least cost possible. This stakeholder group is critical to every DT phase but should focus on more robust engagement in the *empathizing* phase. Nursing collaborators and other frontline caregivers are optimally positioned to facilitate first-hand empathizing experiences for the engineering group.

3.7. Companies and Start-Ups

This stakeholder group is critical at all phases. Companies usually include business strategists that can establish the business case for the HSH, implement the design plan effectively, and highlight its successes [21].

While the cost-benefit seems obvious to the health discipline stakeholders, making a positive business case to health policymakers and health care organizations can be challenging [51]. Collaborating with health care economists could prove useful in establishing a positive business case which can be evaluated during the testing phase. In addition to supporting the need for the HSH, business strategists establish timelines and address logistical considerations such as project schedules, team dynamics, and change management to optimize each HSH rollout to the health care market.

However, academic and commercial HSH development without front-line health care professionals will likely result in limited clinical application and therefore insufficient efficacy, redirecting efforts into a dead-end regarding how much can be achieved to support aging-in-place and quality of health care, safety, life for the older adult, and will culminate in slowing widespread adoption and real-world integration [35,52]. A primary goal for the HSH is forecasting and predicting potential changes in health because with this knowledge the clinical team can implement early interventions prior to a health crisis [15,16]. For example, studies have shown that smart home sensors can recognize changes in ADLs, showing potential for the HSH to support pain management and monitor function, falls, and sleep [17–20]. The consistent integration of the stakeholders including technical and clinical teams has a symbiotic effect to develop HSHs with the ability to predict potential changes in health and mitigate or eliminate health problems which has implications for health care utilization and subsequently can be used to make a positive business case for scaling up.

3.8. Healthcare Policy Makers and Special Interest Groups

Health care policies at the government level are needed to support the development of mechanisms that will facilitate new models of digitally enhanced care [45].

Government policies are needed for the integration of the HSH into everyday clinical practice and to ensure that all older adults—regardless of financial means—have access to the HSH if they desire to use it to support aging-in-place. Policies and procedures governing the use, operationalization, and expectation of the HSHs must be articulated to provide end-users with realistic expectations of the HSHs' capabilities. This is important to protect older adults and their families and to support informed decision-making. Because the health care policymakers function at the macrosystem level, they should leave their helicopter view and engage in the *empathize* phase which will be a driver to take policy recommendations forward during the *defining the problem, idea, prototype*, and *testing* phases.

There are a variety of special interest groups that could be helpful to disseminate information about the HSH to older adults and family caregivers during the *testing* phase. Special interest groups such as the Alzheimer's Association or Dementia Australia could also use their influence to advocate for specific HSH requirements for certain sub-populations, for example, older adults with dementia. Special interest groups are important stakeholders in the testing phase because they can use successful outcomes obtained in the testing phase

and influence the development and implementation of health policies [53] which could enable and solidify mechanisms for access and coverage of the HSH.

3.9. Master System Integrator

The smart building or technical design stakeholders have a critical role in the implementation of technology within the built environment, assessing current systems and stakeholder needs to develop a realistic gap analysis-driven approach to getting from the current state to a desired HSH future state. The technology specialist determines how software and hardware components should be architected to satisfy the requirements captured from stakeholder groups [54].

A Master System Integrator (MSI) should be incorporated into the DT process to *develop the prototype* and in the *testing* phases because this role is knowledgeable about balancing the depth and breadth of knowledge required to design and manage smart building systems in a short- and long-term basis. The multiskilled MSI is described as the "glue" and could be working closely with all stakeholder groups to support the integration of the HSH into real-world settings such as private homes, and retirement villages by connecting the multidisciplinary team members with trade teams for effective design, implementation, and evaluation [55].

4. Implications for Design Thinking for Real-World Integration of the HSH

A DT process that includes critical stakeholders could be effective in finding solutions and providing equitable access to the HSH. However, there are advantages and limitations to using this approach. The advantage of the consistent engagement of stakeholder groups in a DT process is that this interaction includes the relevant stakeholder groups which will ensure that each stakeholder group is able to give feedback and contribute equally through the humanistic and creative practices. Importantly, older adults, family caregivers, and front-line healthcare professionals will be able to provide valuable insights on wide integration and the issues surrounding accessibility. In addition, using a DT approach with the aim of HSH integration could also overcome global health system challenges such as workforce supply issues, pandemics, and ensure cost-effective, individualized care without overburdening the family caregiver. Finding solutions to make the HSH widely accessible is a complex undertaking as it is embedded in social and healthcare policy situated at the macrosystem level. Healthcare and social policies are needed to enable the development of mechanisms that support HSH integration into everyday care approaches.

Yet, the enactment of healthcare policy to drive HSH development and to provide wide access should not be viewed as a panacea for the wider adoption of the HSH. For example, whilst a policy-driven approach in China has indeed led to rapid development and scaling up of HSH to meet the older populations' needs, the demand for HSH by older adults has remained very low [29]. Primary concerns include older adults' lack of knowledge about the HSH, limited understanding of how this technology can support them, and concerns about cost and user-friendliness. Accordingly, potential barriers impeding HSH adoption should be examined, and addressed in tandem with the DT process to overcome these barriers [23,29,56]. Whilst most DT processes are time-limited, the complexity of making the HSH widely accessible will likely require a greater time commitment which may result in inconsistent stakeholder input, which could fragment the process. Another limitation of using the DT process is that it may be challenging to find organizational commitment that is also matched with a design culture and capabilities that can pragmatically support the process and remove barriers that may hinder the DT process and the actions that stakeholders may need to take.

Finally, further discussion is needed regarding how the integration of the HSH will be tested, and the type of health outcomes that could be measured to determine the effectiveness of the HSH in terms of achieving positive health outcomes on a population's health level. More research is needed to understand the readiness for adoption of the

HSH in older adults and their family caregivers, and pragmatic clinical trials are needed to determine the value of the HSH.

5. Conclusions

The development of the HSH does not end with a final product but continues with the integration of the HSH into the lives of everyday older adults who desire to remain living in their ancestral home as they age. Whilst the HSH can make this desire a reality, equitable access for all older adults—regardless of financial means—and scalability can only be achieved if critical stakeholder groups use a process like DT when developing the necessary mechanisms that make access for all older adults possible.

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