HEALTH SPRINGS: CONCEPTUALIZING A COMMUNITY FACILITY TO PROMOTE HEALTHY AGING AT

HIGH-RISE HOUSING IN SINGAPORE

A Dissertation

by

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ABSTRACT

Background and Aims: Due to land constraints and a rapidly aging population, innovative design solutions are needed to improve the situation of eldercare in Singapore. This study explored an "Aging in Place" strategy based on existing public housing neighborhoods to promote healthy aging for older Singaporeans. The researcher proposed and evaluated the feasibility of a new type of community facility (the Health Springs) to be located in the existing unused ground floor area of high-rise public housing buildings.

Methods: This design-based, mixed-methods study sequentially used focus groups and design workshops for grounded data collection and prototype development, followed by a cross-sectional survey to evaluate the potential use of the proposed Health Springs.

Results: Focus group discussions with healthcare workers and older adults (n=38) suggested the need for a highly accessible community facility to increase space for caregiver assistance and improve older adults' autonomy and health, emphasizing social connections beyond the family. Using the focus group findings, the design workshops with healthcare professionals (n=12) developed the proposed Health Springs facility, which included six different activity spaces to potentially support healthy aging. In the cross-sectional survey of public housing residents and design professionals (n=271), 81% of participants indicated they were likely to use the proposed Health Springs, with a perceived usability score (67.9/100) that strongly predicted the overall likelihood of using the Health Springs (p <0.0001). Expected health outcomes related to increased physical activity (p= 0.003) and likely use of individual spaces - a Garden Café (p= 0.0008), and Personal Care Room (p= 0.005) strongly predicted participants' expected usage of the facility.

Implications: Because of the availability of under-used ground floor area of homogeneous public housing buildings, the Health Springs is a feasible, innovative solution that potentially supports healthy aging in Singapore. This study assessed the impacts of perceived usability,

expected health outcomes, and likelihood of using specific spaces on the overall usage of the proposed facility. These findings can improve the design process and quality of future facilities for aging, and may be adapted to comparable high-density urban settings, potentially improving health and quality of life for residents, caregivers, and family members.

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CHAPTER I

INTRODUCTION

Understanding Aspects of Aging

Global Trend of Aging

With medical advancements and improved standards of living, human life expectancy in developed countries is increasing. In 2015, the U.S. Census Bureau estimated that 8.5% of the world's population consisted of older adults (65 years and older) and this number is expected to increase to 16.7% by 2050. Furthermore, there is an uneven distribution of older adults globally, with a higher percentage living in Asia (He, Goodkind, & Kowal, 2016). By 2050, projections suggest that two-thirds of the world's older adults will be located in the Asian region (He et al., 2016). Based on these global trends, the study will explore issues related to aging in Asia, specifically, Singapore. Singapore has a rapidly aging population, with statistics projecting that 1 in 4 adults will be over the age of 65 by the year 2030 (Ministry of Health [MOH], 2016). This research is focused on exploring how older adults can maintain their quality of life as they age in the urban setting of Singapore.

What is Aging?

For adults aged 65 and over, aging is a complex process of changes that affects one's overall functional abilities[1] over time. Aging is an accumulation of interacting biological, social, and behavioral processes influenced by one's physical and social environments. Individuals have different life experiences and socio-economic backgrounds that affect their health. Hence, there is a large variety of factors to be considered when studying the aging process. The more generalizable changes associated with aging are categorized into physiological, psychological, behavioral, and social changes.

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[1] Functional ability: The health-related attributes that enable people to be and to do what they have reason to value; it is made up of the intrinsic capacity of the individual, relevant environmental characteristics and the interactions between the individual and these characteristics (World Health Organization [WHO], 2015).

Physiological Changes

Physiological changes are biological developments that can result in gradual impairment of body functions, greater vulnerability to environmental challenges, and increased risk of disease (World Health Organization [WHO], 2015). These changes include sensory changes such as vision and hearing loss, deterioration of muscle strength, declining functional ability, and overall reduced immunity which results in a higher risk of contracting diseases (Carstens, 1993; WHO, 2015).

Psychological Changes

Psychological changes are frequently associated with the deterioration of cognitive functions and decision-making skills. In older age, deterioration of cognitive ability differs between individuals due to multiple influencing factors, including socioeconomic status, the presence of diseases, and the effect of medication (Carstens, 1993; WHO, 2015). Examples of psychological changes include deterioration in memory, slower reaction, and processing time, and reduced ability to handle complex tasks (Carstens, 1993; WHO, 2015).

Behavioral and Social Changes

Social changes are life events that occur with time and can affect an individual's social and functional roles. These social changes range from retirement to changes in family structure (Carstens, 1993). Life changes can result in a decreased sense of security, control, and number of relationships for older adults (Carstens, 1993). Social changes can result in changes in behavior and attitudes that affect one's health. Behavioral changes that occur with social and lifestyle changes can affect self-esteem, coping mechanisms, and maintenance of identity (Ory, Abeles, & Lipman, 1992). An example of behavioral change that arises from the inability to cope with the physiological aspects of aging is "learned helplessness," in which an individual develops dependent behavior as a means of asserting control over their social environment (Baltes, 1991).

This research used architectural design to explore how older adults can maintain their quality of life despite the physiological, psychological, social, and behavioral changes that can occur with age. A key factor that influences a person's approach to maintaining their quality of life as they age is society's attitude and perception of aging. A supportive environment gives

people the resources to help them maintain their quality of life as they age. Because of the multitude of physiological, psychological, behavioral, and social changes that occur with age, there exists the perception that overall health deterioration is an expected consequence of aging. This perception connects age-related health symptoms to the decrease in productive activity (Rowe & Kahn, 1997) and may diminish and reduce the social contributions of older adults (Angus & Reeve, 2006). The next section examines how a positive social perception of aging can create an age-friendly environment.

Healthy Aging

Healthy Aging is the World Health Organization's (WHO) public health strategy used as a holistic approach to address the needs of aging. The WHO defines Healthy Aging as the "process of developing and maintaining the functional ability that enables well-being in older age" (WHO, 2015; p. 28). The changes that one experiences with aging can be improved through two main courses of action. The first is through improving and maintaining a person's intrinsic capacity[2] (decreasing risks, promoting healthy behavior, and eliminating barriers). The second course of action enables increased functional ability by bridging the gap between a person's capabilities and their maximum potential in an assistive environment (WHO, 2015).

From a top-down approach, healthy aging is achieved through policies and environmental interventions. The second course of action is illustrated in Figure I-1 which demonstrates the interaction between an individual and his or her environment to raise functional ability. There are five factors that influence the interaction between an individual and their environment to assist in the maintenance of functional ability to bolster healthy aging. These factors are: 1) the ability to move around and physical activity, 2) fostering social relationships, 3) maintain basic needs, 4) mental development and autonomy, and 5) the ability to contribute back to society (WHO, 2015). Out of the five factors that assist in maintaining functional ability, three factors can be influenced directly by the built environment. These factors are physical activity, social relationships, and mental well-being.

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[2] Intrinsic capacity: the combination of all the physical and mental capacities that an individual can draw upon (WHO, 2015).
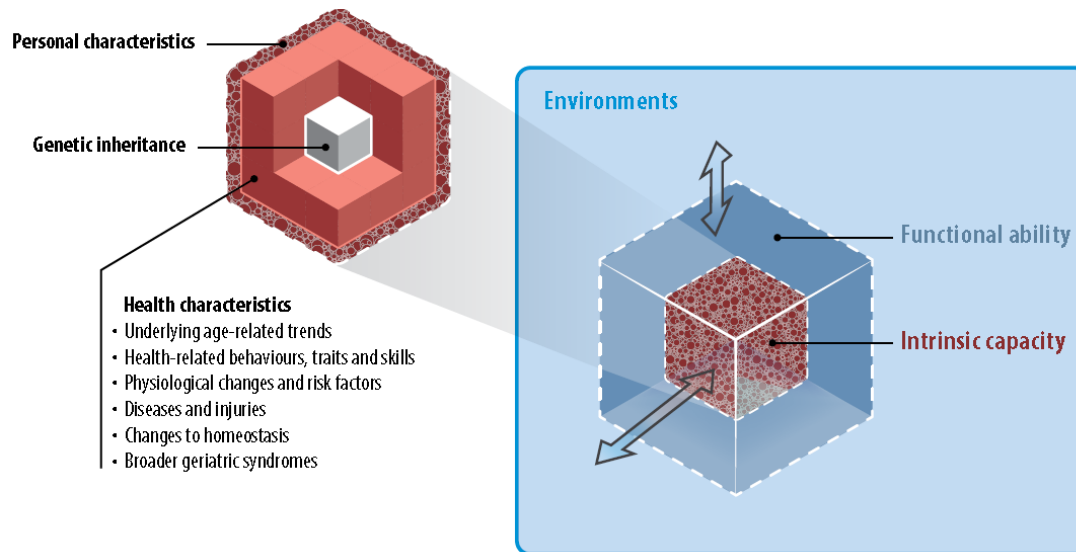
Figure I-1. Maintaining functional ability through the interaction between a person and his environment. (Reprinted from *World report on ageing and health 2015* (p.28), by WHO, Switzerland: WHO. 2015)

Physical Activity and the Built Environment

As a means of maintaining functional ability, physical activity is a key component of healthy aging. Physical activity includes low to moderate intensity tasks, such as walking or housework, as well as high-intensity exercises. Physical activity guidelines for older Singaporeans recommend 150 minutes of moderate-intensity aerobic activity a week; this includes brisk walking, ballroom dancing, golf, gardening, etc. (Sloan, 2011). Studies have shown that lack of physical activity is linked to higher risk of morbidity and disability (I.-M. Lee et al., 2012), while regular physical activity can lessen muscle deterioration and help individuals maintain cognitive function (Bauman, Merom, Bull, Buchner, & Fiatarone Singh, 2016). Furthermore, a Singaporean study of the effects of physical activity on fall-related incidences showed that older adults who took part in group exercise programs had a lower risk of injurious falls compared with the study's control group (Matchar et al., 2017).

Another Singaporean study indicated that habitual low-intensity physical activity such as walking was beneficial for older adults (Wong, Wong, Pang, Azizah, & Dass, 2003). The design of the built environment can influence the levels of physical activity older adults engage in. A few common environmental barriers to walking include the distance between places, high traffic volume, and unsafe pavement conditions (C. Lee & Moudon, 2008). A carefully designed built

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environment can encourage older adults to engage in more physical activity which will, in turn, promote healthy aging.

Social Relationships

High levels of social connections, communal support, relationships with friends and family, and participation in social activities are shown to have a positive impact on older adults' health outcomes as they age. The positive effects of social relationships include lowered risks of mortality, disability, dementia, and depression in older adults (Bassuk, Glass, & Berkman, 1999; Pollack & Von dem Knesebeck, 2004; Seeman, 2000; H.-X. Wang, Karp, Winblad, & Fratiglioni, 2002). A study in Singapore showed that loneliness and low levels of social engagement were directly related to higher rates of depressive symptoms in older adults (Lim & Kua, 2011).

Higher levels of social relationships occur in community-dwelling older adults who have a strong sense of belonging within their environment. A study had shown that the level of social participation in community activities was positively related to older adults' perception of their neighborhood as being walkable and with easy access to community services and amenities (Richard, Gauvin, Gosselin, & Laforest, 2008). Another study showed that older adults living in public housing in Singapore had lower likelihood of perceived isolation compared to counterparts that stayed in private housing due to participation in community events (Wu & Chan, 2012). Living environments that create opportunities for older adults to be socially active can help promote healthy aging.

Mental Well-Being

Mental well-being broadly encompasses the notion of happiness or contentment, the absence of negative determinants in life, resilience to daily stressors, and overall life satisfaction that varies between individuals (Diener & Chan, 2011; WHO, 2018). In this aspect, Ostir and colleagues studied the impact of positive attitudes on the onset of frailty in older adults. Their study revealed that participants who had a higher baseline attitude score had a slower onset of frailty compared with those who had lower scores for positive emotions at the beginning of the study (Ostir, Ottenbacher, & Markides, 2004). A study in Singapore that used the Geriatric Depression Scale as a measure of mental wellbeing found that depression was correlated to the level of perceived connectiveness of the public housing neighborhood and

participants who rated their neighborhood as less connected to the community were more likely to have higher rates of depression (Chong, Yow, Loo, & Patrycia, 2015).

Theoretical Models and Concepts of Health and Environment

Four main theories and concepts were used to structure the preliminary investigation of the research on aging in the urban residential setting, including 1) Environmental Press Theory, 2) Person-Environment Fit, 3) Person-Environment-Occupation Model, and 4) Aging-in-Place. These theories helped to ground and inform the development of this study's proposed intervention and significance.

Environmental Press Theory

Environmental Press Theory refers to the relationship between a person's functional capabilities and environmental stressors (Nahemow & Lawton, 1973). Building on Lewin's theory that behavior is the function of a person in his or her environment (Lewin, Heider, & Heider, 1936), Lawton introduced the "Press-Competence Model" to demonstrate the concept of Person-Environment fit, in which the behavioral outcome is determined by the intersection of a person's "competence" (functional capabilities) and the "demands" of the environment, described as "press" in Figure I-2 (Nahemow & Lawton, 1973). This theory helped to guide the first phase of the research investigation, exploring, and establishing the environmental challenges and their influence on a person's interactions within his or her environment.
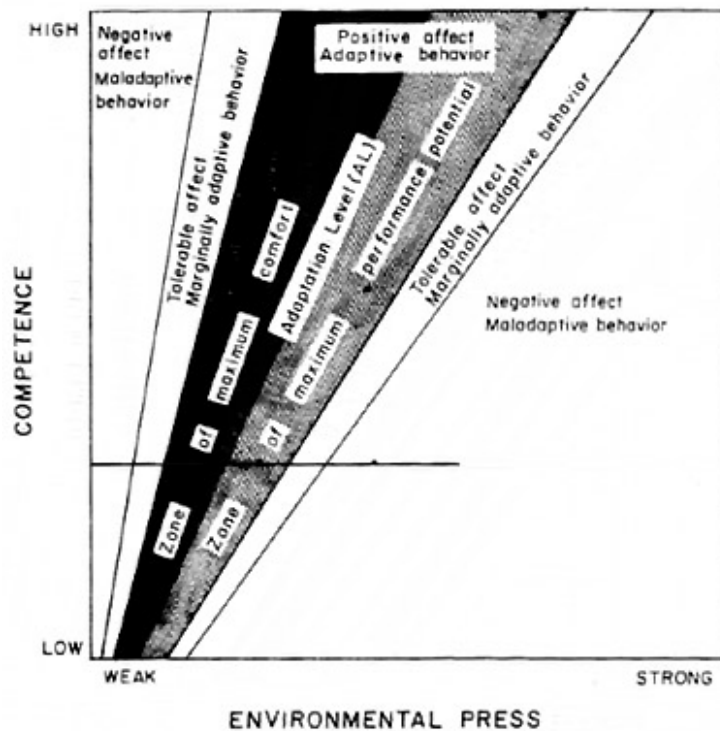
Figure I-2. Graphic representation of an ecological theory of adaptation and aging. (Reprinted from "Toward an ecological theory of adaptation and aging," by Nahemow & Lawton, 1973, *Environmental Design Research, 1*, p.27).

Person-Environment Fit

Person-environment fit (P-E fit) occurs when there is an equilibrium between environmental demands and a person's competence, over a range that produces positive outcomes (Nahemow & Lawton, 1973). Lawton proposes that the individual will achieve a sense of well-being through his or her environment in the shaded area shown in Figure I-2, representing different environmental scenarios along the horizontal axis (Baltes, 1991; Nahemow & Lawton, 1973). While there is a range of environments that fit an individual, the Competence-press model suggests that a well-designed environment can accommodate a broad spectrum of individuals with diverse levels of capabilities (Baltes, 1991). A small change to environmental press can affect the behavior of people with low functional capabilities within the immediate vicinity (Baltes, 1991; Nahemow & Lawton, 1973). This theory suggests that architectural changes and improvements to the environment could influence an individual's behavior and health outcomes. Hence, in Phases Two and Three, this study sought to

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investigate and establish a connection between a proposed architectural intervention and its potential to support healthy aging.

Person-Environment-Occupation Model

Furthering Lawton's Person-environment fit, an additional dimension that should be considered when discussing research on older adults' behavior in the environment is the concept of "occupation." Occupation refers to self-initiated, functional tasks and purposeful activities individuals engage in over their lifetime in order to fulfill their needs for self-maintenance and expression (Brown, 2009; Law et al., 1996). Used by occupational therapists, the Person-Environment-Occupation model, as shown in Figure I-3, engages a holistic approach to assessing the complete needs of an older adult. Occupation is an important inclusion in the Person-Environment transaction as it creates "the dynamic experience of a person engaged in purposeful activities and tasks within an environment" known as Occupational Performance (Law et al., 1996 pg. 16). Based on the theory of how "occupation" and purposeful activities create a dynamic experience for a person, this study sought to explore and introduce new types of activities for older adults to enhance their engagement with their community and improve their health. The theory of purposeful activity and dynamic experience helped develop the scope and methods for Phases One and Two of the research.
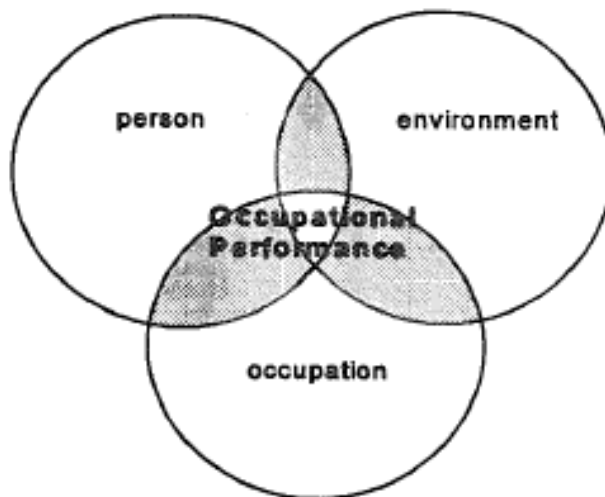
Figure I-3. The Person-Environment-Occupation model of Occupational Performance. (Reprinted from "The person-environment-occupation model: A transactive approach to occupational performance," by Law et al., 1996, *Canadian Journal of Occupational Therapy, 63*(1), pg. 19).

The Person-Environment-Occupation model allows for a flexible, multi-faceted approach towards intervention, with various opportunities to create change grounded in realistic, achievable settings for a targeted individual (Law et al., 1996; Strong et al., 1999). The flexible interaction between the component of person, environment, and occupation[3] is demonstrated in Figure I-4, which illustrates the effects on Occupational Performance when the relationship between Environment and Occupation increases.

The dynamic experience of a person engaged in purposeful activities and tasks within an environment

PERSON

ENVIRONMENT   OCCUPATION

PERSON

ENVIRONMENT   OCCUPATION

The dynamic experience of a person with the increased interaction between Environment and Occupation.
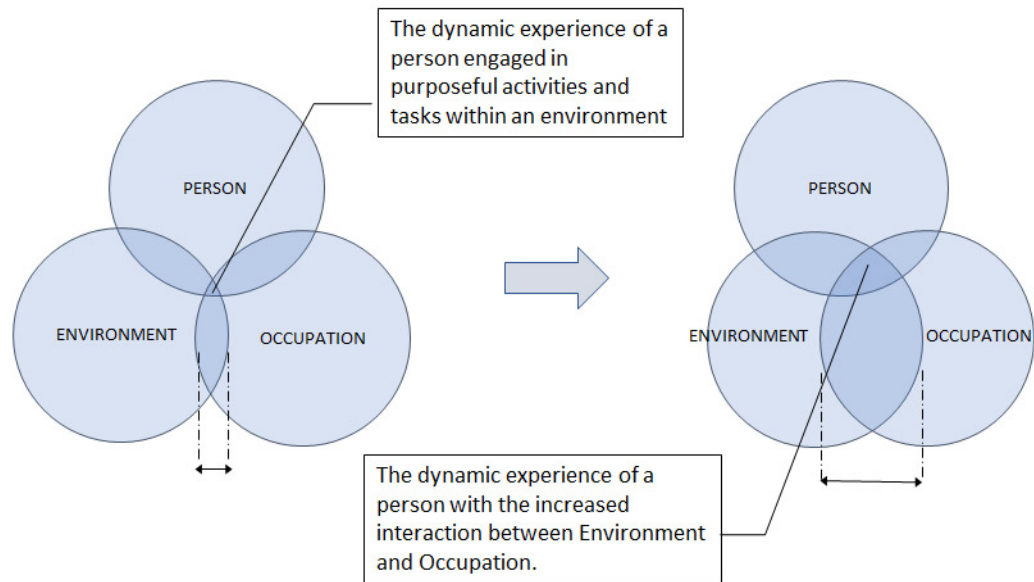
Figure I-4. Effect on Occupational Performance with the increase in interaction between Environment and Occupation. (Reprint [adapted] from "The person-environment-occupation model: A transactive approach to occupational performance," by Law et al., 1996, *Canadian Journal of Occupational Therapy, 63*(1), pg. 19).

Aging in Place

Lastly, aging in place is the concept of a person's ability to remain in one's home and community safely and independently while aging, reflecting the closest Person-environment fit to an individual's needs and preferences (WHO, 2015; Wiles, Leibing, Guberman, Reeve, & Allen, 2012). The concept of the "home" includes the physical house, the compounded symbolic attachments, the extended social community, and the resources available to the construct of the "home" (Peace, Kellaher, & Holland, 2005; Rubinstein, 1990). A study by Wiles and

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[3] Occupation refers to self-initiated, functional tasks and purposeful activities an individual engages in over his life time in order to fulfil his needs of self-maintenance and expression (Brown, 2009; Law et al., 1996).

colleagues, demonstrated that aging in place is linked to a sense of security and familiarity, in which older adults perceive their home as a place of refuge where they can exert their identity, autonomy, and independence while also viewing the extended neighborhood as a means of resources (Wiles et al., 2012). The residential neighborhood exerts a greater influence on older adults, with biological and behavioral changes affecting the degree of mobility and social interaction (Carp, Carp, & Millsap, 1983). For community-dwelling older adults in urban cities like Singapore, the residential neighborhood is highly influential in both physical and social domains, with evidence indicating the planning of neighborhoods makes a major contribution to various quality of life aspects (Newcomer, Lawton, & Byerts, 1986). This concept grounded the overall research investigation in the environmental setting of residential public housing, where the majority of the target users have lived their lives.

Overall, these theories related to the environment and health guided the research investigation on aging in Singapore's urban residential setting. The environmental press theory and Person-Environment fit guided the investigation on the interaction between older Singaporeans and their environment. The theories and concept of the Person-Environment-Occupation model and aging in place guided the investigation to explore meaningful spaces with the potential to+ engage older adults in Singapore's housing community.

Singapore Context

Public Housing in Singapore

With a population of 5.6 million residents distributed over 280 square miles, Singapore's population density is approximately 20,000 persons per square mile, according to the Department of Statistics (Department of Statistics [DOS], 2017). Because of the land limitations of this island country, 80% of Singaporeans live in high-rise public housing apartments that are managed by the Housing Development Board, a government subsidiary (DOS, 2017). The residential distribution for public housing in Singapore is classified into four levels, including five main regions with a total of 29 residential towns. Figure I-5 illustrates the distribution of 29 residential towns in Singapore. Each residential town has approximately 10 public housing districts, each district consist of 3-5 public housing neighborhoods with 10 to 15 public housing

buildings. The density of public housing is illustrated in Figure I-6, with each public housing building consisting of approximately 100 housing units as show in Figure I-7.
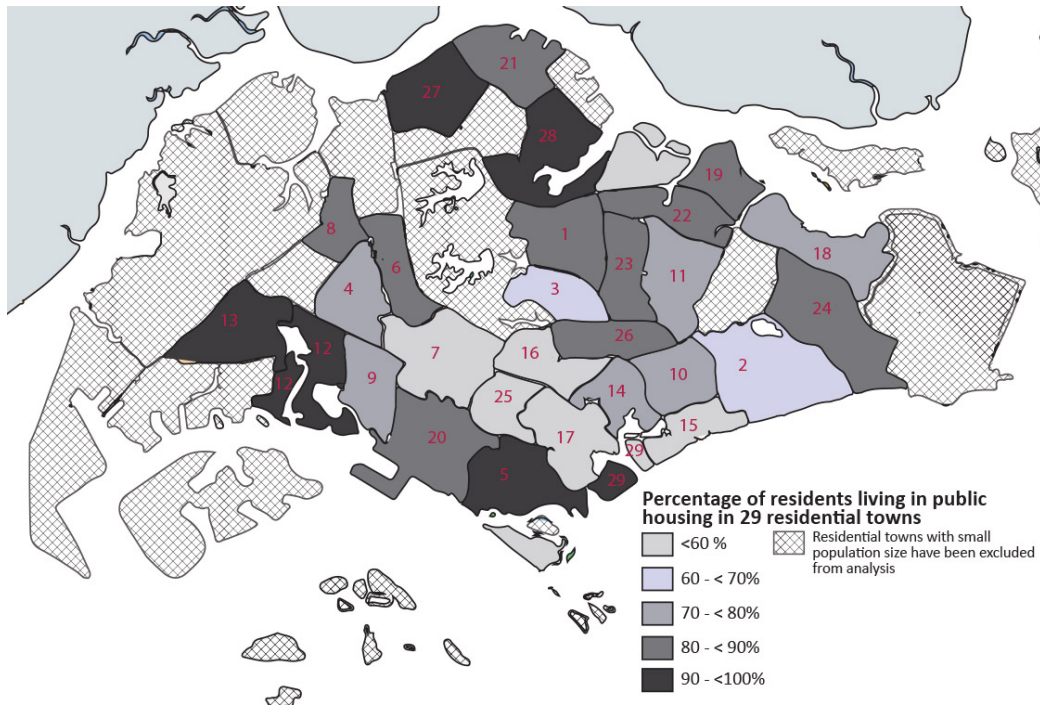
Figure I-5. Percent of residents living public housing residential towns, June 2017 (Reprinted [adapted] from *Population & Land Area* by DOS, 2017, Singapore: Singstat)

Public housing in Singapore has a unique influence on the health behaviors and outcomes of residents. With a focus on supplying affordable housing for the post-war baby boom population, 80% of today's public housing program was developed in the 1960s (Addae-Dapaah & Wong, 2001). For purposes of mass production, public housing design was developed to be homogenous and standardized for residents. An unfortunate outcome of this is that 80% of the existing public housing units are deemed to provide inadequate support for the needs of older adults at the present time (Addae-Dapaah & Wong, 2001).

Figure I-6. Typical example of public housing neighborhoods in Singapore.

Figure I-7. Typical public housing typology in Singapore built between the 1960s to 1980s, constituting 80% of existing public housing.

Aging at Home in Singapore

In Singapore, each separate housing unit has an average of 3.4 residents, and 30% of housing units have at least one older adult resident (DOS, 2015). Currently, there are approximately 413,000 older adults living in public housing units in Singapore, which accounts

for 80% of the older adult population in the country. Figure I-8 illustrates the distribution of older adults across the 29 residential towns in Singapore. The number of older adults living in public housing is expected to double by 2030 (DOS, 2017; C. Liu, Eom, Matchar, Chong, & Chan, 2016). Many older Singaporeans (78%) prefer to age in their current home, either by themselves (6%) or with only their spouses (78%), indicating a strong preference for independent living (Addae-Dapaah & Wong, 2001). Furthermore, a study on residential mobility showed that more than half of older adult participants preferred ordinary housing compared with retirement villages with specialized facilities (Addae-Dapaah & Wong, 2001). Thus, it is imperative to develop strategies to facilitate aging in place to cater to the needs of older Singaporeans.
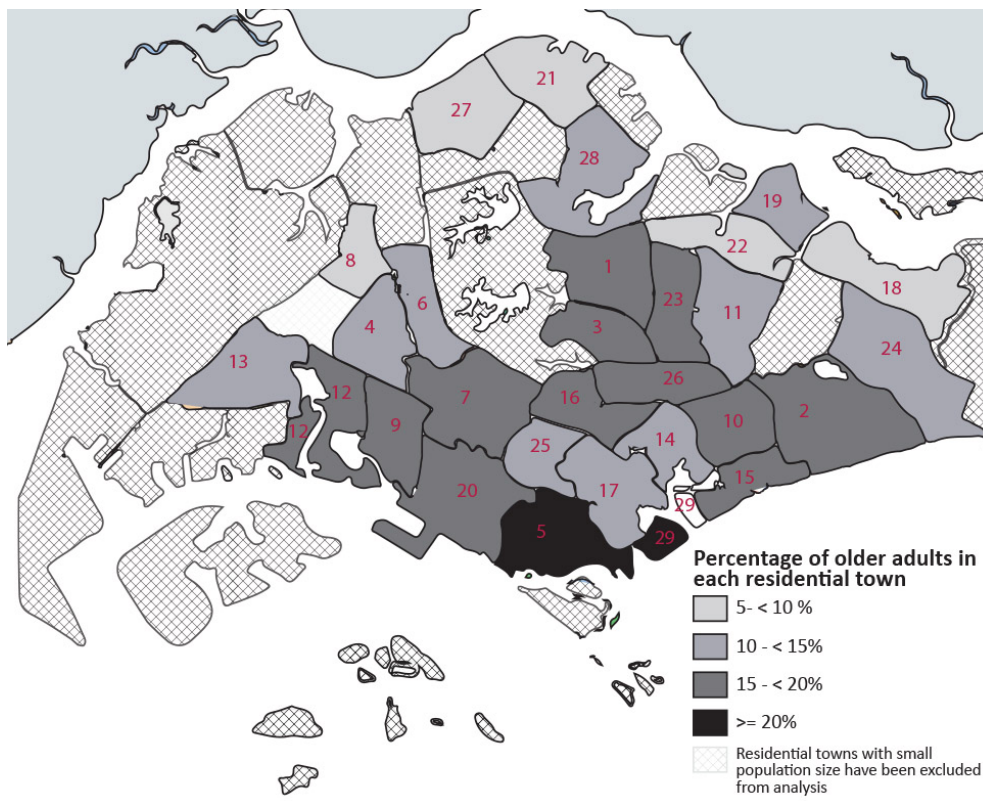
Figure I-8. Percent of residents 65+ by residential towns, June 2017 (Reprinted [adapted] from *Population & Land Area* by DOS, 2017, Singapore: Singstat)

Health Risks at Home

In studying the home environment of public housing in Singapore, there are three major health risks for older adults that are related to the design of public housing. The health risks are

unintentional injuries, limited activities of daily living (ADLs), and lack of social engagement (Addae-Dapaah & Wong, 2001).

Unintentional Injuries

Older adults have a higher risk of unintentional injuries in the home environment as compared with other age groups because they spend a greater proportion of their time at home (Lau, Scandrett, Jarzebowski, Holman, & Emanuel, 2007). Research indicates that there is a strong correlation between falls in older adults and environmental hazards, such as trip hazards and inadequate lighting (van Haastregt, Diederiks, van Rossum, de Witte, & Crebolder, 2000). In Singapore, the issue of environmental hazards is especially significant to community-dwelling older adults. In a review of injuries treated for elderly individuals at a Singapore emergency department, 67.9% of trauma cases were home injuries, with falls being the leading cause of harm (Yeo, Lee, Lim, Quek, & Ooi, 2009). Environmental hazards were the cause of 40% of falls in community-dwelling elderly Singaporeans, compared with 16% of falls in long term care institutions such as retirement homes (Duncan, 2011). Creating a safe environment that minimizes hazards is necessary to reduce barriers for older adults to age in place.

Limited Activities of Daily Living

A common challenge faced by aging in place is that older adults find it increasingly difficult to maintain their Activities of Daily Living (ADLs) within the home environment (Fausset, Kelly, Rogers, & Fisk, 2011). Although the typical home environment can accommodate the functional needs of the average independent adult, it does not necessarily possess the flexibility to quickly adapt to the ever-changing needs of an older adult (Pynoos, Nishita, Cicero, & Caraviello, 2008). In Singapore, it is projected that by 2030, 7% of older adults will have at least one ADL limitation that will require them to need caregiver assistance (Thompson et al., 2014). This projection poses a challenge to older adults' preference of independently aging in place and indicates a significant need for an increase in human and infrastructural support.

Lack of Social Engagement

Isolation is a common barrier to physically and socially aging in place (WHO, 2015). Independent living in a community often results in older adults being socially and physically isolated from those around them as their level of activity decreases with physiological changes.

Bearing that in mind, the issue of accessibility becomes critical in enabling older adults to maintain their connection to the community. Furthermore, another risk stemming from physical and social isolation is the diminished visibility of older adults' presence, which increases the barriers to providing medical attention (WHO, 2015). In Singapore, mobility limitations are correlated to barriers of accessibility as well as ADL limitations, leading to an overall decrease in social activities (Chan, Malhotra, & ØStbye, 2011).

Environmental Barriers to Aging in Place in Singapore

Environmental Hazards

Addae-Dapaah and colleagues list environmental deficiencies such as unsafe flooring, poor placement of light switches, and limited elevator services for high-rise public housing as being among the barriers and hazards that compound the stress and challenges older adults face with the aging process (Addae-Dapaah & Wong, 2001). The deficiencies in Singapore's public housing structure has resulted in studies and government development projects implementing home modifications as a prosthetic aid to the physical environment and community-based care, to enable older adults to age in place in their neighborhood (MOH, 2016; P. Teo, 1997). However, most government aid is a symptomatic response to existing design deficiencies (such as funding for walking aids and elevator upgrades), rather than taking the preventive approach outlined in healthy aging approach which targets health promotion.

Disconnected Planning

In the design of public housing neighborhoods, levels of physical activity are related to land-use mix, aesthetics, and walkability, which are key influencers of older adults' mobility (T. P. Ng et al., 2018). However, the ground floor of Singaporean public housing were designed to support secondary needs, such as residential committee events, instead of the direct needs of the residents as shown in Figure I-9 (Ling & Limin, 2002). A study shows the ground floor space of public housing does not encourage social engagement among residents, typically view the space as a transitional zone between their home and other destinations as shown in Figure I-10, rather than as a place to engage in meaningful activities (Ling & Limin, 2002).

Figure I-9. Example of typical usage and rudimentary treatment of space at the ground floor of public housing buildings.

Figure I-10. Example of typical ground floor setting in public housing buildings.

Social and Policy Barriers to Aging in Place in Singapore

Changing Social Trends

Most social support for Singaporean older adults is provided by immediate family members, supplemented by assistance from government-funded community-based care, such

as senior activity centers, rehabilitation facilities, and dementia centers located within the public housing estate (W. K. M. Lee, 1999; G. Liu, Yap, Wong, Wei, & Hua, 2015; Ramesh, 1992). With emerging social trends such as dual-career families and lower birth rates, the ratio of caregivers to older adults has dropped from 10.5 in 1990 to 5.1 in 2017 (DOS, 2017). This suggests that the traditional role of family caregiver needs to be shared with or transferred to alternative sources outside of the family nucleus.

Lack of Community Resources

A common shortcoming of aging in place is treating the home-based approach as a means to off load the financial and resource burden of eldercare from the state to the community and family, without adequate resources to support the caregiving of older adults (WHO, 2015). Between 1996 and 2006, the number of older Singaporeans using community-based services increased by 52% (G. Liu et al., 2015). However, this created a misalignment issue where senior activity centers administration aimed to serve more clients with few functional needs instead of those older adults who may require more specialized care (G. Liu et al., 2015).

Cost and Financial Barriers

Financial barriers may prevent older adults from attaining appropriate living and care environments. Generally, older adults with lower incomes report housing to be their biggest expenditure, which may determine their access to other resources, such as food and medicine (WHO, 2015). Financial security especially presents a challenge to older Singaporeans after retirement, with sources of income distributed between financial support from children, personal savings or investments, and a compulsory savings program (W. K. M. Lee, 1999). Studies in Singapore have found that personal and compulsory savings generally were not sufficient to feasibly support necessary home modifications to enable aging in place (Addae-Dapaah & Wong, 2001; G. Liu et al., 2015) and that 78% of older Singaporeans were unsure of the amount of money needed to finance aged care (Addae-Dapaah & Wong, 2001; LienFoundation, 2016; G. Liu et al., 2015).

Likewise, while physical activity is encouraged to maintain healthy aging, public health systems tend to perpetuate the limiting stereotype of physical activity as high-intensity

exercises in their public health campaigns. This approach may discourage older adults' self-efficacy toward maintaining an active lifestyle (Wong et al., 2003). Habitual physical and social activities, such as walking, gardening and housework, are described as be more beneficial towards older adults' health than sports-related activities (Wong et al., 2003). More studies regarding a variety of habitual physical activities in the public housing neighborhood need to be conducted to understand the health implications in older adults.

Significance of This Study

Knowledge Gaps

The literature highlights important issues with residential design and public housing, related to social isolation and environmental hazards for older adults. At the building level, issues such as limited elevator service and poorly-located light switches can cause problems. At the neighborhood level, the ground floor space in public housing does not support meaningful activities or social interaction for older adults. At the community level, there are insufficient resources provided for the caregiving of older adults. At the national level, the public health systems have not sufficiently emphasized research on habitual social activities that could potentially have significant positive health outcomes.

Opportunities

There is an opportunity to address the environmental and social barriers to aging in place within the community of public housing in Singapore. This design-based intervention study proposes a community facility to resolve many of the environmental problems of the home and neighborhood, and address the knowledge gaps pertaining to the issues of housing for older adults. By providing an easily accessible space for older adults to independently engage in physical and social activities in a relatively safe and accessible environment, this research proposes to address the needs of older Singaporeans within the public housing neighborhood.

Small improvements in public housing in Singapore may have significant effects on the health behaviors and outcomes of older residents. Coupled with the near homogenous design of public housing typology, improvements to the environmental features can have a major impact at different levels. Furthermore, with a majority of older adults indicating their

preference for independent living and aging in place in their current homes, Lawton's concept of Person-Environment fit may help produce environments that enable older adults to live fuller lives. The design and planning of public housing are crucial to helping older adults maintain their optimal functional ability and increase their intrinsic capacity to achieve healthy aging.

Purpose of the Proposed Intervention

The distal goal of this research is to promote healthy aging in older Singaporeans who live in public housing. The proximal goal of the research is to develop a proposed community facility at the ground floor of public housing buildings (Health Springs) that would increase the opportunities for social, health and wellness activities, and in turn enable healthy aging in older Singaporeans. The Health Springs intervention will incorporate the concept of Occupation[4] (functional and purposeful activities) into the Person-Environment (P-E) fit model.

Creating Environments with Occupational Therapy

The Person-Environment-Occupation (P-E-O) model describes a "dynamic experience of a person engaged in purposeful activities and tasks within an environment" (Law et al., 1996), p. 16). The Health Springs intervention intends to increase the integration of the physical environment and social programs (occupation) to promote Occupational Performance[5] and potential expected health outcomes shown in Figure I-11. The Health Springs intervention proposes to combine social programs and activities, such as therapeutic and recreational bathing, social and educational classes, cooking and dining options and restorative care, in a relaxing and stimulating environment. The synthesis between Environment and Occupation (social program) in the proposed Health Springs Center, has the potential to result in greater opportunities for meaningful experiences, multiplying the functional tasks beyond their basic purpose.

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[4] Occupation refers to self-initiated, functional tasks and purposeful activities an individual engages in over his life time to fulfil his needs of self-maintenance and expression (Brown, 2009; Law et al., 1996).

[5] Occupational Performance is the dynamic experience of a person engaged in purposeful activities and tasks within an environment (Law et al., 1996).
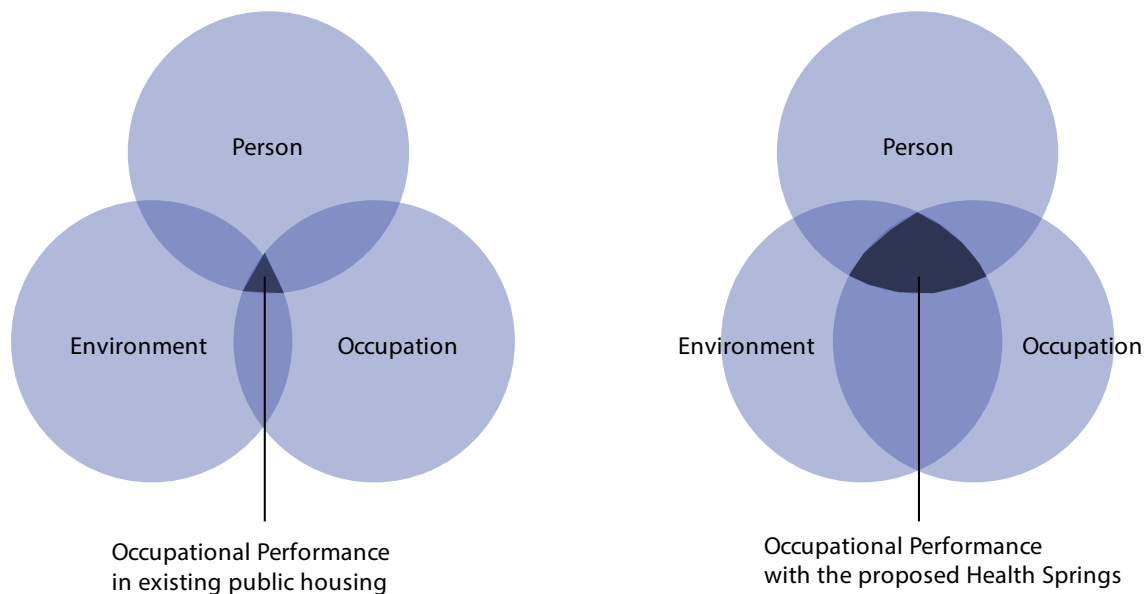
Figure I-11. The anticipated effect on Occupational Performance with the proposed increase in interaction between Environment and Occupation (Reprint [adapted] from "The person-environment-occupation model: A transactive approach to occupational performance," by Law et al., 1996, *Canadian Journal of Occupational Therapy, 63*(1), pg. 19).

The Health Springs Center

The Health Springs Center is a community facility proposed for public housing neighborhoods that aims to promote healthy aging for community-dwelling older adults. Building on concepts of person-environment interactions as discussed in the different works of Lawton and Kahana, the Health Springs intervention incorporates the contemporary component of Occupation. Occupation refers to self-initiated, functional tasks and purposeful activities an individual engages in over his or her lifetime in order to fulfill his or her needs of self-maintenance and expression (Brown, 2009; Law et al., 1996). Occupation is an important component in the Person-Environment transaction because it creates "the dynamic experience of a person engaged in purposeful activities and tasks within an environment" (Law et al., 1996 p. 16). Thus, in the conceptualization of the Health Springs intervention, environmental design features, social programs and activities are integrated to promote healthy aging.

Aims and Objectives

This cross-disciplinary study developed, and tested concepts of a new prototype community facility based on the ground floor of public housing buildings in Singapore. The main purpose was to promote healthy aging (Health Springs), effectively addressing the most important issues affecting the interactions between older adults and their environment. The research described here had three primary aims: 1) analyze the issues faced by older Singaporeans in public housing, 2) develop new design strategies to address the issues and promote healthy aging, and 3) evaluate potential feasibility of the proposed Health Springs design strategies in supporting healthy aging within public housing settings.

Aim One: Understand the Problem

The first aim and phase of this research was to understand user experiences with existing physical and social conditions that influence aging in Singapore's public housing. The first phase of this study used focus group discussions to study the functional aspects of bathing and falls prevention, as a means to explore the connection between the psychophysiological issues of aging and the home environment.

1. Objective One: To understand perceptions of P-E fit through the experience of users (older adults and caregivers) on aging in public housing, with relation to falls and habitual physical and social activity.
2. Objective Two: To understand current design issues, specifically the shortcomings of existing bathroom design strategies used for older adults.
3. Objective Three: To explore alternative design and social features that could potentially promote healthy aging for the new community facility (Health Springs) located in public housing.

Aim Two: Create a Solution

The second aim and phase of the research was to explore design solutions incorporating environmental and social features in a conceptual community facility (Health Springs), capable of producing positive health outcomes. The findings from Phase One were used to guide the design exploration in Phase Two.

1. Objective One: Organize and review focus group information using an established design programming matrix ("Problem Seeking," by Pena & Parshall, 2012) to establish factors that can promote healthy aging and usage of the proposed Health Springs wellness centers.

2. Objective Two: Explore a new typology of community facility by developing a 3D simulated model that represents the Person-Environment-Occupation interaction in the Health Springs and to test the overall acceptability of the 3D model.

Aim Three: Evaluate the Health Springs

The third aim and last phase of this research was to test the potential design and health benefits of the Health Springs with a larger, more representative, and more diverse population sample.

1. Objective One: To investigate the likely use of the proposed Health Springs wellness centers.

2. Objective Two: To examine the relationships between perceived usability, expected health outcomes, and the likely usage of individual spaces in the Health Springs with overall use of the Health Springs.

3. Objective Three: To compare the opinions of three population groups (housing residents, older adults, and design/planning professionals)) regarding their opinions on the likely use of the proposed Health Springs.

Methods

Architectural Design-Based Research

In addition to testing existing theories, design-based research encompasses multiple methodological approaches with the intention of creating new theories or practices that react with reality. (Anderson & Shattuck, 2012; Barab & Squire, 2004; Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003; F. Wang & Hannafin, 2005). The method of research produces rich ethnographic data that describes and responds to reality by involving relevant stakeholders in multiple inquiries through design sessions (Anderson & Shattuck, 2012; Barab & Squire, 2004; F. Wang & Hannafin, 2005). This makes the application of design-based research into real-life

settings more congruous than typical research methodologies (see the comparison in Table I-1 below).

Table I-1.
Comparing Psychological Experimentation with Design-Based Research Methods.

Category	Psychological Experimentation	Design-Based Research
Location of research	Conducted in laboratory settings	Occurs in the buzzing, blooming confusion of real-life settings where most learning actually occurs
Complexity of variables	Frequently involves a single or a couple of dependent variables	Involves multiple dependent variables, including climate variables (e.g., collaboration among learners, available resources), outcome variables (e.g., learning of content, transfer), and system variables (e.g., dissemination, sustainability)
Focus of research	Focuses on identifying a few variables and holding them constant	Focuses on characterizing the situation in all its complexity, much of which is not now *a priori*
Unfolding of procedures	Uses fixed procedures	Involves flexible design revision in which there is a tentative initial set that are revised depending on their success in practice
Amount of social interaction	Isolates learners to control interaction	Frequently involves complex social interactions with participants sharing ideas, distracting each other, and so on
Characterizing the findings	Focuses on testing hypothesis	Involves looking at multiple aspects of the design and developing a profile that characterizes the design in practice
Role of participants	Treats participants as subjects	Involves different participants in the design so as to bring their differing expertise into producing and analyzing the design

(Reprinted from "Design-based research: Putting a stake in the ground," by Barab & Squire, 2004, *The Journal of the Learning Sciences, 13*(1), pg. 5).

A key part of design-based research is using multiple iterations or rounds of adjustment to aspects of the study design, allowing researchers to test and generate theories in a naturalistic setting (Barab & Squire, 2004). Constant adjustment to the research investigation due to influences from external factors is similar to the creative process of design in architectural projects. Thus, the nature of design-based research is ideal for an architectural

study on environmental and geriatric behavioral studies, formulating a health/design intervention as part of the study.

Mixed-Method: Exploratory Sequential Research

It was important to establish a systematic framework for the underlying structure of the study, because design-based research incorporates the influence of external elements to shape and adjust the research inquiry. For this study, the researcher used Clark and Creswell's exploratory sequential research design to investigate new architectural strategies in the Health Springs that will promote healthy aging for older Singaporeans living in public housing.

Exploratory sequential research is typically used in scenarios pertaining to product development or generating new intervention programs (Creswell & Clark, 2017). Exploratory sequential research design is usually divided into multiple research phases, where one research phase will influence the development of the following phase (Creswell & Clark, 2017). The initial phase typically emphasizes the collection and analysis of qualitative data; this results in the product development, which is then followed by quantitative tests of the final developed feature (Creswell & Clark, 2017). The Health Springs research used the underlying structure of exploratory sequential research to guide the investigation in three distinct phases.

Phase One: Focus Group Discussions

As the first step in this exploratory research, Phase One sought to understand the user's experience with existing social conditions and environmental design that influence aging in Singapore's public housing using focus group discussions with healthcare workers and older adults. To understand the good and poor Person-environment fit of the existing housing environment in relation to aging, five domains of investigation were identified for discussion in the focus group sessions: 1) environmental barriers, 2) existing design solutions, 3) innovative design solutions, 4) health-seeking behaviors and 5) social connections. During the focus group discussions, the preliminary design of a potential community facility was conceptualized, emphasizing possible social and environmental features that promote healthy aging. Information gathered in this phase was used to develop the Health Springs design intervention in Phase Two.

Phase Two: User Design Workshop

As the intermediate phase on the research, Phase Two aimed to discover new design approaches for healthy aging in public housing through a series of design workshops. The design workshops used feedback from healthcare professionals with expertise in geriatric care to explore: 1) potential social and environmental features of the Health Springs that would support older adult use, and 2) design strategies that minimized potential environmental barriers associated with Health Springs. Physical and social features that focus group participants associated with improved health outcomes were incorporated into the design concept of Health Springs to form a three-dimensional prototype. The design generated from this phase was then assessed in Phase Three.

Phase Three: Online Survey

As a final step in this exploratory sequential research, Phase Three studied the potential application of the Health Springs concept by investigating the extent to which public housing residents might use the Health Springs facility in their neighborhoods through surveying a larger, more representative, and diverse population sample. The focus group discussions and design workshops in Phases One and Two explored the types of environments and activities expected to support healthy. Phase Three aimed to test the likely use of the proposed Health Springs, and how it is influenced by the overall perceived usability, expected health outcomes associated with the use, and the likely use of individual spaces.

Sample and Recruitment

Collaboration with the Geriatric Education and Research Institute of Singapore

This project was conducted in collaboration with the Geriatric Education and Research Institute (GERI) of Singapore. GERI is a dedicated research institute of the Khoo Teck Puat General Hospital in Singapore that emphasizes age-related health issues with the intention of promoting healthy aging. GERI was approached to collaborate on this research because of the institution's focus on the continuity of care between acute and community settings for older adults in Singapore. The institute is involved with a broad range of research-related projects, including novel studies on national health policies, innovative senior care delivery in the community, and clinical research and educational initiatives.

Role of GERI in the Study

GERI assisted with data collection in Singapore and provided expert feedback in translating data into design solutions through the design workshops, and at other stages of the study. GERI's affiliation to Khoo Teck Puat General Hospital grants the institution access to the main hospital's Falls Clinic (a geriatric outpatient clinic that focuses on treatment and assessment of falls in older adults) and a network of step-down community care associations, including several senior care centers in public housing neighborhoods. GERI's affiliation with multi-tiered clinical services allowed for the Health Springs research to draw participants from a broad population range. GERI also assisted in the study's submission to obtain approval from Singapore's Institutional Review Board.

Recruitment Strategy

Recruitment was divided into three phases to align distinct population samples with each of the three research phases. The overall recruitment phase was conducted between May 2016 and October 2018. The timeline of the different recruitment phases is highlighted in Table I-2. Table I-2 also describes the different stakeholder groups targeted for participation in the exploratory design-based research for their different opinions and input on aging in public housing. The four main participant categories are older adults, healthcare workers, housing residents, and design/planning professionals. The research also recruited participants from different location settings, such as senior activity centers, a primary care clinic, public housing neighborhoods, and design and planning firms.

Table I-2.

Recruitment Setting, Time Frame, and Participant Categories by Research Phase.

Older Adults	Healthcare Workers	Housing Residents	Design/Planning Professionals
Phase ONE Focus Groups (May-Aug 2016)			
22 older adults were recruited from five senior activity centers and a Falls Clinic. 6 focus group discussions were conducted, with each group having about 4 older adults aged 65 and older.	16 caregivers from the five senior activity centers and a Falls Clinic participated in four focus group discussions in groups of 3-5 participants, separately from older adult participants.	Not included	Not included
Phase TWO Design workshops (Oct-Nov 2016, Feb-Apr 2017)			
Not included	12 healthcare professionals from GERI institute were recruited for design workshops. 40 healthcare workers and caregivers from the five senior activity centers and Falls Clinic recruited for a preliminary survey of Health Springs	Not included	Not included
Phase THREE Large-Scale Survey (Jun-Oct 2018)			
The study recruited approximately 40 older adults from four senior activity centers similar to Phase One for their feedback on the Health Springs intervention using a paper survey.	Not included	146 residents from four different public housing residential towns were recruited through the social media pages of public housing residential committees.	83 participants from 6 different agencies involved in the planning, design, and development of public housing will be recruited. The survey will be distributed to the various companies via corporate emails, from which the participants may access the online link to Qualtrics.

Summary

This study undertook a sequenced, exploratory, design-based approach to understand the challenges older Singaporeans face while living in public housing. Through exploring the environmental and social barriers older Singaporeans face, the research developed an innovative new type of community facility (the Health Springs Wellness Center) that could promote healthy aging. The research was evaluated at each phase by the multiple groups of stakeholders involved in the design, health planning, and potential use of the Health Springs.

References

Addae-Dapaah, K., & Wong, G. K. M. (2001). Housing and the elderly in Singapore – financial and quality of life implications of ageing in place. *Journal of Housing and the Built Environment, 16*(2), 153-178. doi:10.1023/a:1017960600667

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher, 41*(1), 16-25.

Angus, J., & Reeve, P. (2006). Ageism: A threat to "aging well" in the 21st century. *Journal of Applied Gerontology, 25*(2), 137-152.

Baltes, M. (1991). The behavioral system of dependency in the elderly: Interaction with the social environment. In M. Ory, R. Abeles, & P. D. Lipman (Eds.), *Aging, health, and behavior* (pp. 83-106). Thousand Oaks, CA: SAGE.

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences, 13*(1), 1-14.

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine, 131*(3), 165-173.

Bauman, A., Merom, D., Bull, F. C., Buchner, D. M., & Fiatarone Singh, M. A. (2016). Updating the evidence for physical activity: summative reviews of the epidemiological evidence, prevalence, and interventions to promote "active aging". *The Gerontologist, 56*(Suppl_2), S268-S280.

Brown, C. (2009). Ecological models in occupational therapy. In E. Crepeau, E. Cohn, & B. Schell (Eds.), *Willard & Spackman's occupational therapy* (pp. 435-445). Philidelphia, PA: Lippincott Williams & Wilkins.

Carp, F. M., Carp, A., & Millsap, R. (1983). Equity and satisfaction among the elderly. *The International Journal of Aging and Human Development, 15*(2), 151-166.

Carstens, D. Y. (1993). *Site planning and design for the elderly: Issues, guidelines, and alternatives*. New York, NY: John Wiley & Sons.

Chan, A., Malhotra, C., & ØStbye, T. (2011). Correlates of limitations in activities of daily living and mobility among community-dwelling older Singaporeans. *Ageing and Society, 31*(4), 663-682.

Chong, K. H., Yow, W. Q., Loo, D., & Patrycia, F. (2015). Psychosocial well-being of the elderly and their perception of matured estate in Singapore. *Journal of Housing For the Elderly, 29*(3), 259-297.

Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9-13.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*: Thousand Oaks, CA: SAGE.

Diener, E., & Chan, M. Y. (2011). Happy people live longer: Subjective well-being contributes to health and longevity. *Applied Psychology: Health and Well-Being, 3*(1), 1-43.

DOS. (2015). General Household Survey 2015. Retrieved 03/12/2018, from Singapore
        Department of Statistics https://www.singstat.gov.sg/docs/default-source/default-
        document-library/statistics/visualising_data/highlights-of-ghs2015.pdf

DOS. (2017). Population & Land Area. Singapore Department of Statistics Retrieved
        03/12/2018, from Singapore Department of Statistics
        https://www.singstat.gov.sg/statistics/latest-data#16

Duncan, P. (Producer). (2011, 03/12/2018). Falls: Public health problem and fear epidemic.
        [PDF] Retrieved from http://aic-learn.sg/uploadedFiles/Training_Grants/HDMP-
        ILTC/A.Epidemilogy%20of%20Falls.pdf

Fausset, C. B., Kelly, A. J., Rogers, W. A., & Fisk, A. D. (2011). Challenges to aging in place:
        Understanding home maintenance difficulties. *Journal of Housing For the Elderly, 25*(2),
        125-141. doi:10.1080/02763893.2011.571105

He, W., Goodkind, D., & Kowal, P. R. (2016). *An aging world: 2015* (Vol. P95/16-1). Washington,
        DC: U.S. Government Publishing Office.

Lau, D. T., Scandrett, K. G., Jarzebowski, M., Holman, K., & Emanuel, L. (2007). Health-related
        safety: A framework to address barriers to aging in place. *The Gerontologist, 47*(6), 830-
        837. doi:10.1093/geront/47.6.830

Law, M., Cooper, B., Strong, S., Stewart, D., Rigby, P., & Letts, L. (1996). The person-
        environment-occupation model: A transactive approach to occupational performance.
        Canadian Journal of Occupational Therapy, 63(1), 9-23.

Lee, C., & Moudon, A. V. (2008). Neighbourhood design and physical activity. *Building Research
        & Information, 36*(5), 395-411. doi:10.1080/09613210802045547

Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., & Group, L. P. A. S.
        W. (2012). Effect of physical inactivity on major non-communicable diseases worldwide:
        an analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219-229.

Lee, W. K. M. (1999). Economic and social implications of aging in Singapore. *Journal of Aging &
        Social Policy, 10*(4), 73-92. doi:10.1300/J031v10n04_05

Lewin, K., Heider, F., & Heider, G. M. (1936). The psychological worlds and the physical world. In
        Principles of topological psychology (pp. 66-75). NY: McGraw-Hill.

LienFoundation. (2016). Survey reveals Singaporeans' concerns and aspirations of aged care
        [Press release]. Retrieved from
        http://www.lienfoundation.org/sites/default/files/Media%20Release%20-%20Survey%2
        0Reveals%20Singaporeans%E2%80%99%20Concerns%20and%20Aspirations%20of%20A
        ged%20Care.pdf

Lim, L. L., & Kua, E.-H. (2011). Living Alone, Loneliness, and Psychological Well-Being of Older
        Persons in Singapore. *Current Gerontology and Geriatrics Research, 2011*, 9.
        doi:10.1155/2011/673181

Ling, O. G., & Limin, H. (2002). Public space and the developmental state in Singapore.
        International Development Planning Review, 24(4), 433-447. doi:10.3828/idpr.24.4.6

Liu, C., Eom, K., Matchar, D. B., Chong, W. F., & Chan, A. W. M. (2016). Community-based long-
        term care services: If we build it, will they come? *Journal of Aging and Health, 28*(2),
        307-323. doi:10.1177/0898264315590229

Liu, G., Yap, P., Wong, G. H., Wei, H. X., & Hua, E. C. (2015). Day care centers for seniors in Singapore: looking back and looking ahead. *Journal of the American Medical Directors Association, 16*(7), 630. e637-630. e611.

Matchar, D. B., Duncan, P. W., Lien, C. T., Ong, M. E. H., Lee, M., Gao, F., Sim, R., Eom, K. (2017). Randomized Controlled Trial of Screening, Risk Modification, and Physical Therapy to Prevent Falls Among the Elderly Recently Discharged From the Emergency Department to the Community: The Steps to Avoid Falls in the Elderly Study. *Archives of Physical Medicine and Rehabilitation, 98*(6), 1086-1096. doi:https://doi.org/10.1016/j.apmr.2017.01.014

MOH. (2016). *I feel young in my Singapore: Action plan for successful aging*. Retrieved from Singapore: https://sustainabledevelopment.un.org/content/documents/16269Action_Plan_for_Suc cessful_Aging.pdf

Nahemow, L., & Lawton, M. P. (1973). Toward an ecological theory of adaptation and aging. *Environmental Design Research, 1*, 24-32.

Newcomer, R. J., Lawton, M. P., & Byerts, T. O. (1986). *Housing an aging society: Issues, alternatives, and policy*. NY: Van Nostrand Reinhold Company.

Ng, T. P., Nyunt, M. S. Z., Shuvo, F. K., Eng, J. Y., Yap, K. B., Hee, L. M., Chan, S.P., Scherer, S. (2018). The Neighborhood Built Environment and Cognitive Function of Older Persons: Results from the Singapore Longitudinal Ageing Study. *Gerontology, 64*(2), 149-156.

Ory, M. G., Abeles, R. P. E., & Lipman, P. D. E. (1992). *Aging, health, and behavior*. Thousand Oaks, CA: SAGE Publications, Inc.

Ostir, G. V., Ottenbacher, K. J., & Markides, K. S. (2004). Onset of frailty in older adults and the protective role of positive affect. *Psychology and Aging, 19*(3), 402.

Peace, S., Kellaher, L., & Holland, C. (2005). *Environment and identity in later life*. UK: Open University Press.

Pollack, C. E., & Von dem Knesebeck, O. (2004). Social capital and health among the aged: comparisons between the United States and Germany. *Health & Place, 10*(4), 383-391.

Pynoos, J., Nishita, C., Cicero, C., & Caraviello, R. (2008). Aging in place, housing, and the law. *Elder Law Journal, 16*(1), 77-105.

Ramesh, M. (1992). Social security in Singapore: Redrawing the public-private boundary. *Asian Survey, 32*(12), 1093-1108.

Richard, L., Gauvin, L., Gosselin, C., & Laforest, S. (2008). Staying connected: Neighbourhood correlates of social participation among older adults living in an urban environment in Montreal, Quebec. *Health Promotion International, 24*(1), 46-57.

Rowe, J. W., & Kahn, R. L. (1997). Successful aging. *The gerontologist, 37*(4), 433-440.

Rubinstein, R. L. (1990). Personal identity and environmental meaning in later life. *Journal of Aging Studies, 4*(2), 131-147.

Seeman, T. E. (2000). Health promoting effects of friends and family on health outcomes in older adults. *American Journal of Health promotion, 14*(6), 362-370.

Sloan, R., Chia M., O'Muircheartaigh, C., et al. (2011). National Physical Activity Guidelines: Summary Guide for Professionals. In H. P. Board (Ed.), *Singapore*. Singapore: Health Hub.

Strong, S., Rigby, P., Stewart, D., Law, M., Letts, L., & Cooper, B. (1999). Application of the person-environment-occupation model: A practical tool. *Canadian Journal of Occupational Therapy, 66*(3), 122-133.

Teo, P. (1997). Space to grow old in: The availability of public spaces for elderly persons in Singapore. *Urban Studies, 34*(3), 419-439.

Thompson, J., Malhotra, R., Love, S., Ostbye, T., Chan, A., & Matchar, D. (2014). Projecting the number of older Singaporeans with activity of daily living limitations requiring human assistance through 2030. *Annals of the Academy of Medicine Singapore, 43*, 51-56.

van Haastregt, J. C., Diederiks, J. P., van Rossum, E., de Witte, L. P., & Crebolder, H. F. (2000). Effects of preventive home visits to elderly people living in the community: Systematic review. *British Medical Journal, 320*(7237), 754-758.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

Wang, H.-X., Karp, A., Winblad, B., & Fratiglioni, L. (2002). Late-life engagement in social and leisure activities is associated with a decreased risk of dementia: a longitudinal study from the Kungsholmen project. *American Journal of Epidemiology, 155*(12), 1081-1087.

WHO. (2015). *World report on ageing and health* (9241565047). Retrieved from https://apps.who.int/iris/bitstream/handle/10665/186463/9789240694811_eng.pdf;jse ssionid=CBDE0E6F221A21DDF95354287C975C36?sequence=1 (2018).

Wiles, J. L., Leibing, A., Guberman, N., Reeve, J., & Allen, R. E. (2012). The meaning of "aging in place" to older people. *The Gerontologist, 52*(3), 357-366.

Wong, C. H., Wong, S. F., Pang, W. S., Azizah, M. Y., & Dass, M. J. (2003). Habitual Walking and Its Correlation to Better Physical Function: Implications for Prevention of Physical Disability in Older Persons. *The Journals of Gerontology: Series A, 58*(6), M555-M560. doi:10.1093/gerona/58.6.M555

Wu, T., & Chan, A. (2012). Families, friends, and the neighborhood of older adults: Evidence from public housing in Singapore. *Journal of Aging Research, 2012*.

Yeo, Y. Y. C., Lee, S. K., Lim, C. Y., Quek, L. S., & Ooi, S. B. S. (2009). A review of elderly injuries seen in a Singapore emergency department. *Singapore Medical Journal, 50*(3), 278-283.

CHAPTER II

PHASE ONE: FOCUS GROUP DISCUSSIONS

Study Design

As the first step in this exploratory research, Phase One used focus groups with healthcare workers and older adults to understand the user's experience with existing conditions in Singapore's public housing, and the effects of environmental design on aging at home. During the focus group discussions, the preliminary design of a community facility with possible social and environmental features that promote healthy aging was conceptualized. Information gathered in this phase was used to develop the Health Spring intervention in Phase Two.

Theoretical Framework and Study Domains

Two main theories guided the research in Phase One: theory of Person-Environment fit and Social Cognitive theory. These two theories helped develop five domains of investigation that formed the structure of the focus group discussions. The five domains of investigation were: 1) environmental barriers, 2) existing design solutions, 3) innovative design solutions, 4) health-seeking behaviors, and 5) social connections.

Person-Environment Fit

Person-Environment fit (P-E fit) occurs over a range of time in which there is a balance between environmental demands and a person's competence that produces positive health outcomes (Lawton, Altman, & Wohlwill, 1984), as illustrated in Chapter One. Proposed by Lawton, theory of P-E fit is related to the social-ecological model of Kurt Lewin, in which a person's behavior is considered as the function of the individual and the environment (Lewin et al., 1936). Additionally, Lewin's theory considers the concept of an ever-changing reality, and states that, as the environment changes, so would the person and his or her behavior (Tai-Seale, 2008). Lewin's social-ecological model recognizes that both the objective measure of change and subjective perception of changes occur in the interaction between person and environment.

Thus, P-E fit theory established the need to investigate the issues related to environmental barriers, existing design strategies, and innovative design solutions.

Social Cognitive Theory

Bandura's social cognitive theory emphasize an individual's perception of his or her environment as a critical component that regulates health behavior (Bandura, 1977). It addresses five variables including the knowledge of health risks and benefits, self-efficacy, outcome expectations, proximal and distal goals, and barriers and perceived facilitators (Tai-Seale, 2008). Of these five variables, Bandura asserts that self-efficacy contributes the most toward influencing behavior and affects one's motivation toward goal attainment.

Self-efficacy is an individual's personal belief in his or her ability to achieve specific goals (Bandura, 1977). In aging, self-efficacy is related to an individual's health-seeking behavior (activities and daily routines an individual performs to maintain his or her health). A contributing factor to self-efficacy and motivation is the extent of social support that individuals can enlist in order to sustain their efforts (Bandura, 2004). The distal goal of this research is to promote healthy aging in older Singaporeans living in public housing. Thus, the researcher sought to understand an individual's self-efficacy, perceived facilitators, and social support, which promote healthy aging. The domains of health-seeking behaviors and social connections were established as areas of investigation.

Specific Objectives

The proximal goal of the research was to develop a proposed community facility at the ground floor of public housing buildings (referred to here as the Health Springs) that would increase the opportunities for social, health and wellness activities for older Singaporeans to enable healthy aging. In studying the five domains, the research limited the focus group discussions to the functional ability of bathing and falls prevention as a means to explore the connection between the psychophysiological issues of aging and the home environment. Functional activity of bathing and fall prevention were used to focus the discussion of aging in the public housing unit as home injuries that commonly occurred in Singapore were significantly attributed to falls (Yeo et al., 2009) as discussed in Chapter One. Furthermore, one

third of the fall injuries in Singapore homes occurred in the bathroom area (Addae-Dapaah & Wong, 2001).

Objective ONE: To understand the perceptions of P-E fit in public housing through the experience of users (older adults and caregivers) on aging in relation to falls and daily physical activity.

Objective TWO: To understand current design issues, specifically the shortcomings of existing bathroom design strategies used for aging individuals.

Objective THREE: To explore alternative design and social features that promote healthy aging for the new Health Springs community facility located in public housing.

Study Variables and Measures

The five domains of investigation identified for discussion in the focus group sessions were 1) environmental barriers, 2) existing design solutions, 3) innovative design solutions, 4) health-seeking behaviors and 5) social connections. These five domains were used to structure the research's investigation of older adults' experience with aging in Singapore's public housing and possible opportunities to promote healthy aging.

Environmental Barriers

As mentioned in Chapter One, environmental barriers, and hazards, such as unsafe flooring and dim lighting, compound the stress and challenges that older adults face during the aging process (Addae-Dapaah & Wong, 2001). Likewise, poor planning of public housing neighborhoods affects physical activity and social interactions of older adults (Ling & Limin, 2002; T. P. Ng et al., 2018). The focus group discussions were intended to explore common environmental barriers faced by older adults who reside in public housing, in terms of their activities of daily living, particularly regarding the functional issues of bathing and falls prevention.

Existing Design Solutions

Existing design solutions developed to assist older adults in Singapore tend to focus on implementing home modifications as a prosthetic to the physical environment (MOH, 2016; P. Teo, 1997). The focus group discussions intended to explore the types of existing design

solutions that older adults and healthcare workers considered as useful to fall prevention and the functional ability of bathing.

Innovative Design Solutions

Taking the preventive approach that targeted health promotion through healthy aging, the focus group discussions explored different types of innovative design solutions that could help prevents falls and encourage ADLs. These were environmental and social features that might promote components of healthy aging, such as physical activity, social relationships, and mental wellbeing.

Health-Seeking Behaviors

Health-seeking behaviors are the activities and daily routines an individual performs to maintain his or her health in older age. Health-seeking behaviors are related to a person's perception of his or her environmental' barriers, perceived facilitators, and self-efficacy (Bandura, 2004; Lewin et al., 1936). The focus group discussions intended to explore how perceived environmental barriers and facilitators of aging influenced older adults' health-seeking behaviors and their attitudes toward achieving healthy aging.

Social Connections

Social connections and support influence older adults' motivation toward goal achievement, like healthy aging (Bandura, 2004). The focus group discussions intended to understand how social support, community resources, and living arrangements with family and friends would promote healthy aging for older adults in public housing.

<center>**Method**</center>

<center>*Using Focus Group Discussions*</center>

Using focus groups in the initial phase of the research explored Singaporeans' perception of aging and introduced the Health Springs concept as a potential strategy to enhance the aging experience and current lifestyles of older Singaporeans living in public housing. Focus group discussions allowed for a more in-depth understanding of social complexities and a wide range of opinions on environmental challenges (Bricki & Green, 2007; Creswell & Clark, 2007). A primary reason this study used focus groups was to help participants grasp new design concepts that can be difficult to understand and visualize. The dynamics of

the focus group discussion helped to overcome unfamiliar design solutions for some participants, as others were able to relate their views and assist each other without the researcher's intervention.

Development of Survey and Semi-structured Topic Guide for Focus Group Discussions

Brief Survey

Each participant completed a brief survey questionnaire before the focus group discussions. The survey (Appendix A) was divided into three main parts: 1) participants' opinions and attitudes toward falls and fall prevention strategies, 2) an adapted Home Safety Self-Assessment Tool and 3) participants' opinions and attitudes to new design features that promote functional ability in bathing and help prevent falls through healthy aging. The survey also collected the basic demographic data, living situation, and activities of daily living (ADL) scores of each participant prior to the focus group discussion.

Participants' Opinions and Attitudes on Falls and Fall Prevention Strategies

The survey also quantified participants' current usage and opinions on the following fall prevention strategies: home safety features, live-in caregiver, fall prevention education program, and home visits from trained therapists. The participants evaluated each strategy using a 3-point Likert Scale (Very Helpful, Somewhat Helpful, Not Helpful at all).

An Adapted Home Safety Self-Assessment Tool

The survey adapted the Home Safety Self-Assessment Tool (HSSAT) (Horowitz, Nochajski, & Schweitzer, 2013) to establish older adults' and healthcare workers' awareness of environmental hazards in bathrooms with a 10-item checklist. The HSSAT is a simple and user-friendly instrument developed to help older adults and caregivers who are not trained in environmental evaluation to identify fall risks in a home environment (Horowitz et al., 2013). The HSSAT has been used in USA, Brazil, Canada, Hong Kong, and England (Tomita, Saharan, Rajendran, Nochajski, & Schweitzer, 2014). For the Singapore context, the HSSAT for bathroom toolkit was slightly modified to relate to Singaporean participants. It was also translated into Mandarin for older adults with difficulty in reading English. Refer to Appendix A for illustration of the HSSAT.

Focus Group Discussion using Semi-Structured Guide and Visual Prompts

Semi-Structured Guide

A semi-structured guide, as illustrated in Table II-1, was used during the focus group discussions. It divided the five research domains into three main categories of investigation:

1) Domains of health-seeking behaviors and social connections: Understanding the user's experience and concerns with falls, bathroom ADLs, and difficulties associated with caregiver assistance.

2) Domains of environmental barriers and existing design solutions: Understanding the environmental challenges concerning aging and the shortcomings of existing fall prevention strategies in the bathroom.

3) Domain of innovative design solutions: Understanding attitudes towards a new bathing and lifestyle facility in public housing.

Table II-1.
Topic Guide for Focus Group Discussions and Research Intention of The Questions.

Research Topic	Questions for Older Adults	Questions for Healthcare Workers
Fall Concerns, Bathroom ADLs, and Difficulty of Caregiver Assistance	1. Do any of you have friends or know someone who has fallen in the bathroom? How did you feel about it? 2. Have you ever experienced a fall in the bathroom, and what were you doing when you fell?	1. What difficulties do you face when helping elderly clients in the bathroom compared to other personal care assistance?
Environmental Challenges and Fall Prevention Strategies in the Bathroom	1. How do you get around inside your bathroom? What is the biggest problem you face when getting around and using the bathroom? 2. When using the bathroom, some people prefer having help from safety features, (like shower seats and grab bars) rather than getting help from a personal assistant. Describe why you prefer one or the other.	1. What parts of the bathroom make helping the elderly difficult and increase the risks of falls? (E.g. Lighting, flooring, shelving, insufficient space, bathroom entrance, difficulty moving from WC to shower etc.) 2. What fall prevention and safety measures do you typically use when assisting an elderly in the bathroom? Can you list the steps? 3. How useful are bathroom safety features such as grab bars and shower seats in helping the elderly clients manage their bathroom activities **on their own?** 4. How useful are bathroom safety features in **helping you assist** an elderly client in the bathroom?
Attitudes Toward a New	1. Hot baths, jacuzzis and hot springs, as well as hydrotherapy, have been known to improve the overall health of users.	1. Hot baths, jacuzzis and hot springs, as well as hydrotherapy, have been known to improve the overall health of the

Table II-1. *Continued*
Topic Guide for Focus Group Discussions and Research Intention of The Questions.

Research Topic	Questions for Older Adults	Questions for Healthcare Workers
Bathing and Lifestyle Facility	Have you had any previous experience in any of these activities and what did you like about the experience?	users. Based on your own experiences, what do you think an older adult might like about such places and activities?
	2. If this spa and bathing facility was available for you at any time, every day, who would you like to go with, and when would you most likely go? What would affect your decision to go?	2. If this spa and bathing facility is also a wellness center for falls prevention and is located within residential estates (like a community garden or common exercise areas), how do you think it can improve the outreach to older adults?
	3. If this spa and bathing facility is also a wellness center for fall prevention, what do you think are some of the benefits in having this wellness center in your neighborhood vs. fall proofing your home?	3. What do you think are the advantages and disadvantages of having this new neighborhood wellness center that focuses on spa and bathing compared to fall proofing strategies of individual homes for older adults?
	4. Now we would like to discuss some of the features you think are good to have in this wellness center that promotes health, community bonding and can reduce falls. (Refer to Health Springs Wellness Center Ideas Board)	4. Now we would like to discuss some of the features you think are good to have in this wellness center that promotes health, community bonding and can reduce falls. (Refer to Health Springs Wellness Center Ideas Board)

Visual Prompts

Two types of visual prompts were used during the focus group discussions: the first illustrated typical environmental hazards found in the bathroom (Appendix B) and the second, illustrated environmental and social features that promote healthy aging (Appendix C). The first set of visual prompts that illustrated environmental hazards were used for the focus group discussions with older adults but not with the healthcare workers. Using the visual prompts encouraged robust discussion from both groups of participants and alleviated difficulties with understanding new design concepts or features.

Study Sample and Setting

Two different population groups were sampled in this phase: (1) older adults and (2) healthcare workers. Older adults were the main target group for the Health Springs intervention, and their experience with existing design solutions informed the exploratory research. Healthcare workers were sampled to provide an outsider perspective of the older adults' experience; the topics addressed specific needs related to assisting older adults in the functional activity of bathing and their observations on older adults behavior in relation to

caregiver assistance. The focus groups were conducted separately for older adults and healthcare workers.

Recruitment took place in the town of Yishun because of the affiliation of the Geriatric Education and Research Institute of Singapore (GERI) to the Khoo Teck Puat General Hospital, the primary general hospital catering to the northern region of Singapore (one of the five regions). Recruitment for Phase One took place in five senior activity centers and the main hospital's Falls Clinic (a geriatric outpatient clinic that focuses on treatment and assessment of falls in older adults) in the residential town of Yishun, as a convenient sampling. Based on the 2015 General Household Survey of Singapore, there were 62,900 households located in Yishun, of which 91.4% were public housing units, which is higher than the national average of 80.1% (DOS, 2015). A report published in 2018 indicated that 10% to15% of the population in Yishun was 65 years and older, which is within the range of the national average of 11% (DOS, 2018).

Recruitment Procedure

The recruitment for the focus group discussions took place between May and August of 2016. The researcher contacted the various senior activity centers and the Falls Clinic for their interest in participating in the study. After the facilities agreed to participate, facility administrators invited eligible older adults and healthcare workers to partake in the process a few weeks before the first focus group discussion was scheduled.

Older Adult Participants

For older adult participants, the recruitment process was conducted through two visits to each senior activity center and the Falls Clinic. During the first arranged visit, the researcher conducted a pre-screening with the shortlisted older adult participants by administering the Clinical Frailty Scale (CFS) and the Abbreviated Mental Test (AMT). Eligible older adult participants were given a written "Invitation to Participate" and an "Information Sheet" containing all the elements of informed consent with more information about the study and were given a few days to consider their participation. During the second visit, older adult participants who wished to participate in the focus group discussions were enrolled in the study, and informed consent was obtained before each discussion. The information sheet and

consent form were translated into Mandarin for older adults that required the language translation.

Healthcare Workers

For healthcare worker participants, the recruitment process was conducted in a single visit to each participating facility. The facility administrator informed healthcare workers of the focus group discussions prior to the researcher's visit. During the scheduled visit, the researcher provided an "Information Sheet" that contained details about the study to the participants. Healthcare workers who wished to participate were enrolled in the study, and signed informed consent was obtained before each discussion. The materials used for focus group discussions with healthcare workers were provided in English language.

Inclusion and Exclusion Criteria

Older adult participants who were eligible for inclusion were those who were community-dwelling older adults living in public housing. Older adults had a physical status ranging from very fit to moderately frail on the Clinical Frailty Scale (CFS). Older adults were required to have sufficient cognitive function to provide a meaningful response to the focus group discussion and surveys; they were assessed for cognitive function using the Abbreviated Mental Test (AMT) and required to achieve a score of more than 7 out of 10. Participants were able to converse in their choice of either English or Mandarin. Older adults who required minimal assistance with wheelchairs and walking devices were eligible to participate in the focus group discussions. Older adults excluded from the study were those who were institutionalized for long-term care, had substantial cognitive impairment, or were unable to converse in either English or Mandarin language.

Healthcare workers and caregivers eligible for inclusion were staff, caregivers, and volunteers at the Falls Clinic and the senior activity centers, whose occupational duties included assisting older adults with physical and functional activities. Healthcare workers were recruited to provide insights on issues related to bathing activities.

The separate focus group discussions for older adults and healthcare workers were conducted on the same visit to each participating facility. The focus group sessions had two parts: a brief individual survey and the group discussion.

Brief Survey

A brief survey questionnaire was presented to each participant prior to the focus group discussions. The survey took 10 minutes to complete and collected basic demographic data and information on participants' current health status, daily activities, and routine. All identifying information was coded to protect participants' confidentiality. The survey was developed in English and translated to Mandarin for Mandarin-speaking older adults because these are the two most commonly spoken languages in Singapore.

Focus Group Discussions

Discussions were based on a sequence of semi-structured questions regarding participants' experience relating to the five domains of 1) environmental barriers, 2) existing design solutions, 3) innovative design solutions, 4) health-seeking behaviors and 5) social connections. The focus group discussions each lasted approximately 1 hour. The researcher moderated the discussion by asking specific questions using a topic guide and visual cue cards depicting environmental hazards at home and new design features and programs that would promote healthy aging. The focus group discussions were led by the researcher in native-level English or Mandarin and were conducted until theme saturation was reached.

Observation Protocol During Focus Group Discussions

All sessions were audio-recorded and the tapes were transcribed verbatim by professional transcriptionists. Sessions conducted in Mandarin were transcribed verbatim and were then subsequently translated into English.

IRB Approval

As an international study, the research received IRB approval from both Singapore's National Health Group and Texas A&M University. Written informed consent was obtained before the start of the focus group discussions from participants who were eligible and enrolled in the study. All identifying information was coded to protect participants' confidentiality.

Data Cleaning and Method of Analysis

The results section presents the data collected from the brief survey and the extracted findings from the focus group discussions. The data collected from the focus groups with older adults and healthcare workers, were categorized into the five domains of investigation: 1) environmental barriers, 2) existing design solutions, 3) innovative design solutions, 4) health-seeking behaviors, and 5) social connections). After sorting the data into the five domains, further thematic analysis of the transcripts was conducted to extract common recurring issues brought up by participants in discussion.

This research used computer-assisted qualitative data analysis software tool NVivo. The advantages of using NVivo is the mixed-method analysis of the data collected. NVivo supports quantitative analysis of qualitative data, enabling accurate and transparent data analysis while reducing researcher bias (Welsh, 2002). Running the transcripts of the focus groups discussions through NVivo allows the researcher to manually but quickly develop a coding scheme, electronically assign codes, and study the revealed hierarchy and relationships in themes based on NVivo's quick processing of data.

Results

Participants' Characteristics

For this phase, the study recruited 22 older adults in total, with each focus group having up to 4 older adults over the age of 65. The study also recruited 16 healthcare volunteers, nurses, and caregivers in total, with each focus group having up to 4 participants.

Older Adult Characteristics

In the sample of older adults, as shown in Table II-2, the mean age was 74.5 years old, and about 55% of the participants were women. For living arrangements, 37% of older adult participants lived with their spouses; 37% lived with their children; and another 10% lived alone. Regarding self-reported medical assistance, 21% of older adult participants could manage their medication. In regard to previous history of falls, 32% of participants had experienced a fall.

Table II-2.
Older Adults' Characteristics (n=22)

Item	Scale		Percentage (%)	Mean (SD)	% of missing data
Age	Continuous			74.5 (5.7)	13.6
Gender	Binary (1= Female)		55	-	0
Ethnic group	Categorical	Chinese:	90	-	0
		Malay:	10		
Living arrangements	Categorical	With spouse:	37	-	13.6
		With children:	37		
		With relatives:	16		
		Alone:	10		
Type of dwelling	Categorical	3-4 room HDB*:	63	-	13.6
		5 room HDB:	21		
		1-2 room HDB:	11		
		Studio apartment:	5		
Medication assistance	Categorical	Assisted by spouse:	37	-	13.6
		Assisted by children:	37		
		Self:	21		
		Helper:	5		
Fall experience	Binary (1= Yes)		32	-	0

*HDB: Public housing units under the government agency Housing Development Board (HDB)

Self-Report of Current ADL Needs

A self-report question incorporated in the brief survey used the Katz Index of Independence in Activities of Daily Living to measure older adults' ability to perform tasks such as bathing and toileting. The results are shown in Figure II-1. In general, more than 75% of older adult participants reported themselves being independent when performing ADL tasks such as dressing and getting out of bed, indicating high levels of self-efficacy. However, compared with other ADL activities, bathing and continence presented a greater need for caregiver assistance, hence confirming the need to study older adults' functional ability in regard to bathing and the home environment.
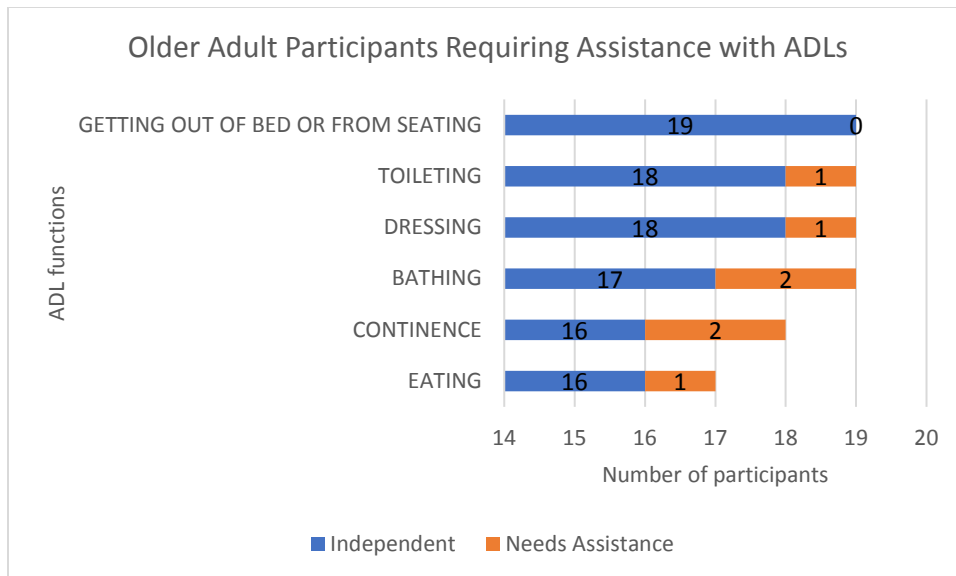
Figure II-1. Distribution of older adult participants requiring assistance in functional activities

Healthcare Workers Characteristics

Table II-3 illustrates the broad range of occupational profiles for the healthcare workers involved in the phase. Most participants were care staff at the senior care centers or nurses from the Falls Clinic, with the first-hand experience with supporting older adults' bathing and toileting needs. The case manager position holds similar roles to occupational therapists and conducts home assessment for older adult clients. For gender distribution, male healthcare workers made up approximately 40% of the sample group.

Table II-3.
Healthcare Workers' Characteristics (n=16)

Item	Scale		Percentage (%)	% of missing data
Gender	Binary (1= Female)		63	0
Ethnic group	Categorical	Chinese:	69	0
		Malay:	6	
		Indian:	13	
		Others:	13	
Role	Categorical	Care Staff:	31	0
		Nursing aid:	25	
		Nurse:	19	
		Admin:	13	
		Case Manager:	6	
		Facility Manager:	6	

Participants' Opinions and Attitudes on Falls and Fall Prevention Strategies

Fear of Falls

The brief survey asked both older adult to rate their fear of falls and healthcare worker to rate the older adults' fear of falls. The response was a 4-point scale ranging from "Very much = 4" to "Not at all = 1" to describe their fear of falls. Comparing the responses from the two groups, healthcare workers rated the fear of falls to be higher in older adults (M= 3.44, SD= 0.73), compared with the response from the older adults' self-assessment who did not have a strong response to the fear of falls (M= 3, SD= 0.97).

Different Fall Prevention Strategies

The brief survey aimed to compare the users' experience with the broad categories of fall prevention strategies currently practiced in Singapore, which typically consisted of bathroom modifications and personal assistance. Bathroom modifications included home safety features such as handrails and emergency pull cords. Personal assistance was defined as either live-in caregivers or home visits from trained therapists. The research also included a fourth category, educational programs, such as fall prevention programs, to explore alternative fall prevention strategies linked to health promotion and healthy aging. Participants were asked to rank the different safety strategies between "Very Helpful= 3", "Somewhat Helpful= 2" and "Not Helpful at All= 1". For both groups, bathroom and home safety features were the highest-rated fall prevention strategy, as shown in Table II-4. Older adults rated educational fall prevention programs as the second most helpful fall prevention strategy compared with either of the personal assistance service options (live-in caregiver or home visits). Both the older adults' responses to fear of falls and fall prevention strategies suggest an overall desire for independence and self-efficacy for completing bathroom-related ADLs.

Table II-4.

Rating of Different Fall Prevention Strategies By Participant Group.

	Older Adults		Healthcare Workers	
	Mean	*SD*	*Mean*	*SD*
Home safety features (e.g. grab bars, pull cords etc.)	2.68	0.65	3.00	0.00
Live-in caregiver	1.90	0.83	2.44	0.63
Fall prevention program	2.28	0.83	2.56	0.63
Home visits from trained therapist	2.06	0.80	2.56	0.63

SD: Standard deviation.

The Adapted Home Safety Self-Assessment Tool and Perception of Hazards

Using the Home Safety Self-Assessment Tool (HSSAT) for bathrooms (Horowitz et al., 2013) the brief survey evaluated participants' awareness of environmental hazards as a factor of falls in older adults. Healthcare worker participants were found to be able to identify unobtrusive but salient environmental hazards that corresponded with existing research on common causes of falls in bathrooms. For example, healthcare workers could identify hazards such as dim lighting and trip hazards such as bath rugs. In contrast, older adult participants could identify the three environmental hazards (wet floor, lack of grab bars and raised edge at shower area), but were less sensitive towards nuanced environmental hazards, as shown in Figure II-2. The top three environmental hazards identified by older adult participants corresponded with the three improvement items from the Enhancement for Active Seniors program (EASE) that were eligible for government subsidy and funding (HDB, 2017).

Identification of Environmental Hazards Using HSSAT

Participants Response by Percentage

Environmental Hazards	Healthcare Workers	Older Adults
Wet floor	100%	45%
Lack of grab bars in the shower area	94%	50%
Presence of unsafe bath rugs	88%	18%
Dimlighting	88%	23%
Lack of grab bars near the toilet	81%	45%
Slippery tub (lack of bath mat, etc.)	75%	23%
Clutter	63%	23%
Raised edge at shower area	56%	36%
Lack of bath chair in the shower area	56%	32%
Toilet is too high or low	44%	14%
Others	13%	0%

Figure II-2. Comparing participants' response to environmental hazards in the bathroom.

Focus Groups

In the analysis conducted, the researcher studied the relationships between the following themes 1) Environmental barriers, 2) Existing design solutions, 3) Innovative design solutions, 4) Health-seeking behaviors, and 5) Social connections.

In the first part of the focus group discussions, the researcher asked questions about fall concerns, bathroom ADLs, and the difficulty experienced in assisting older adults. Participants' responses were coded based on the domains of social connections and health-seeking behaviors.

In the second part of the focus group discussions, the researcher asked questions on environmental challenges and fall prevention strategies in the bathroom. Participants' responses were coded based on the domains of environmental barriers and existing design solutions.

During the third part of the focus group discussion, the researcher asked questions on attitudes and opinions toward a new bathing and lifestyle facility in public housing. Participants' responses were coded based on the domains of innovative design solutions. In this section,

quotes from healthcare workers will be denoted with an "H" and quotes from older adults were denoted with an "R."

Objective ONE: To Understand the Experience of Older Adults and Caregivers in Relation to Falls and Daily Physical Activity.

Health-Seeking Behaviors

In running a word frequency query on NVivo, the researcher searched for the top 10 words (expanded to include stemmed words and synonyms) frequently mentioned in the focus group discussions on health-seeking behaviors (Table II-5).

Table II-5.
Top Ten Words Mentioned in Discussions Related to Health-Seeking Behaviors

Word	Count	Weighted Percentage (%)*	Similar Words
Activities	20	0.85	active, activities
Old	20	0.85	old
Alone	18	0.77	alone
Friends	17	0.72	friends
Try	17	0.72	try
Mental	14	0.60	mental, mentality, mentally
Weak	13	0.55	weak
Swimming	13	0.55	swim, swimming
Family	12	0.51	family
Independent	12	0.51	independent, independently

*Weighted Percentage—the frequency of the word relative to the total words counted.

Fall Concerns

Based on the top ten words used in the discussion related to older adults and healthcare workers experience in relations to falls, words such as "Old," and "Alone" were frequently used in the focus group discussions, as seen in Table II-5. The data reflected that older adult participants associated aging with a heightened sense of vulnerability to hazards and isolation.

> *R1: At my home, there's a place for exercise. But because I'm alone, I'm scared to go. I think what happened if I fall, there's no one to help me.*

When older adults spoke of falls, they associated falls with the loss of mobility and control. To older adults, the fear of a severe fall and its incapacitating effects could produce a sense of hopelessness and worry.

> *R1: If you need someone to help bathe you, then you have no choice. Will we become like this once we get older? I keep thinking and worrying about it! (Laughs) I hope I won't deteriorate one day.*

> *R2: Because of this one thing (falling), I cannot walk straight. Because of this, I cannot work. You know, I miss all my good opportunities because of one small matter. From then on, I don't know what to do anymore.*

Older adults and healthcare workers highlighted that psychological concerns and fears of losing their independence with age and falls motivated older adults' health-seeking behaviors. These health-seeking behaviors of older adults' affected their motivation in pursuing an active lifestyle and remain socially connected, which became more apparent in later discussions related to health-promoting design solutions of the Health Springs.

<u>Accepting Caregiver Assistance</u>

In the discussion related to older adults and healthcare workers experience in to daily physical activity, words associated with independence, such as "myself" and "independent," were used frequently in discussions with older adults. The discussions indicated that regarding health-seeking behaviors related to caregiver assistance, older adults preferred to maintain autonomy in their activities of daily living, as long as they were physically capable, instead of relying on caregiver assistance.

> *Researcher: Do you feel it is better to have someone help you to the bathroom, or do you prefer to do things by yourself?*
> *R1: By myself.*
> *R2: We haven't reached that stage yet. We're still young.*
> *R3: I'll do it by myself. Cooking, grocery, all by myself. It's my house, after all.*
> *R4: It doesn't seem convenient, and it's a bit embarrassing. If you have a stroke, then you have no choice. If you can't even move, then you need someone to help you.*

Healthcare workers further supported the notion of maintaining older adults' functional independence due to limited community and family support in terms of labor, time, and separate living arrangements.

H1: We try to make the patients more independent, especially physically, so they can help themselves.
H2: Because nobody has the time to help them (older adults). That's why helping themselves is better for the family and the patient. If he (the patient) keeps calling for help, the family cannot manage.

However, a challenge to caregiver assistance related to independence was older adults' perception of their objective physical health capabilities and their health beliefs. According to healthcare workers, older adults' cognitive impairment, personal bias, and preference to maintain autonomy and privacy, could compromise their safety. These characteristic traits of older adults resulted in healthcare workers taking additional precautionary measures to monitor older clients in their care during bathroom-related ADLs. Healthcare workers highlighted the need for cooperative and compliant behavior from older adults when assisting in bathing and toileting.

H1: Some of the elderly, they think they can. They say, "Can manage." But some elderly we know definitely cannot manage, and we have to go with them and stand beside them even though they can independently do their business. You never know – for some reason they can suddenly blackout.

H2: Sometimes, the elderly they prefer privacy. So even though they cannot manage, they still do not want you to go inside.

H3: Some of them, they're quite serious in their dementia, then when you try to hold them, they will say "No, don't hold me, I can walk by myself." So you have to try and find some ways to assist him.

Social Connections

In running a word frequency query on NVivo, the researcher searched for the top ten words (expanded to include stemmed words and synonyms) frequently mentioned in the focus group discussions on social connections (Table II-6).

Table II-6.

Top Ten Words Mentioned in Discussions Related to Social Connections.

Word	Count	Weighted Percentage (%)	Similar Words
Friends	48	1.57	friend, friends, support
Family	40	1.33	family, kin
Activities	37	1.16	active, activities, together, trip
Center	30	0.98	center, centers, centre, centres, middle
Floor	31	0.88	based, deck, floor, flooring, floors, level, story
Space	29	0.83	placed, places, space
Enjoy	28	0.68	enjoy, enjoyable, enjoying, love, loving, used, useful, using
Slippery	19	0.63	slippery
Lighting	23	0.62	bright, clean, clears, light, lighting, lightings
Chat	22	0.62	chat, chattering, talking, meeting

*Weighted Percentage—the frequency of the word relative to the total words counted.

Difficulties of Providing Caregiver Assistance

Furthermore, based on the top ten words used in the discussion related to older adults and healthcare workers experience in relations to falls, words such as "Friends," and "Family" were frequently used in the focus group discussions. Older adult participants regarded falls as a personal experience that, at most, extended to asking family members for help. Thus, most older adults sought to mitigate the problem of falls themselves or through family arrangements on bathroom use.

> R1: Of course, I'm afraid of falling. We have to be careful ourselves. We just have to be careful. Hold on to things so we will not fall.

> R2: My daughter asked my grandchildren not to use the bathroom until grandma has used it

Healthcare workers mentioned that older adults' physical health status and mental capacity played a role in requiring caregiver assistance, suggesting that older adults who were physically and mentally impaired would require help from beyond family members. The majority of the healthcare workers discussed the need for at least two healthcare workers to

assist an older adult in a wheelchair during bathroom-related ADLs. Depending on the activity performed and the older adult's physical health status, bathing or transferring the older adult could require between one to three trained caregivers at a given time.

> *H1: I find it very challenging if the elderly is on a wheelchair. I find it very tough to bring her into the toilet. We need two persons because she totally depends on us. So, we have two persons, one to make sure that she stands up. Then we need to change her. This is very challenging.*

Older adult participants who had experiences with falling also mentioned the need for professional caregiver assistance because family members could not always offer adequate support. Problems related to family members acting as primary care assistants included the lack of time commitment, separate living arrangements, and poor physical strength to support older adults with their functional activities.

> *H1: The problem is if they have mental impairment, they don't know what they're doing. They can walk, they can stand, so if the family is busy, they will just stand up and go by themselves. If they're already physically not fit, and mentally also disturbed, they need friends, if not their family.*

However, the data collected indicated that the family played a large role in supporting older adults' social engagement. The discussion also showed that family would influence older adults' participation in community activities such as enrolling in senior care centers, especially when family members were unable to commit time to look after the older adult.

Care in the Community

Healthcare workers mentioned that educational programs hosted within the senior activity centers in the public housing neighborhoods were well received by older adults who attended. The high attendance in classes indicated that older adults would rely on community support and resources to provide information on issues related to aging.

> *H1: Recently we had a HDB (Housing Development Board) sponsored class in our center for the elderly. One of the subjects was how to use the bathroom, and they (the older adults) asked a lot of questions for this subject. It's the concern for their own safety because some of them have issues with their vision or have physical problems, it is easy to fall down. That kind seminar lets them ask these questions.*

Healthcare workers discussed the benefits of having strong social support and resources situated in the community within public housing neighborhoods. Healthcare workers highlighted that the location of senior activity centers near older adults' homes encouraged active older adults to visit more frequently and remain socially engaged.

> *H1: I think because we (senior activity centers) are a more home-based facility so coming here is good for the more active ones (older adults). It's a good way of really going into the community, telling them (older adults) about falls prevention and social engagement.*

However, discussions with older adult participants suggested that educational material on falls emphasized prescriptive prevention strategies such as bathroom modification but did not explain or emphasize the significant health implications of falls. In the focus group discussions, a large majority of older adult participants did not perceive falls as a primary health problem. When asked what actions were taken after experiencing a fall, older adult participants admitted that most did not bother to visit a doctor despite sustaining injuries. The lack of action towards health-seeking measures suggests that older adults were not aware that they were compromising their overall health by downplaying the severity of a fall.

> *Researcher: When you fell, did you go to a hospital?*
> *R1: No. I only hurt this side it still hurts until now.*
> *Researcher: Did you see a doctor?*
> *R1: No. I fell, but it was not a big deal. I could get up slowly.*

Discussion with older adult participants regarding fall concerns suggests that community resources and social support systems can be structured to encourage older adults to seek help outside the family. Community resources should emphasize the significant impact of fall injuries on one's health; this may encourage older adults to modify their health-seeking behaviors and maintain their health in older age, based on informed decision-making.

Objective TWO: To Understand the Shortcomings of Existing Bathroom Design Strategies

Used in Response to Aging.

Environmental Barriers

Common hazards of the average Singaporean public housing bathroom brought up by older adults and healthcare workers were wet floors, differences in flooring height, trip hazards and clutter like rugs or carpets, inadequate space for a wheelchair, a commode, and the restrictions to caregiver assistance within the bathroom and at the doorway, poor lighting, and poor color contrast. In running a word frequency query on NVivo, the researcher searched for the top ten words (with stemmed words) frequently mentioned in the focus group discussions on environmental barriers. The researcher further refined this list of words to eliminate repetition of associated environmental hazards such as "slippery" and "wet," thus resulting in seven main items (Table II-7). Out of the top seven words, "Floor," "Slippery," and "Space" were the three most frequently mentioned items.

Table II-7.

Top Seven Words in Discussion Related to Environmental Barriers in The Bathrooms of Public Housing

Word	Count	Weighted Percentage (%)**	Similar Words
Space*	82	3.94	space/wheelchair/door
Slippery*	62	2.98	slippery, wet
Floor	46	2.21	floor, flooring, floors
Lighting	24	1.15	light, lighting, lightings
Install	22	1.06	install, installed, installing
Chair	20	0.96	chair
Standing	20	0.96	standing

*Items which were combined with similar conditional words.
**Weighted Percentage—the frequency of the word relative to the total words counted.

Space Limitations

The environmental barrier of space constraint in public housing bathroom posed challenges to healthcare workers and caregivers assisting older adults in their bathroom-related ADLs. Many healthcare workers mentioned the difficulty of transferring wheel-chair dependent

older adults within the bathroom space, moving around the doorway of bathrooms in public

housing, and the restrictions of installing safety features because of the lack of space.

> *H1: I had a patient who wanted to install this seat because the patient wants to sit down while showering but because the area in the bathroom is really small, there is no space for them to do that.*

> *H2: There isn't sufficient space in most of the toilets in Singapore now. I think you can't really fit a commode chair inside.*

> *H3: There is one family that I can remember where the patient usually walks in. She uses the wheelchair but because the space is really limited so she has to get out from the wheelchair then slowly walk in.*

During the focus group discussions, older adult participants reported that the lack of

space influenced their ability to install safety features that would help with fall prevention.

> *R1: We senior folk should have that handlebar for standing or sitting.*
> *Researcher: Do you think it will help?*
> *R2: It depends. Sometimes it isn't properly installed.*
> *R1: Sometimes it's only installed at the entrance, but it is useless to install it at that wall.*
> *R3: If it doesn't hinder movement, then it'll be useful. But now we're still active and it's easier to stand, a chair (shower seat) might hinder our movements or block our way.*

<u>Wet Flooring</u>

For older adult participants, their main environmental challenge was the presence of

wet floors in the bathroom space. The environmental hazard of wet floors mostly stemmed

from the design of public housing bathrooms, which do not have sufficient space to provide

separate dry and wet areas. The shower space was usually within the same area as the sink and

water closet.

> *H1: I have visited homes where the toilets are really small. The wash handbasin is right at the toilet bowl and it is so near, it is very hard for them (older adults) to maneuver around.*
> *H2: (in response to having a partition for dry and wet areas) See when the toilet is small, there no point to have this. Some cosmetic features would stop the water from spilling out. So these are some of the ideas that we want to have, but is actually causing more hazard. Imagine our wheelchair, the commode, cannot go in.*

Older adults highlighted how wet floors would compromise their balance, increasing the

risk of falls while using the bathroom. The physical stress of wet floors on a person's balance

was likewise highlighted by healthcare workers who stated they had to wear special footwear in the bathroom to assist older adults with their bathroom ADLs.

> *R1: I'm afraid of slippery floors. Old people are afraid of the danger if the floors get wet. I am very careful every time I do my laundry. Once I get up after cleaning, I throw away the soapy water. Then I use clean water to scrub again, after that only will I flush the water away. Really! That soapy water is very slippery, you fall very easily.*

> *H2: Actually, we wear particular boots to protect us from the wet floor. So for us it's ok.*

Existing Design Solutions

In running a word frequency query on NVivo, the researcher searched for the top ten words (expanded to include stemmed words and synonyms) frequently mentioned in the focus group discussions on existing design solutions for fall prevention. The researcher further refined this list of words to eliminate repetition of associated design solutions, resulting in eight main items (Table II-8).

Table II-8.
Top Eight Words Mentioned in Discussions Related to Existing Design Solutions

Word	Count	Weighted Percentage (%)**	Similar Words
Bar	29	2.17	bar, bars, blocking, measures, preventive
Mat/Floor*	29	2.17	floor, floors, flats, mat
Chair/Bench*	29	2.17	chair, chairs, aid, stool, sit, seating, supported, supporting
Door	16	1.20	door, doors, doorway
Light	15	1.12	bright, brightness, gently, light, lighting, lightings
Slippery	13	0.97	clean, cleaning, wet
Nothing	12	0.90	No safety features installed
Using	11	0.82	assistants, use, using, available, helper, helps

*Items which were combined with similar conditional words.
**Weighted Percentage—the frequency of the word relative to the total words counted.

<u>Safety Features</u>

Existing design solutions for fall prevention targeted the physical demands of the bathroom and home environment. Grab bars were the top item discussed by participants regarding the assistive features in the homes. Participants mentioned that grab bars afforded older adults the capability of retaining their autonomy over functional activities. The affordance that design solutions provided to older adults in terms of autonomy was preferred over other fall prevention strategies such as caregiver assistance.

> *R1: It's easier to stand. There's a support at your side. The doctor recommended us to buy. So when you stand, you can apply pressure to help yourself.*
> *Researcher: Do you prefer to have these safety features for you to help yourself, or you prefer someone to help you in the toilet?*
> *R2: I prefer to do it myself. It's more like… it feels like I'm troubling people.*
>
> *H: At least when they (older adults) hold it they can stand properly. Otherwise their legs will be shaking because they have no strength. When they pull on the bar at least they can stabilize themselves.*
> *Researcher: Why are those accessories (safety features) more effective than having someone with you in the toilet?*
> *H2: Because they can have some strength*
> *H3: Yeah, support. They can actually like help assist the caregiver or whoever that's helping. At least they can put in some effort. It's better than just depending on the caregiver.*

<u>Unmet Needs</u>

Despite the availability and installation of safety features in public housing units, older adult participants felt that such safety features were not always appropriate for their needs, citing that they were independent, young, or active. An older adult mentioned in the focus group discussion his preference to stand while showering despite having installed a shower seat – indicating that bathroom modifications tend to be passive design strategies that do not consider the psychological needs and preferences of older adults. Barriers to the effectiveness of existing design strategies are created by not considering older adults' mental states or psychological preferences, along with their functional needs.

> *R1: I have that bench in the toilet, but I don't want to sit on the bench when I shower. I can stand and shower.*

Objective THREE: **To Explore Alternative Design and Social Features That Promote Healthy Aging for a New Type of Community Facility Located in Public Housing.**

Innovative Design Solutions

The final part of the focus group discussion asked questions on attitudes and opinions about a new bathing and lifestyle facility in public housing. This portion of the focus group discussions used the semi-structured guide and visual prompts (Appendix C) that focused on new design solutions for health promotion and healthy aging. The semi-structured guide opened the discussion on attitudes towards a new bathing and lifestyle facility while the visual prompt (Appendix C) was used to collect information on specific design and social features that older adults and healthcare workers felt would promote healthy aging.

In running a word frequency query on NVivo, the researcher searched for the top ten words (expanded to include stemmed words and synonyms) frequently mentioned in the focus group discussions on innovative design solutions (Table II-9).

Table II-9.
Top Ten Words Mentioned in Discussions Related to Innovative Design Solutions

Word	Count	Weighted Percentage (%)	Similar Words
Water	194	1.12	water
Hot	127	0.73	hot
Family	122	0.71	families, family
Swimming	120	0.69	swim, swimming
Space	112	0.65	space, spaces
Activities	104	0.60	active, activities
Friends	102	0.59	friend, friendly, friends
Bath	97	0.56	bath, baths
Private	92	0.53	private, privacy
Wellness	80	0.46	well, wellness

*Weighted Percentage—the frequency of the word relative to the total words counted.

Community-Based Lifestyle

Based on the top ten words used in the discussion related to older adults and healthcare workers experience in relations to falls, words such as "Friends,", "Family", and "Activity" were

frequently used in the focus group discussions. To address the social isolation of older adults and the need for caregiver assistance, the research proposed a community-based wellness and lifestyle center which included group activities in the form of hydrotherapy, bathing springs, group exercises, and massages (the proposed center was coined the Health Springs to facilitate focus group discussions). Healthcare worker participants supported the overall concept of group activities that promote a community-based lifestyle, citing benefits for older adults' mental well-being and social interaction.

> H1: They (older adults) want some interaction.
> H3: They need the community and someone to love them.
> H1: With the community here, we have to plan to celebrate something, small functions that they can enjoy.
> H2: Some celebration like Hari Raya, Chinese New Year, any occasion.
> H1: We do like this, celebrate here. It will attract them down and out of their home.
> H3: With this (community setting), they can communicate together.
> Researcher: I see. And do you think communication is important?
> H1: Of course. It can release stress. It's a very big help for the elderly. Otherwise, they can get depressed, dementia, and will get mental problems very quickly.

Some healthcare workers were concerned that the idea of bathing springs in a group setting would not be culturally accepted by Singaporean older adults as there was no prevalent culture of hot springs in Singapore. A few healthcare worker participants felt that older adults' usage of a bathing spring in a group setting depended on the profile of the older adults, citing gender, age, ethnicity, education, financial status, and past experiences as factors that would affect usage.

However, in discussing the proposed community-based lifestyle of the Health Springs, the older adult participants were more accepting of a bathing experience in a group setting, compare with healthcare workers. Older adults recounted their experience with village living when their access to water-based group activities was at the rivers and beach near their home villages in Singapore. An example of a village lifestyle living is illustrated in Liu Kang's Life by the River (Kang, 1975) as shown in Figure II-3. The artwork is an illustration of a typical Singapore village (kampong) life in the 1970s demonstrating the proximity of houses to the river, with children playing in the foreground. In comparison to modern swimming pool complexes, older

adult participants stated their preference for the natural, casual settings found in the historical villages in Singapore, mostly due to the familiarity of the environmental settings.

Life by the River by Liu Kang. Collection of the National Heritage Board.

Figure II-3. Liu Kang's Life by the River (Reprinted from *Life by the River* [Painting], Kang, 1975, National Gallery Singapore).

> R1: It would be better to have hot springs. Everyone can be together with hot springs, together, together is better…
> R2: Going out together is very enjoyable.
> R3: Swimming pools don't have hot water, just cold water. I swim very early, I swim at six-thirty, wow, it's very cold.
> R4: We never had this kind of setting (swimming pools) when we were small, we did it by the riverside..
> R5: There was no swimming pool last time. It was mostly ocean. We just went to play with a large group of friends of the same age. We ran outside to play at the shallow end. It was near where I used to live.

Health Promotion

The Health Springs emphasized outreach to older adults, with the expectation that a community-based bathing solution could overcome the isolation issues that older adults face when home alone, in terms of safety and mental well-being. Healthcare workers felt that the

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benefits of a community-based facility with activities in group settings could promote physical activity, social interaction, and mental well-being of older adults.

> *H1: At a day-care center they will help you…improve the living style. Like they come here, they connect with the people, our people. So they make friends, release the stress, then they join activities, and make themselves busy with activities. They do physio activities and occupational therapy, things that help with physical movement.*

> *H2: Some of my patients they seldom do anything. Their only entertainment is watching television. So probably having to go back to their childhood days, playing in their kampung (village setting) and all, it'll be good if they can come together and conduct courses with the elderlies. We need to get them to come out of their house to do something else like Mathematics or like Crafts.*

Accessibility

When discussing a possible location for the Health Springs, older adults cited accessibility barriers at existing senior activity centers and other places of interest, as a major factor in their ability to use a facility. Both older adults and healthcare workers were concerned about the accessibility and location of the proposed community facility to assist older adults with their functional needs.

> *H1: And they (older adults) have to travel you know, when there's traveling there's bound to be problems.*
> *Researcher: So, we need to make sure that it's nearer their homes?*
> *H2: Yeah, maybe like few blocks away, at their void deck (ground floor of public housing buildings).*

> *R1: Close to my house is better. But now it's so far. Even walking is already a problem.*
> *R2: At home is better, at home is more convenient.*

Specific Design and Social Features

The last part of the focus group discussion attempted to capture participants' opinions on specific detailing of the proposed community-based bathing solution. Visual images were used to capture the features participants would like to have in the Health Springs. The images selected were chosen to represent design concerns as well as preferred activity spaces. For design features, participants were asked to compare and choose their preferred feature and discuss the architectural spaces.

For design features, participants were given five pairs of design features to compare, for example, for boundary type, participants were asked to choose between a "walled enclosure" or a "nature enclosure." Participants were given images of each feature to help with the comparison and selection as shown in Figure II-4.

Figure II-4. Set of design features presented during focus group discussions.

The responses were tabulated in Table II-10 and Figure II-5. Based on the focus group discussions, both older adults and healthcare workers showed a strong preference for natural landscaping elements for the outdoor spaces (approximately 60% of responses). Approximately 50% of healthcare workers and older adults preferred a public setting for the pool area, citing additional safety from the higher visibility of older adults' activity in a public setting, as shown in Figure II-4. Figure II-4 also shows the features that had higher participant preference.

For general space and shower settings, 70% to 80% of healthcare workers felt that older adults would prefer a more private and family-oriented space, citing the conservative nature of older adults. These responses from healthcare workers contrasted with responses from older adults, in which 63% preferred a space that encouraged group interaction, and 50% preferred semi-private showers. In the focus group discussion, several older adults mentioned that semi-private settings could afford them the additional security of a communal watch, thus helping with fall prevention and promoting social interaction.

Table II-10.
Participants' Preferences for Type of Design Features.

		Older Adults (n=16)	Healthcare Workers (n=16)
Item	*Binary Scale*	*%*	*%*
Boundary Type (1= Nature Enclosure)	*0= Wall enclosure* *1= Nature Enclosure*	60	63
Pool Size (1=Public setting)	*0= Intimate setting* *1= Public setting*	54	56
Social Setting (1= Group-setting)	*0= Family-setting* *1= Group-setting*	63	31
Seating Type (1= Bench)	*Binary* *0= Individual lounge chair* *1= Bench*	56	75
Shower Configuration (1= Semi-private)	*0= Private* *1= Semi-Private*	50	20
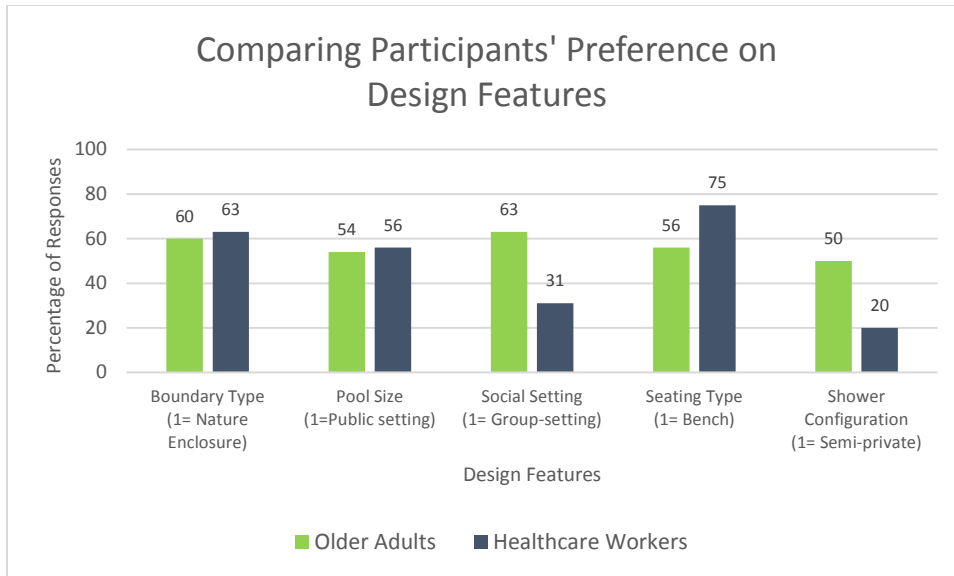
Figure II-5. Comparing healthcare workers and older adults response to proposed design features.

For social features, participants were given nine items and were asked to choose between one to three items that they would like to have in the proposed Health Springs. Participants were given images of each social feature to facilitate the discussion, as shown in Figure II-6. The responses were tabulated in Table II-11 and Figure II-7. The top three social features based on the total percentage score for both groups of participants were "Massage," "Care Station," and "Garden," as seen in Table II-11.

Physical activities

1) Physiotherapy   2) Massage   3) Water Aerobics

Programs for Wellbeing

4) Sauna   5) Grooming   6) Aromatherapy

7) Gardening   ?

Social and educational activites

8) Healthcare worker's station   9) Educational and training programs

Figure II-6. Programmatic features presented during focus group discussions.

When comparing participants' responses to physical activities, more healthcare workers (16.7%) chose physiotherapy compared to older adults (6.5%). Older adults said they would prefer to engage in group water exercises (12.9%), compared to individual physiotherapy (6.5%).

When comparing participants' responses regarding social and educational activities, both groups of participants recognized the need for a healthcare workers' booth in the Health Springs to aid older adults' needs and activities. An interesting aspect was the training and educational activities, with more older adults choosing the social program (12.9%) compared to

healthcare workers (8.3%). The preference for training and educational activities suggests that older adults sought health-promoting activities to help them cope with aging in an independent manner.

Table II-11.

Participants' Preference for Types of Social Programs

	Older Adults (n= 31)	Healthcare Workers (n=36)	Total (n=67)
	%	%	%
Physical Activity			
Massage	29.03	22.22	**25.4**
Physiotherapy	6.45	16.67	11.9
Water Exercise	12.90	2.78	7.5
Social and Educational Activities			
Healthcare workers' booth	12.90	16.67	**14.9**
Training & Educational activities	12.90	8.33	10.4
Programs to promote mental Wellbeing			
Gardening	12.90	13.89	**13.4**
Grooming	6.45	8.33	7.5
Aromatherapy	3.23	11.11	7.5
Sauna	3.23	0.00	1.5
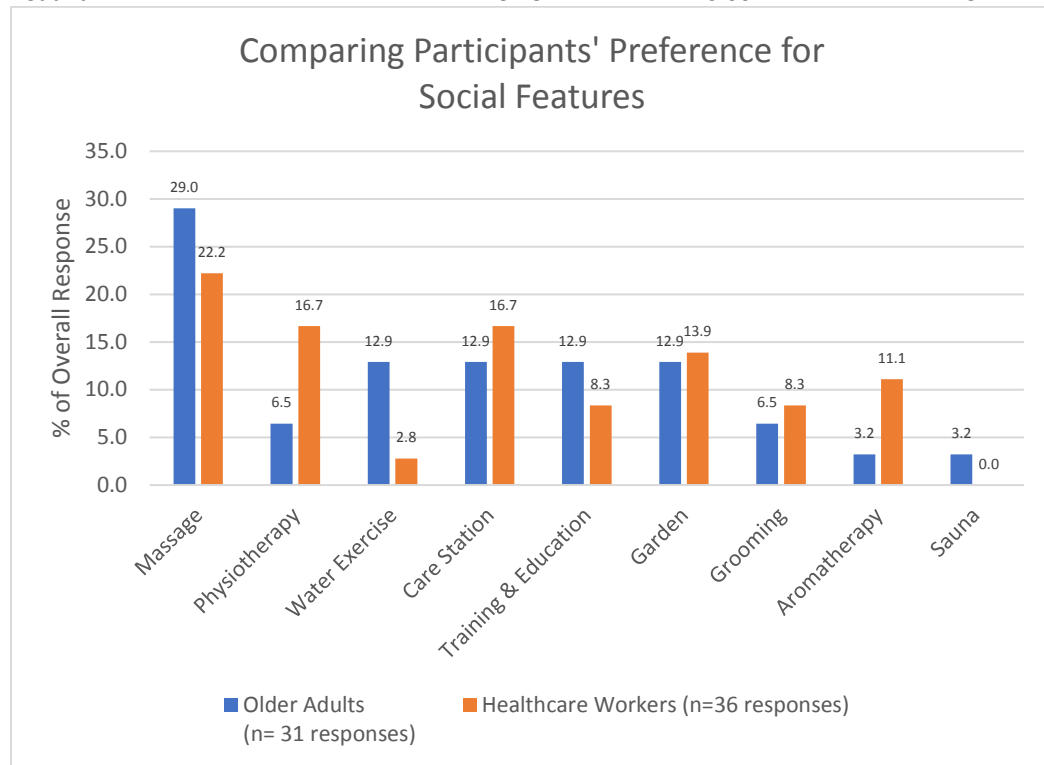
Figure II-7. Comparing healthcare workers and older adults' preference for social programs and activities.

Discussion

Analysis of data from the focus group discussions revealed that the domains of health-seeking behaviors and social connections influenced the participants' opinions and responses towards the three physical domains of environmental barriers, existing design solutions, and innovative design solutions. Overall, the feedback received from the brief survey and focus group discussions could be distilled into three overarching topics: 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connection, 3) Environmental Features for Accessibility and Safety.

Autonomy and Health Promotion

Older adult participants preferred to maintain their independence for functional activities that included bathing and toileting. The brief survey found that older adults preferred bathroom modifications and educational programs over caregiver assistance as the main strategies to assist with fall prevention. The focus group discussions indicated that these two strategies afforded older adults more autonomy over their functional activities, compared to personal care assistance. Furthermore, the focus group discussions indicated that fear of falls motivated older adults to seek health-promoting activities to enable them to cope with the physiological changes brought about by aging. When discussing innovative design solutions for functional activities, healthcare workers supported a community-based setting to reap the additional benefits of increased social interactions, mental wellbeing, and improved cognitive function.

Family, Community, and Social Connections

The focus group discussions indicated that for older adults to age in place, the system of care needed to extend beyond the family. Family caregivers were often burdened with the lack of time, separate living arrangements, and inadequate training to attend to older adults' needs. However, family members played an influential role in shaping the mindset of older adults to participate in community activities. In discussing innovative design solutions that approached the functional activities of bathing in community settings, older adults were receptive to the concept. Older adults could relate the proposed community setting to their past experiences in

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the villages where their everyday interaction extended beyond the immediate family to the community.

Environmental Features for Accessibility and Safety

The focus group discussions indicated that the limited space within public housing units was the main environmental challenge in fall prevention and caregiver assistance. These discussions suggest that healthcare workers were more attuned to the safety needs of older adults and were able to identify more environmental challenges, suggesting that more education is required to assist older adults in fall prevention. Older adults and healthcare workers cited accessibility as the main environmental barrier to community resources such as the existing senior activity centers. In the discussion of social and design features for the proposed Health Springs, the older adults chose features that had a larger group setting, citing the benefits of a communal watch to improve fall prevention, and were willing to compromise some of their privacy for safety.

Limitations

Limiting Bias

Focus group discussions were susceptible to bias introduced by participants dominating the discussion or from the researcher's prompts. Using prepared material such as the semi-structured guide and the visual prompts reduced the introduction of the researcher's bias into the focus group discussions. Likewise, for participant bias, the focus group discussions sampled participants from different backgrounds, with a range of physical health status, to minimize the possibility of a group or individual dominating the discussion. While this research recruited older adults from senior activity centers to share their experience with community-based centers, this may have introduced a degree of bias favorable toward community-based health centers. Future research should be expanded to include older adults who do not attend a community-based center.

Limitations of Analysis by NVivo

Using NVivo to analyze the data allowed for the quick tabulation of coded data by frequency. The generated data does not reflect negative or positive feedback from participants.

Hence a narrative analysis of the five domains helps to give a more detailed understanding of the issues discussed.

Summary

The data collected from the focus group sessions were highly relevant to the research, as it presented an environmental and phenomenological context and holistic appreciation of an older person's life experiences, an approach often used by occupational therapists in developing health interventions (Gitlin, Corcoran, & Leinmiller-Eckhardt, 1995; Rowles, 2009). The three overarching topics of 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connection, and 3) Environmental Hazards, Accessibility, and Safety was subsequently used to guide Phase Two of the research in the design workshops.

References

Addae-Dapaah, K., & Wong, G. K. M. (2001). Housing and the elderly in Singapore – financial and quality of life implications of ageing in place. *Journal of Housing and the Built Environment, 16*(2), 153-178. doi:10.1023/a:1017960600667

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & behavior, 31*(2), 143-164.

Bricki, N., & Green, J. (2007). A guide to using qualitative research methodology. New York: Medicins Sans Frontieres.

Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: SAGE.

DOS. (2015). General Household Survey 2015. Retrieved 03/12/2018, from Singapore Department of Statistics https://www.singstat.gov.sg/docs/default-source/default-document-library/statistics/visualising_data/highlights-of-ghs2015.pdf

DOS. (2018). *Population Trends, 2018*. (ISSN 2591-8028). Singapore: Ministry of Trade & Industry, Republic of Singapore Retrieved from https://www.singstat.gov.sg/-/media/files/publications/population/population2018.pdf.

Gitlin, L. N., Corcoran, M., & Leinmiller-Eckhardt, S. (1995). Understanding the family perspective: An ethnographic framework for providing occupational therapy in the home. *American Journal of Occupational Therapy, 49*(8), 802-809.

HDB. (2017, 08/12/2017). Enhancement for Active Seniors (EASE): EASE Improvements. Retrieved from https://www.hdb.gov.sg/cs/infoweb/residential/living-in-an-hdb-flat/for-our-seniors/ease

Horowitz, B. P., Nochajski, S. M., & Schweitzer, J. A. (2013). Occupational therapy community practice and home assessments: Use of the Home Safety Self-Assessment Tool (HSSAT) to support aging in place. *Occupational Therapy in Health Care, 27*(3), 216-227.

Kang, L. (1975). *Life by the River* [Painting]. Retrieved from: https://www.nationalgallery.sg/artworks/artwork-detail/P-0521/life-by-the-river

Lawton, M. P., Altman, I., & Wohlwill, J. F. (1984). Dimensions of environment-behavior research. In M. P. Lawton, I. Altman, & J. F. Wohlwill (Eds.), *Elderly people and the environment* (pp. 1-15). US: Springer.

Lewin, K., Heider, F., & Heider, G. M. (1936). The psychological worlds and the physical world. In *Principles of topological psychology* (pp. 66-75). NY: McGraw-Hill.

Ling, O. G., & Limin, H. (2002). Public space and the developmental state in Singapore. *International Development Planning Review, 24*(4), 433-447. doi:10.3828/idpr.24.4.6

MOH. (2016). *I feel young in my Singapore: Action plan for successful aging*. Retrieved from Singapore: https://sustainabledevelopment.un.org/content/documents/16269Action_Plan_for_Successful_Aging.pdf

Ng, T. P., Nyunt, M. S. Z., Shuvo, F. K., Eng, J. Y., Yap, K. B., Hee, L. M., . . . Scherer, S. (2018). The Neighborhood Built Environment and Cognitive Function of Older Persons: Results from the Singapore Longitudinal Ageing Study. *Gerontology, 64*(2), 149-156.

Rowles, G. (2009). The meaning of place as a component of self. In E. Crepeau, E. Cohn, & B. Schell (Eds.), *Willard & Spackman's occupational therapy* (11th ed., pp. 111-119). Philidelphia, PA: Lippincott Williams & Wilkins.

Tai-Seale, T. (2008). *Social and Behavioral Determinants of Health*. Texas A&M Univiersity: Texas A&M Univiersity.

Teo, P. (1997). Space to grow old in: The availability of public spaces for elderly persons in Singapore. *Urban Studies, 34*(3), 419-439.

Tomita, M. R., Saharan, S., Rajendran, S., Nochajski, S. M., & Schweitzer, J. A. (2014). Psychometrics of the Home Safety Self-Assessment Tool (HSSAT) to prevent falls in community-dwelling older adults. *American Journal of Occupational Therapy, 68*(6), 711-718.

Welsh, E. (2002). Dealing with data: Using NVivo in the qualitative data analysis process. *Forum qualitative sozialforschung/Forum: qualitative social research,* 3(2) Article 26.

Yeo, Y. Y. C., Lee, S. K., Lim, C. Y., Quek, L. S., & Ooi, S. B. S. (2009). A review of elderly injuries seen in a Singapore emergency department. *Singapore Medical Journal, 50*(3), 278-283.

CHAPTER III

PHASE TWO: DESIGN WORKSHOPS

Study Design

As the second step in this exploratory research, Phase Two aimed to use the data discovered in Phase One to formulate a conceptual design for the Health Springs, a community facility that aims to promote healthy aging at the ground floor of Singaporean public housing building. This new concept for a new community-based facility was explored through a series of design workshops with healthcare professionals who have expertise in geriatric care. Drawing from the healthcare professionals' knowledge the design workshops sought to refine and further develop the Health Springs based on the issues of 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connection, 3) Environmental Features for Accessibility, and Safety. The expert panel of healthcare professionals were asked for feedback on: 1) the potential advantages of the Health Springs, and 2) how to minimize environmental barriers associated with the Health Springs.

Phase Two research was divided into three main parts: data organization, the design workshops, and the preliminary survey conducted at the final stage. Data organization used the findings from Phase One to inform design strategies for the Health Springs prototype in Phase Two. The design workshops focused on incorporating the physical and social features from Phase One into a three-dimensional concept model guided by comments from the expert panels based on the findings of 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connection, 3) Environmental Features for Accessibility, and Safety from the focus group discussions. Finally, the design of the Health Springs center generated from the design workshops was assessed in a preliminary visual survey developed as a precursor for Phase Three's final survey.

Theoretical Framework

Two main theories were used to guide the research in Phase Two: social ecological theory and pragmatism. These two theories helped structure the process of investigation for the design workshops.

Social Ecological Theory

The social ecological approach to health promotion focuses on environment-based and community-oriented strategies to improve a person's quality of life (Stokols, 1996). In social ecological theory, the environment plays multiple roles in influencing public health, acting as a stressor or an enabler of health promotion (Stokols, 1996). The social ecological theory was used to address the complex challenge of healthy aging because its main strategy to health promotion is the synergy of behavioral, organizational, cultural, community planning and legislative perspectives (Stokols, 1996). By merging behavioral and environmental strategies in the multi-disciplinary approach, the application of social ecological theory could reduce typical weaknesses from a strictly behavioral or environmental public health intervention (Stokols, 1996). Following social ecological theory's multi-disciplinary perspectives, the researcher identified a variety of healthcare professionals to contribute their input in the design workshops geared toward promoting healthy aging.

Pragmatism

Pragmatism proposes that a hypothesis is "true" if its applicability is generally and widely accepted through the rigorous clarification of an investigation (James, 1975). Pragmatists propose that experience accounts for one's ability to process the environment and its phenomena (James, 1975). Pragmatism further proposes that an individual's perception is formalized through its relation to others – parts of a whole experience (James, 1975). Charles Peirce applies the principle of pragmatism in the inquiry of "reality" by stating that a pragmatic view would provide the researcher the insight and ability to assess various concepts and inquiries with greater consideration (Atkin, 2017). Pragmatism was used as an approach to guide the investigation through design workshops that aimed to formulate a community-based facility that promotes healthy aging.

Specific Objectives

The proximal goal of the research was to develop a proposed community facility at the ground floor of public housing buildings (known as the Health Springs) that would increase the opportunities for social, health, and wellness activities for older Singaporeans, thus promoting healthy aging. The findings from Phase One highlighted the importance of 1) autonomy and health promotion, 2) family, community, and social connections, and 3) environmental features for accessibility and safety. These were used to guide the design exploration in Phase Two to address the following study objectives.

Objective ONE: Organize and review focus group information using Pena's "Problem Seeking" design programming matrix (Pena & Parshall, 2012) to establish factors that promote healthy aging and potential use of the proposed Health Springs.

Objective TWO: Explore a new typology of community facility and develop a 3D simulated model that represents the Person-Environment-Occupation interaction in the Health Springs and to test the overall acceptability of the 3D model.

Method

Incorporating Design Workshops

Driven by design-based research methodologies, design workshops were used as a means of investigation in this phase. Design-based research is described as a "goal-oriented problem-solving activity" (Archer, 1970; Olsen & Heaton, 2010). Two key components of the design-based research are the involvement of multiple stakeholders and the process of iteration – where multiple rounds of adjustment to study components are made when new information is discovered (Anderson & Shattuck, 2012; Barab & Squire, 2004; F. Wang & Hannafin, 2005). In the reflective iteration process, a design-based inquiry begins with an indeterminate problem and eliminates ambiguity through several rounds of pragmatic decision making to produce a rich, ethnographic solution (Dewey, 1998). New architectural concepts are developed in "the formation of image-schemas that represent objects and events spatially at an abstract level" (Reed, 2013 p.16). In architecture, design-based research involves the play and exploration of perceptual organization to create new meaningful spaces.

Perceptual organization is the grouping or association of certain elements in the visual field based on underlying qualitative characteristics (Wagemans et al., 2012). Perceptual organization influences the way we observe and experience our environment and is intrinsically related to cognitive linguistics (Wagemans et al., 2012). This connection between the visual elements and language results in the symbolic meaning attached to the interpretation of spaces (Broadbent, 1996; Burks, 1949; Peirce, 1902). In attaching meaning to the built environment, the users' meaning carries significant value because their perspective reflects the needs of the contemporary social landscape (Rapoport, 1990). Thus, different user perspectives would help create an inclusive, relevant community space in Singapore's public housing neighborhood that supports the needs of residents' healthy aging. Hence, building upon the feedback from older adults and healthcare workers from senior activity centers in Phase One, it was necessary to include the multifaceted perspective of healthcare experts specializing in the diverse spectrum of geriatric care in Phase Two's design workshops. An expert panel of healthcare professionals from different background of geriatric care was assembled for the design workshops.

Thus, the researchers used a combination of words and images to tap into the expert panel's collective cognitive problem-solving skills in order to create new design solutions that address healthy aging in public housing and to create meaningful spaces for older adults. Design-based research provided a congruous solution for the social ecological approach to healthy aging in public housing.

Study Development

Phase Two utilized the Image-Present-Test technique from John Zeisel's *Inquiry by Design* to conduct a rigorous review of the proposed Health Spring design through the iterative design process with the expert panel. The Image-Present-Test technique (Zeisel, 2006) moves the proposed design solution towards a domain of acceptability (Archer, 1970), as shown in Figure III-1. As outlined in Ziesel's Inquiry by Design, *Imaging* is formulating ideas and knowledge (data organization), *Presenting* is externalizing and organizing the images (design workshops), and *Testing* is reviewing and validating the images (preliminary survey) (Zeisel, 2006). This sequence guided Phase Two's three main parts of 1) data organization, 2) design workshops, and 3) preliminary survey conducted at the final stage and is outlined in Figure III-2.
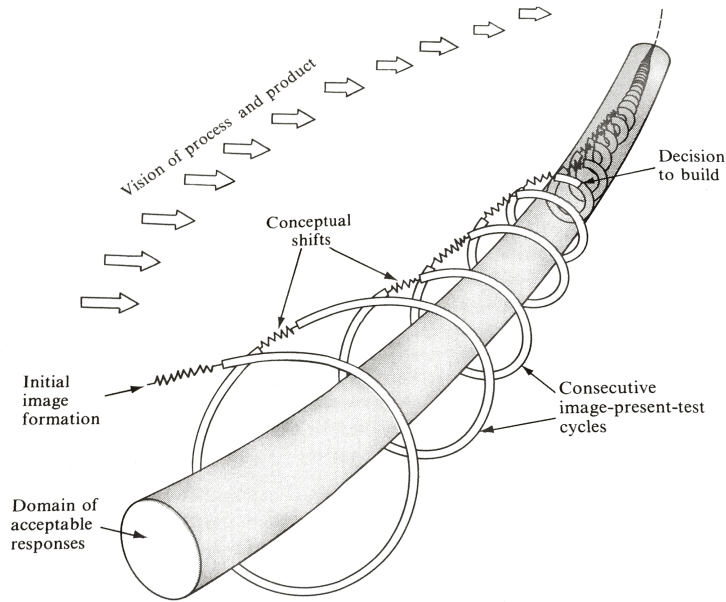
Figure III-1. Diagram illustrating the Image-Present-Test process and design development. (Reprinted from *Inquiry by design: Environment/behavior/neuroscience in architecture, interiors, landscape, and planning* (p.30). Zeisel, 2006, NY: W.W. Norton).
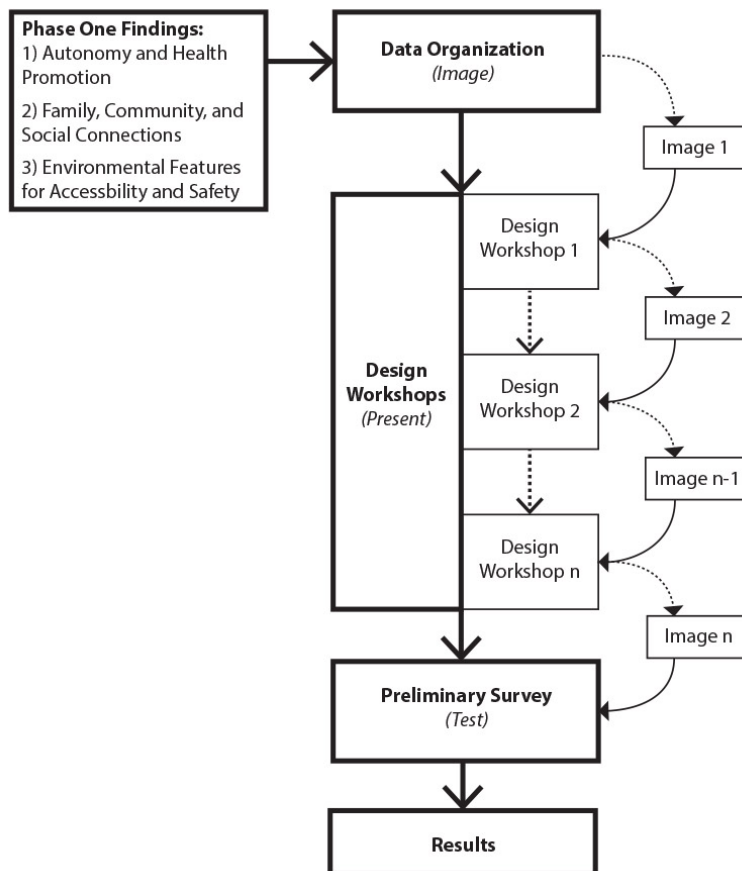
Figure III-2. Structure of design organization, design workshops, preliminary survey based on Ziesel's Image-Present-Test

Image: Data Organization

   The findings from Phase One were used to inform design strategies for the Health Springs prototype in Phase Two. The findings from Phase One were categorized into the four broad topics of 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connections and 3) Environmental Features for Accessibility, and Safety. These domains of aging, which older adults and healthcare workers had expressed concern within Phase One, were further defined and checked against existing literature to ensure content validity, before conducting the design workshops. The findings from Phase One were used to define the study variables of Phase Two. Prior to the design workshops, the researcher presented the compiled results of specific physical features and social programs that the older adults and healthcare workers from Phase One felt could provide meaningful support and activity for the proposed community facility.

Autonomy and Health Promotion

   The focus group discussions indicated that older adults preferred to maintain their independence for functional activities that included bathing and toileting. Furthermore, the discussions indicated that physiological changes related to aging motivated older adults to seek health-promoting activities. This information relates to research on the positive correlation functional autonomy on older adults' subjective wellbeing (Hwang, Lin, Tung, & Wu, 2006; Perrig-Chiello, Perrig, Uebelbacher, & Stähelin, 2006). When discussing specific features of the proposed Health Springs during the focus group discussions, both older adults and healthcare workers showed a strong preference for incorporating more natural landscaping elements into the design of the proposed Health Springs and to have a dedicated space for a garden within the facility. More older adults indicated a preference in having educational programs in the proposed Health Springs (12.9%) compared to healthcare workers (8.3%). Figure III-3 below reflects the images that were shown to the Phase One participants that received higher levels of positive response.

Participants wanted more integration of greenery into the proposed Health Springs

Participants wanted a dedicated garden space within the proposed Health Springs

Massage and therapy programs

Educational programs related to aging issues

Figure III-3. Examples of specific images shown during the focus group discussions that participants expressed strong interests in relation to autonomy and health promotion.

Family, Community and Social Connections

The focus group discussions indicated that for older adults to age in place, the system of care needed to extend beyond the family to include the immediate community. Older adults reported their preference for a community-setting for aging-in-place care related to their childhood experiences in the villages. The importance of social connections relates to other studies where older adults with strong social networks had lowered risk of cognitive decline (Bassuk et al., 1999). When discussing specific features and programs of the proposed Health Springs, older adults from the focus groups indicated a higher interest in group exercises (12.9%), compared to individual physiotherapy (6.5%). 63% of older adults in the focus group discussions preferred a space that encouraged group interaction, instead of spaces that were limited to only family use, this is illustrated in Figure III-4.

Scale of spaces that encourages interactions with members of the community

Possible types of group exercises

Figure III-4. Examples of specific features and programs that were well received by older adults in the focus group discussions.

Environmental Features for Accessibility and Safety

The focus group discussions had indicated that the limited space within public housing units was the main environmental challenge in fall prevention and caregiver assistance. Several publications on Singapore public housing have highlighted the need to upgrade the quality of public housing design to address safety in the home (Addae-Dapaah & Wong, 2001; S. E. Teo & Kong, 1997). Older adults and healthcare workers cited accessibility as the main environmental barrier to community resources, such as the existing senior activity centers. The older adults' concerns corresponded with research in urban settings, where perceived accessibility to amenities was positively correlated with older adults' social participation (Richard et al., 2008). When discussing specific features of the proposed Health Springs during the focus group discussions, there was a strong preference for open spaces which would enhance better caregiver assistance from the increased visibility and additional space. Both older adults and healthcare workers from the focus group discussion also highlighted the need for a central caregiver space to provide assistance at the proposed Health Springs. The specific features discussed in Phase One are illustrated below in Figure III-5.

Open spaces for better visibility

Specific safety features like benches to allow older adults to enjoy water activties

Caregiving assistance

Semi-private showers to allow for better caregiver assistance while providing a degree of privacy

Figure III-5. Specific physical features and social programs for improving safety and access.

Present: Design Workshops

Using the organized information from Phase One, design workshops were conducted to develop a new architectural concept for a community facility in public housing neighborhoods that could support healthy aging. The design workshops were conducted via web-based video conference sessions, with each session lasting approximately 90 minutes. The same expert panel attended all design workshops, which were moderated by the researcher. The design workshops were structured into two parts. After a 45-minute presentation by the researcher, the expert panel had an additional 45 minutes for commentary and discussion. At the first design workshop, the findings from the Phase One focus group discussions were presented. The expert panel's commentary and discussion on the findings were used to inform the development, presentation, and further exploration of design concepts in the subsequent design workshops. The researcher took notes of the commentary by annotating plans and

images presented during the workshops. The design workshops were conducted until design saturation was reached and a final prototype of the proposed Health Springs was generated for testing with a larger audience.

Presentation and Visual Prompts

A 3D simulation model was first introduced and used during the design workshops as it allowed for an enriched representation of the proposed Health Springs intervention and supported the meaningful discussion of proposed spaces (Clayton, Teicholz, Fischer, & Kunz, 1999). The researcher used Sketchup Pro for the initial conceptualizing of the Health Springs model to facilitate quick and interactive in-model discussion with the expert panel. Later stages of the design workshops utilized Autodesk Revit 2017 for a more accurate representation of built space, and Lumion v7 for photo-realistic 3D renderings. Local plans and photographic images from current public housing buildings were used to arrange the spatial layout in order to present an accurate setting for the Health Springs within Singapore's public housing neighborhoods.

During the Phase One focus group discussions, a visual ideas board had been used to discuss and compare physical and social features that would promote and support functional activity. The 3D simulation of the proposed Health Springs extracted and presented the participants' preferences for different unique spaces within the proposed Health Springs.

Decision-making Structure

The design workshops utilized Pena's "Problem Seeking" design programming matrix to assist with the decision-making process. Analysis of the user design workshop discussions was guided and categorized by Pena's problem-seeking matrix and presented to the diverse group of healthcare professionals to establish and review the defined characteristics of environmental influence. Borrowing from this matrix, the researchers used the Five Steps of the matrix to categorize data from the design workshops. The Five Steps were "Establish Goals, Collect Facts, Test Concepts, Determine Needs and State Problems" (Pena & Parshall, 2012). This process reduced uncertainty in designing for users' needs and created a dynamic exchange between analysis and synthesis during the design workshops (Pena & Parshall, 2012; Sanoff, 2016).

Test: Preliminary survey

A one-time online survey was distributed at the senior activity centers and the Falls Clinic. Healthcare workers were asked to provide feedback on the finalized images of the Health Springs developed during the design workshops. The participants were asked to rate a series of conceptual renderings of the Health Springs based on perceived use and ability to support healthy aging. The online survey took approximately 10 to 15 minutes to complete and was anonymous. It was hosted on Qualtrics, which is an online software used for collecting and analyzing data. At the beginning of the survey, participants were given information on the study and required to give their electronic consent to indicate they met the inclusion criteria and then access the survey.

The preliminary survey (Appendix D) included visual images of spaces within the proposed Health Springs. The main purpose of the preliminary survey was to test the proposed spaces of the Health Springs and establish a heuristic connection between the proposed spaces and the study variables. The survey was divided into three main parts: 1) participants' characteristics, 2) participants' opinions on the Health Springs' potential to support healthy aging and 3) participants' opinions on the Health Springs' potential use and intergenerational use.

Study Sample and Setting

For the design workshops, with help from the study's Singaporean collaborators, a convenient sample for an expert panel was obtained by the Geriatric Education and Research Institute of Singapore (GERI). During the final stage of the design workshops, a preliminary survey tested the conceptual design of the proposed Health Springs. The preliminary survey used visual images to convey the concept of the proposed Health Springs and served as a pilot test for developing Phase Three's large-scale survey. The preliminary survey was distributed to healthcare workers, and caregivers from four senior activity centers and a local clinic focused on the prevention and treatment of falls in older adults (referred to here as the Falls Clinic).

Because GERI was affiliated to the Khoo Teck Puat General Hospital, the primary hospital catering to the North region, the researcher was granted access to senior activity centers and the Falls Clinic that were part of the continuum of care provided by the general hospital.

Recruitment for Phase Two took place in four senior activity centers, the Falls Clinic, and GERI – all in the same residential town of Yishun, which is located in the North region of Singapore (one of the five regions). For the preliminary survey, recruitment sites were similar to sites from Phase One, as the research aimed to recruit some healthcare workers from Phase One for their opinions on the proposed Health Springs prototype, as conceptualized from the focus group data. As the researcher anticipated that healthcare workers from Phase One may drop out of Phase Two of the study, additional healthcare worker participants were recruited for the preliminary survey.

Recruitment Procedure

The recruitment took place from October to November 2016 for the design workshops and from February to April 2017 for the preliminary survey. For the preliminary survey, the researcher contacted the various senior activity centers and the Falls Clinic for their interest in participating in the study. After the facilities agreed to participate, facility administrators invited healthcare workers to complete the preliminary survey via a survey link that was distributed through a recruitment email.

Inclusion and Exclusion Criteria

Healthcare workers and caregivers eligible for inclusion were staff, caregivers and volunteers at the senior activity centers, the Falls Clinic, and GERI; participation was restricted to those who were familiar enough with the physical limitations of older adults to give informed input on design and programmatic features related to functional activities.

IRB Approval

As an international study, the research received IRB approval from both Singapore's National Health Group and Texas A&M University. The preliminary survey was conducted online, and no sensitive information was obtained; because the study presented minimal to no risk to participants, expedited approval was granted, with a waiver of documentation for implied consent. All identifying information was coded to protect participants' confidentiality.

Results

Data Organization and Design Workshops

The reviewed findings from Phase One's focus group discussions were first presented to the expert panel during the data organization stage. Subsequently, the expert panel of 12 healthcare professionals was called upon to attend design workshops regularly to help develop and refine the design and concept of the proposed Health Springs based on Phase One's findings. The expert panel consisted of a senior consultant in geriatric care, a consultant in geriatric care, a falls specialist, three nursing staff from the Falls Clinic, three community care nurses, an occupational therapist and two research associates from GERI. They were asked to attend the design workshops regularly; attendance levels ranged between eight to ten participants at each session. The expert panel's commentary guided the design considerations for the subsequent design workshop and a total of four design workshops were conducted. Figure III-6 shows the process between the data organization stage and the iterative process of the design workshops. All workshop sessions were moderated by the researcher, who had a background in healthcare architecture.
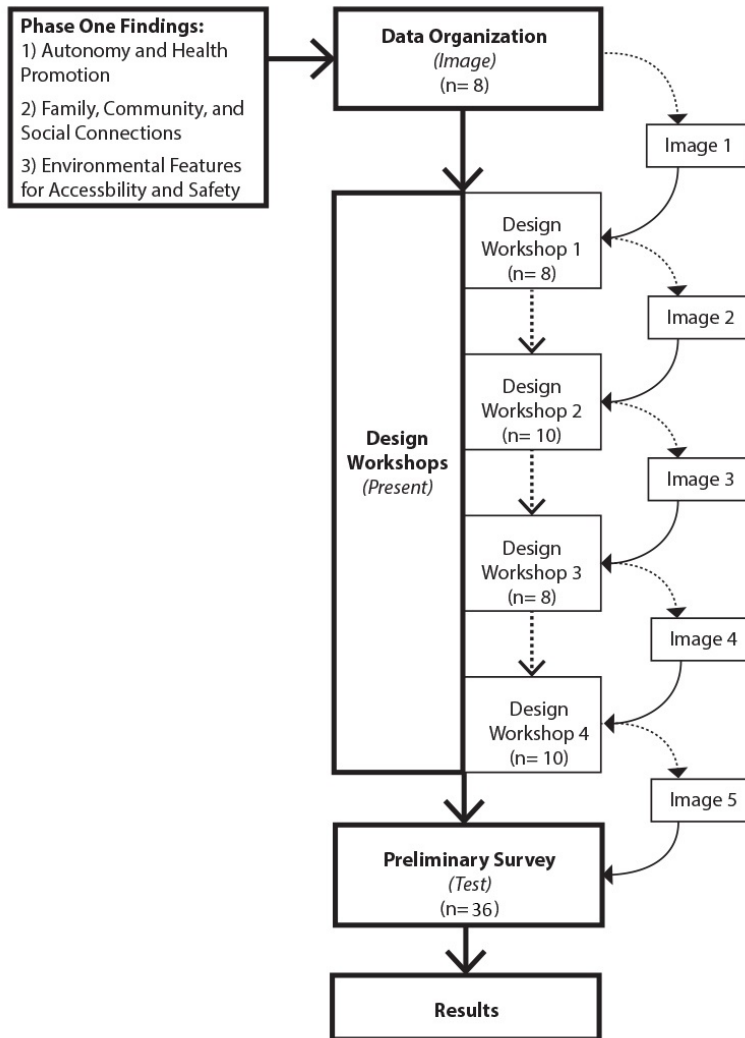
Figure III-6. Flowchart of resulting design process for Phase Two.

Data Organization

The findings from Phase One indicated that older adults were interested in social programs and group activities related to educational development and health promotion. These findings were presented in Phase Two's data organization discussion prior to the design workshops. Based on these findings, the expert panel, assembled in Phase Two, suggested that older adults had the potential to act as agents of change and that the proposed Health Springs should function as a social node for informal education. Based on social learning theory, observational learning is the process of learning where individuals mimic behavior from role models (Bandura & Walters, 1977). Individuals with higher self-efficacy who exhibited positive health-seeking behaviors were effective in influencing their peers to behave similarly (Bandura

& Walters, 1977). The proposed Health Springs aims to create a social environment where older adults could interact with other older adults of differing physical health status to encourage the exchange of ideas and exposure to healthy behaviors.

Likewise, the expert panel commented on the advantage of the proposed Health Springs serving as a node for informal learning that differed from a typical healthcare setting. Reforming the urban environment in a manner that allows for information and people to be easily accessible creates opportunities for informal learning beyond an institutional setting (Carr & Lynch, 1968). By transferring ownership of the communal space from institution-based management to the housing residents and older adults, the proposed Health Springs would create a space that allows for active, engaged learning.

A problem noted by the expert panel was the balance of promoting older adults' functional autonomy while also supporting healthcare workers' responsibility in providing adequate care. One discussed strategy to reduce the burden on healthcare workers was to create environmental and social programs that would improve older adults' functional autonomy. The Health Springs initiative would potentially achieve this by incorporating environmental features that follow universal design guidelines and provide adequate safety features to assist ambulant older adults in their activity. Simultaneously, physical activity was identified as a means of promoting the physical health, self-esteem, and self-efficacy of older adults (McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000).

More importantly, the layout of the Health Springs should be designed in a way that supports healthcare workers' decision-making ability regarding older adults' health competency. Decisions regarding older adults' frailty are subjective, and the level of risk tolerance varies among healthcare workers (Clemens & Hayes, 1997). Assessing older adults' health competency can create additional stress for healthcare workers, in addition to their daily routine. For example, in Phase One, a healthcare worker mentioned that, despite an older adult patient's ability to handle his bathroom activities, she would remain close by to assist if needed. She interpreted the spatial conditions as being of high risk because she did not have a clear line of sight to her client.

Supporting healthcare workers' ability to make decisions on their client's health competency allows for greater tolerance of risk assessment and reduces the stress placed upon healthcare workers (Clemens & Hayes, 1997). The expert panel suggested that the layout of the Health Springs should provide an adequate amount of safety features and enable healthcare workers to determine an older adult's needs quickly, from a short distance.

Design workshops

Using Pena's design programming matrix, the preliminary goals were established before the design workshops and were based on Phase One findings. The goals were aligned to increasing older adults' functional autonomy and health promotion, increasing older adults' family, community, and social connections, and improving environmental features targeting safety and accessibility for older adults. Following the presentation of Phase One findings, the expert panel provided commentary that was classified into concepts, needs, and problems as per Pena's design programming matrix. The expert panel's commentary guided the design considerations for the subsequent design workshop. Table III-1 shows the streamlining of the comments made by the expert panel grouped with each workshop and the resulting design schemes.

Table III-1.
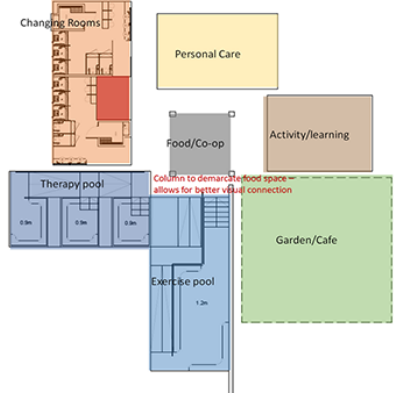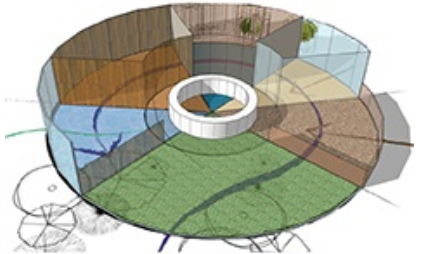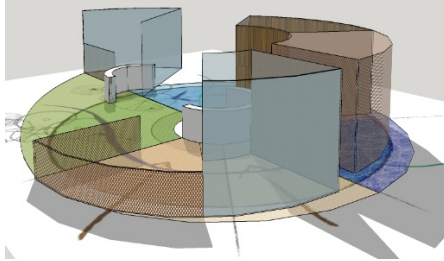
Iterative Process of Streamlining the Expert Panel's Comments with Design Schemes.

Data Organization	Design Workshop 1	Design Workshop 2	Design workshops 3 & 4
Autonomy and Health Promotion			
"Concerned that healthcare workers may 'rob' older adults of their independence."	"Environmental and social features should engage older adults' dexterity and physical capabilities. Focus on adaptability and program flexibility, so different people will be encouraged to use the space at different times."	"Individual spaces, like single pools for therapy, are not desired - too little space for caregiver assistance and does not encourage socializing."	"Improve daylighting in the pool area and increase the natural elements of plants."
Notes: To establish design solutions that promote self-efficacy and minimize learned helplessness.	*Notes: Programs should be planned for everyday activities and* healthy aging. *Design of proposed Health Springs should enable flexible use.*	*Notes: Improve safety aspects and increase the opportunity for social interactions.*	
Family, Community and Social Connections			
1. "Older adults' preferred social programs and group activities. Peers of older adults to act as agents of change." 2. "Health Springs can perform as a social node for gathering and exchange of information by providing opportunities for informal education."	1. "Develop spaces that encourage multi-generational use." 2. "Staff care station should not resemble hospital care. Should have more community involvement and openness of information accessibility." 3. "Develop the landscaping aspect of the Health Springs further to establish a unique characteristic."	1. "Spatial elements should be meaningful and culturally relevant that show ownership and belonging for older adults and Singaporeans." 2. "Likes the concept of integrating the healthcare workstation and food station to re-structure volunteer and education spaces. Culturally significant in Singapore - bonding over food." 3. "Use the natural landscaping to break away from traditional eldercare institutional design.	1. "Orientate chairs to face activity areas for visual connections to programs and social activities." 2. "Connect the existing community garden and fitness corner with Health Springs for expansion of larger event space."

Table III-1. *Continued*
Iterative Process of Streamlining the Expert Panel's Comments with Design Schemes.

Data Organization	Design Workshop 1	Design Workshop 2	Design workshops 3 & 4
		Create multiple opportunities for access to nature/pet therapy."	
Notes: To investigate social learning theory and create environments for observational learning.	*Notes:* 1. *Create spaces for intergenerational use and social interactions.* 2. *Proposed a variety of places for informal learning to increase social engagement.* 3. *Design of the proposed Health Springs should promote access to nature and mental wellbeing of the users.*	*Notes:* 1. *Study traditional Southeast Asian architecture.* 2. *Research on food culture and Singaporean identity.* 3. *Show more scenes that demonstrate access to nature in indoor spaces and integration with public housing neighborhood.*	*Notes: Create opportunities for social interactions and people watching through interior planning and connection to the existing neighborhood.*
Environmental Features, Accessibility, and Safety			
"Find the middle ground between autonomy and safety (older adults' vs. healthcare workers' agendas)."	"Multiple entryways for accessibility to draw more people into space." "Improve integration into existing public housing layout (typical grid layout)."	"Reduce angular corners which results in blind spots for healthcare workers and increase the visibility of spaces. Curvilinear spaces reduce environmental hazards such as bumping and bruising. Replace walls with railings/fences wherever possible."	"Improve visibility into rooms such as Activity rooms - by using full-height glass panels instead of windows to promote social interactions. To increase the level of privacy with personal care room to be semi-private instead."
Notes: Understand healthcare workers' work processes regarding older adults' mobility and independence.	*Notes: To use the column grid of public housing to design for adaptability. Position near existing elevators for accessibility.*	*Notes: Improve safety, wayfinding, functional autonomy, and walkability.*	

Table III-1. *Continued*
Iterative Process of Streamlining the Expert Panel's Comments with Design Schemes.

Data Organization	Design Workshop 1	Design Workshop 2	Design workshops 3 & 4
	Floorplan V.01	Floorplan V.02	Floorplan V.03
	Internal Render V.01	Internal render V.02	Internal render V.03
	Health Springs V.01	Health Springs Render V.02	Integrated Floorplan V.03

Design Workshop 1 Review

The first set of images for the proposed Health Springs were derived from the expert panel's commentary and data from Phase One's focus group discussions. The proposed Health Springs included the following seven main spatial and programmatic categories: 1) outdoor event space, 2) information/learning area, 3) community care zone, 4) relaxation pool, 5) water exercises area, 6) shower and changing area, and 7) a staff/care station. The seven programmatic categories were derived from older adults' preferences highlighted during the focus group discussions. These images were presented to the expert panel for feedback during Design Workshop 1. These are illustrated in Figure III-7.
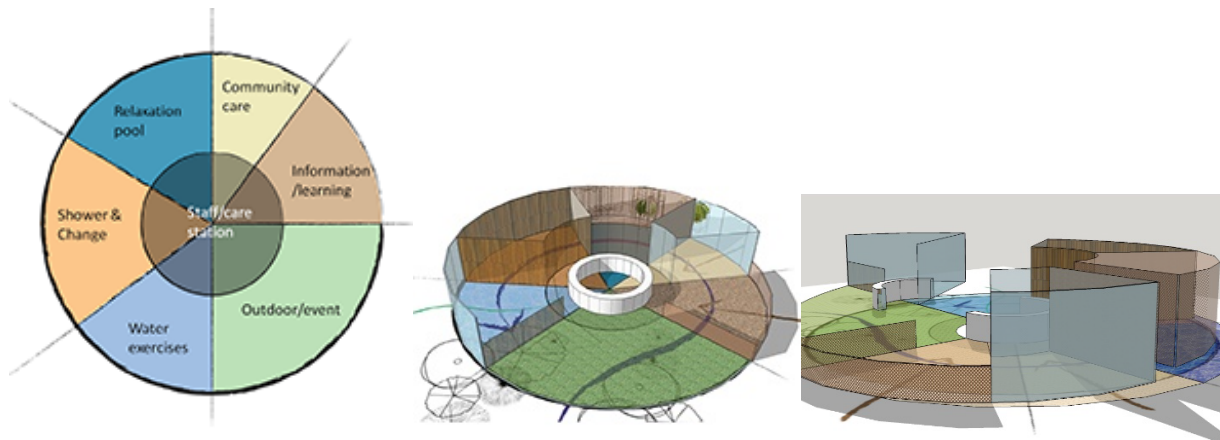
Figure III-7. Images of the proposed Health Springs presented in Design Workshop 1.

The expert panel's commentary from Design Workshop 1 focused on ensuring that the proposed Health Springs would be a highly usable facility that would attract a diverse mix of housing residents from different age groups. The commentary of the expert panel can be grouped into five main factors that influence the usability of the proposed Health Springs: 1) adaptability, 2) intergenerational use, 3) safety and service, 4) accessibility and 5) natural environment.

The expert panel emphasized the need for programmatic and architectural adaptability of the proposed Health Springs. The programs included should be flexible in order to encourage everyday activities and serve multiple functions to engage a wide variety of interests within the same space.

"We should focus on adaptability and program flexibility, so different people will be encouraged to use the space at different times."

The expert panel highlighted that flexible programs would ensure that the Health Springs would be used at different times and provide a meaningful space for residents of public housing, as well as older adults. This initiative guided the future design workshops and research inquiry to create a highly usable facility that would appeal to a diverse range of housing residents. The expert panel felt that public housing residents using the proposed Health Springs could create opportunities for social bonding beyond the older adult's family structure. Hence, the researcher looked into the diversification of social programs within the proposed Health Springs. Encouraging different everyday activities would foster higher levels of social interaction, which is related to a better quality of living and healthy aging in the community (Menec, 2003). Likewise, the proposed Health Springs needed to be integrated into a public housing setting and adaptable for different functions at various scales. Modular design elements would support planning for different public housing sites (Lynch, 1958).

"Can we improve integration into existing public housing layout (typical grid layout), I don't see this circular form working well now. We need spaces of different sizes that can be change to suit the event."

The expert panel also brought up the concept of intergenerational programming and use of the proposed Health Springs. Intergenerational activities could take place at the information and learning area or the community care zone within the proposed Health Springs. The two-way benefits of intergenerational use in the proposed Health Springs could re-shape public perception towards facilities designed for older adults into an awareness of potential shared value for the community.

"Develop spaces that encourage multi-generational use. We don't want the space to only be for older adults – I think it would be good if children can use the space like for daycare and the grandparents can accompany them"

Intergenerational programming and use of activities and spaces can encourage substantive interaction between older adults and younger counterparts, like youths and children (Weintraub & Killian, 2007). Intergenerational activities improve the mental wellbeing

of older adults and can minimize cognitive decline (Weintraub & Killian, 2007). Furthermore, intergenerational activities can produce learning opportunities for both older adults and younger children, which, in turn, empowers older adults and produces a sense of volunteerism and civic participation (Morrow-Howell, Tang, Kim, Lee, & Sherraden, 2005; Newman & Hatton-Yeo, 2008; WHO, 2007).

To ensure the usability of the proposed Health Springs, older adults' safety needs and the needs of healthcare workers should be addressed. The expert panel emphasized that programmatic spaces in the proposed Health Springs would need to provide different levels of safety features and privacy to cater to older adults at different levels of physical health status.

> *"The environmental and social features in the center (Health Springs) should engage older adults' dexterity and physical capabilities, no point if they cannot use the space by themselves."*

The researcher noted that safety features such as handrails for ambulant older adults, ramps for wheelchair access, and chair lifts or stair crawl devices needed to be added to the design to enable older adults of differing levels of frailty (from very fit to moderately frail) to access the proposed Health Springs. The expert panel also suggested that programs could happen in the outdoor event space and the water exercise area of the proposed Health Springs would help promote physical activity and health of older adults. Lastly, the expert panel requested that circulation routes of caregivers in the proposed Health Springs should be coordinated to allow for a clear operational flow to provide adequate service and care to older adults quickly and efficiently.

When discussing the location of the proposed Health Springs at the ground floor of public housing, the expert panel suggested for the subsequent design workshop that the proposed Health Springs should be located near the elevator core of the buildings as it could reduce the travel time from older adults' homes in public housing to the proposed Health Springs. Furthermore, the expert panel requested that specific design considerations should be made to prevent the proposed Health Springs from resembling a typical healthcare facility for older adult care. The expert panel guided the discussion on creating a community facility that would encourage greater community bonding.

*"(The Health Springs Center should have) Multiple entryways to increase accessibility...
to draw more people into space."*

*"Staff care station should not resemble hospital care. Should have more community
involvement and openness of information accessibility."*

Improving accessibility to the proposed Health Springs would encourage older adults to
visit and use the community facility. Subsequently this could improve the older adults' social
interactions and physical health. During Phase One's focus group discussions, older adults
reported that the main barriers of access to existing community facilities were poor location
and lack of proximity to other services.

Lastly, the expert panel commented on the incorporation of the natural environment to
improve the potential use of the proposed Health Springs. Studies on access to nature have
highlighted the positive relationship between mental wellbeing and exposure to nature (Maller,
Townsend, Pryor, Brown, & St Leger, 2006; Rodiek, 2002).

*"...aside from the outdoor event space, plants, greenery, and water elements can also
be introduced to all parts of the center (Health Springs) to help create a unique,
defining design characteristic."*

The expert panel also preferred to have natural ventilation and daylighting incorporated
into the design of the Health Springs to engage the senses of older adults. Because multi-
sensory stimulation related to sight, sound, taste, smell, and touch has been shown to minimize
behavioral problems related to dementia (Baker et al., 2003), the proposed Health Springs
aimed to increase older adults' exposure to sensory stimulation. The expert panel noted that
the design should also create a comfortable micro-climate for older adults that would allow for
prolonged use of the space.

Design Workshop 2 Review

The second set of images for the proposed Health Springs was further developed from
the expert panel's commentary in Design Workshop 1. In the revised layout, the originally
proposed spaces for the Health Springs were modified to incorporate new activities and
functions based on the expert panel's feedback. The outdoor event space was modified to an
outdoor event and café space; the information/learning room became an outdoor class and

childcare space; the community care zone included personal care and grooming services; the water exercise and relaxation pool were combined into a larger water therapy area and the staff station was re-purposed as a community co-op. The images were presented to the expert panel during Design Workshop 2 and can be seen in Figure III-8.
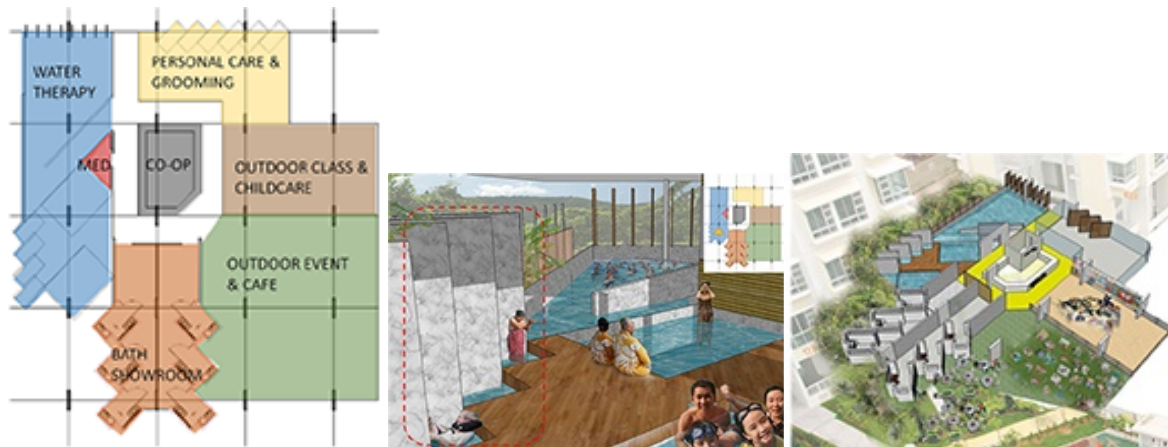
Figure III-8. Examples of images presented during Design Workshop 2

The expert panel's commentary from Design Workshop 2 continued to focus on the usability of the proposed Health Springs for housing residents of public housing from different age groups. In the workshop, the expert panel discussed ways to promote the potential use of the Health Springs by ensuring 1) good spatial coherence and wayfinding for older adults, 2) adequate proximity between activity zones, relaxation areas and healthcare support in the Health Springs and 3) culturally relevant spaces and programs.

The second set of images presented to the expert panel introduced the typical public housing grid and modular units for adaptable space usage and possible integration into different public housing sites, as seen in the Figure III-9. The seven programs of outdoor events, information/learning room, community care, water exercise and relaxation, and shower areas were arranged around the primary circulation. The primary circulation route was established for housing residents and older adults to move around the proposed Health Springs in a logical, circular flow in order to address wayfinding and spatial coherence, as shown in Figure III-9. A secondary circulation route was introduced for healthcare and volunteer workers to ensure operational flow and emergency evacuation if needed. To increase privacy in the seven programmatic spaces, the researcher introduced individualized pods and units, as shown in the

Health Springs Render V.02. The expert panel commented that the high degree of privacy compromised the visual ability of healthcare workers and requested to remove walls and angular corners to increase visibility of spaces, improving both the wayfinding for older adults and the provision of care.

> "…angular corners creates blind spots for healthcare workers and makes it difficult to look after older adults…. Curvilinear spaces can reduce hazards such as bumping and bruising and increases the visibility of spaces… Replace walls with railings/fences wherever possible."

> "Individual spaces, like single pools for therapy, are not desired - too little space for caregiver assistance and does not encourage socializing."
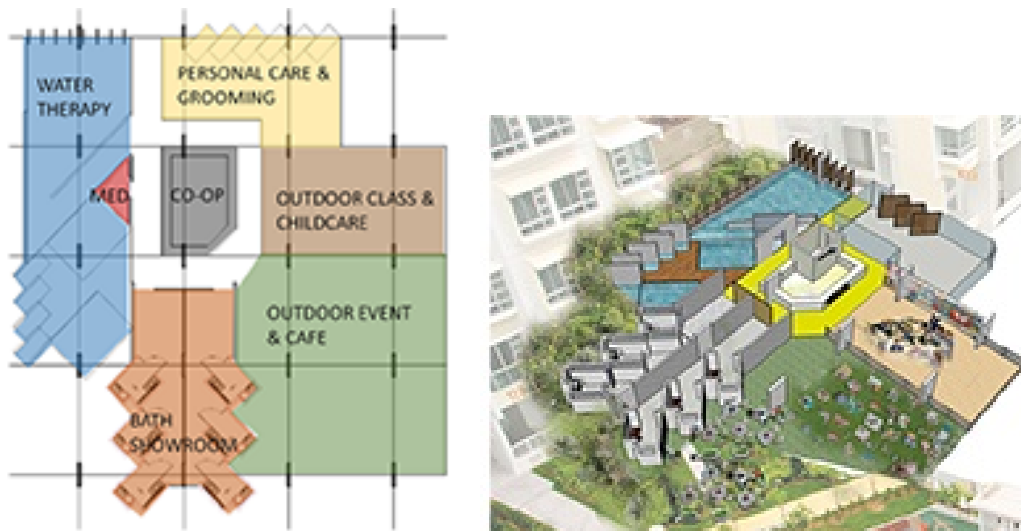
Figure III-9. Floorplan v.02 with primary and secondary routes of circulation and Health Springs render V.02.

The expert panel additionally highlighted the need to balance the proximity between activity zones, relaxation areas, and healthcare support. The expert panel emphasized that there were insufficient designated resting areas in proximity to the activity areas for older adults to rest and watch the activities, inhibiting their ability to use the proposed Health Springs comfortably. Furthermore, the expert panel commented that the medical corner and the co-op, as shown in Floorplan V.02, were too close to each other and were not adequately distributed to extend the zone of visual surveillance throughout the proposed Health Springs.

Lastly, the expert panel discussed improving the design and programs of the Health Springs to incorporate more culturally relevant elements that would increase the potential use of the facility. In response to the comments, the researcher conducted a review of Singaporean

vernacular architecture and a few popular traditional housing typologies emerged, including the traditional Malay house, the traditional Chinese house and temple construction, and the traditional shophouse.

> *"Spatial elements should be meaningful and culturally relevant that show ownership and belonging for older adults and Singaporeans."*

The traditional Malay kampong (village) house of Singapore is a common type of Singaporean housing that was used prior to the development of public housing (B.-H. Chua, 1991). The traditional Malay house is comprised of a semi-open veranda, or entrance, that allowed for high levels of interaction between owners and neighbors, as shown in Figure III-10 (Bay, 2004). The entrance space (anjung) leads into a formal entertaining space with full-length windows (serambi) that is located on the inner part of the house (Bay, 2004). An important design aspect of the entrance space (anjung) is that it was located near pedestrian paths with low fences and railings—and that this high visibility promoted community spirit in the village (Bay, 2004).
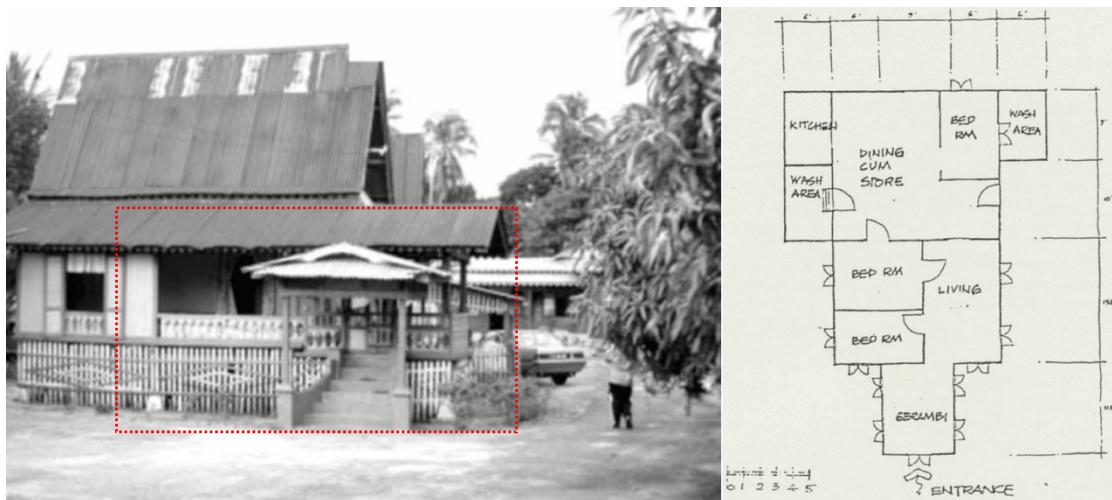
Figure III-10. A traditional Malay house with photo of an anjung[1] and a floorplan showing the serambi[2] (1. Reprinted from "Sustainable community and environment in tropical Singapore high-rise housing: the case of Bedok Court condominium," by Bay, 2004. *Architectural Research Quarterly, 8*(3-4), pg. 333-343. 2. Reprinted from "Adjusting religious practices to different house forms in Singapore," by Chua, 1991, *Architecture and Behavior, 4*(1), pg. 3-25.)

Research of traditional Chinese architecture in Singapore noted the similarities between the planning of the Chinese house and temple, as seen in Figure III-11(a) typical Ming hall with column bays (Khol, 1984), Figure III-11(b) semi-rural Singaporean Chinese house with bays

(Kohl, 1984), and in Figure III-11(c) floorplan of Malaysian Chinese temples (Khol, 1984).

Notable design characteristics of traditional Chinese architecture are the elaborate truss system

for the roof resting on columns and spacing between columns to create "bays" as shown in

Figure III-11(e) the conserved Tan Yeok Nee Mansion in Singapore (Knapp, 2013), and Figure III-

11(f) timber truss system (Knapp, 2013). The extensive use of columns and bays allows for the

open, flexible flow between spaces while also maintaining a strong, visible, and central core of

the traditional house, as shown in Figure III-11(d) Southern Chinese house floorplan (B. H. Chua,

1988).
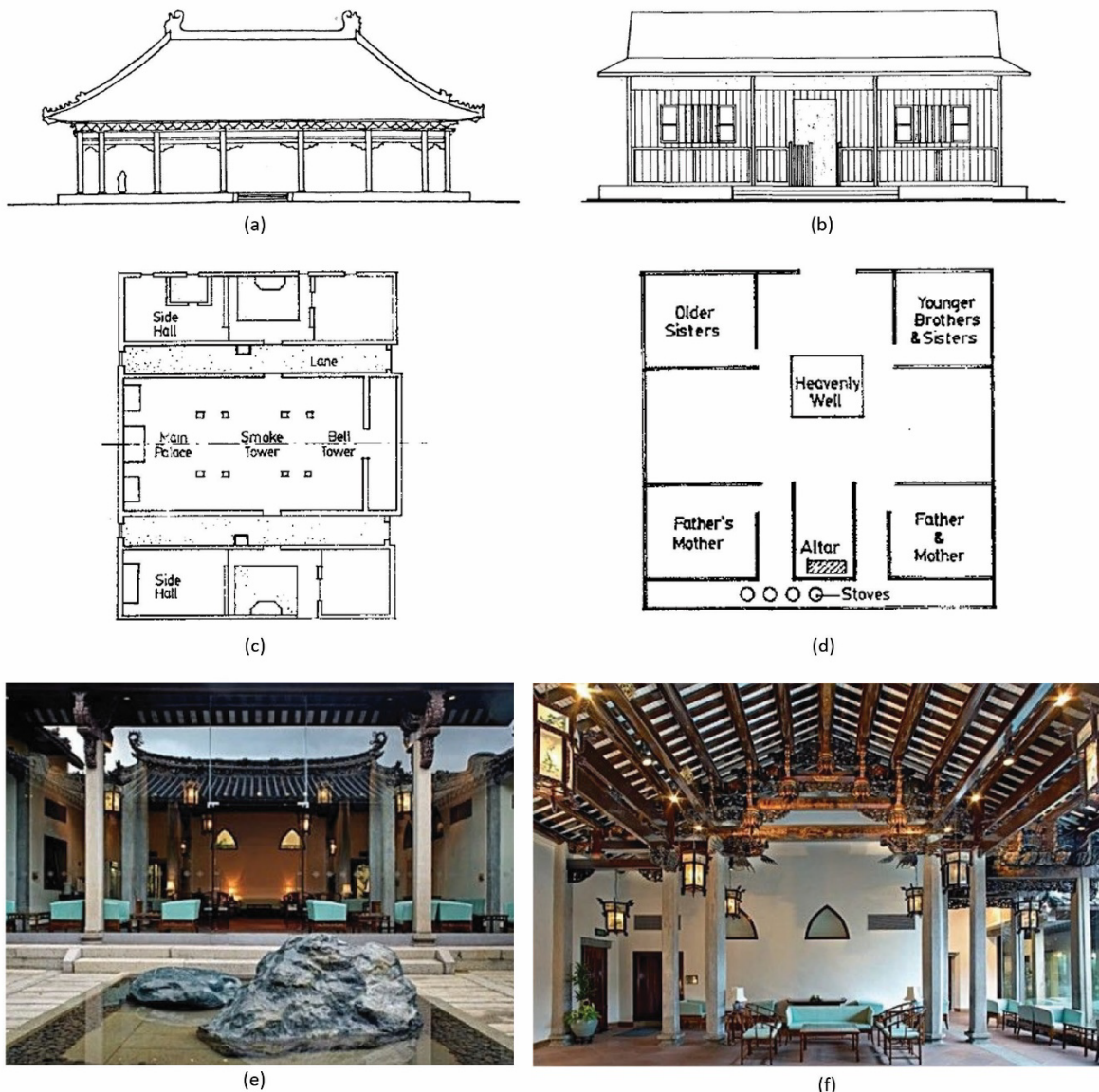
Figure III-11. Set of images portraying historical Southeast Asian architecture. (Reprinted from Khol, 1984; Knapp, 2013; B. H. Chua, 1988).

Finally, another influential, traditional housing design is the shophouse, a row of narrow terraced housing that can span up to 60 or 70 feet in length, as shown in Figure III-12 (Savage, 2001). The shophouse possesses multiple functions, serving commercial needs on the first floor and a housing unit on the upper floors (Savage, 2001). Traditional shophouses in Singapore possess characteristics of Chinese architecture, such as an inner courtyard, exposed structures, and emphasis of the roof (Savage, 2001). Elements of local Malay architecture are also incorporated into the design of Singapore shophouses, with the inclusion of the veranda (anjung) (Savage, 2001). The veranda became a stipulated requirement, known as the five-foot way, during colonial rule, during which each shophouse would have a frontage that was open and continuous, allowing pedestrian traffic to flow into the shops seamlessly (Savage, 2001). Façade ornamentation of the shophouses includes false fronts with parapets and open balustrades that created a prominent architectural style (Savage, 2001).
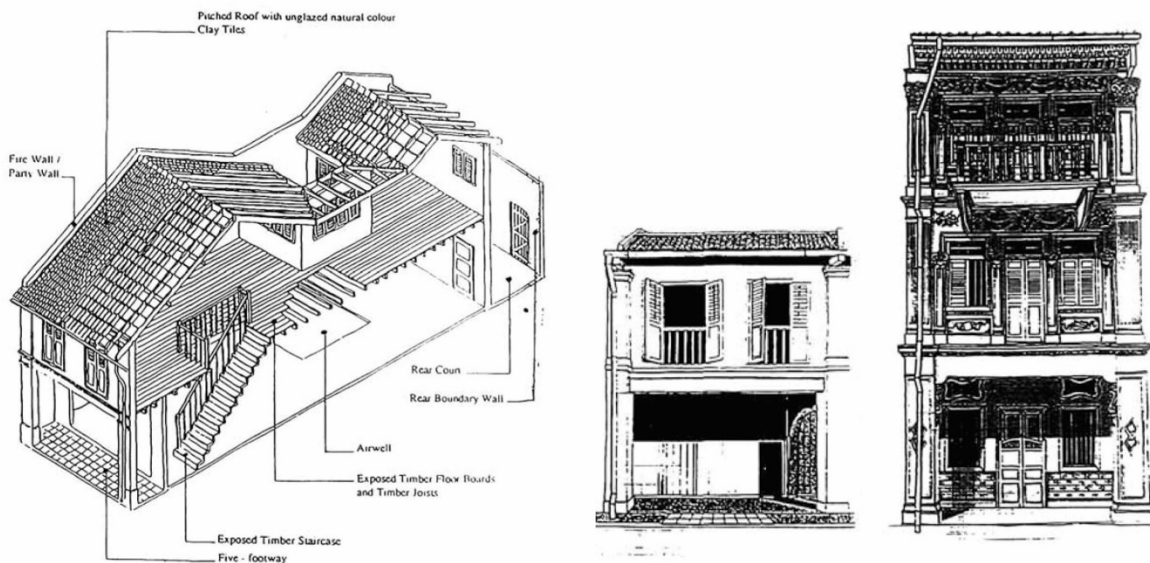
Figure III-12. Shophouse details in axonometric section and comparisons between early and late shophouse façade styles. (Reprinted from "Singapore shophouses: Conserving a landscape tradition," by Savage, 2001. *SPAFA Journal (Old series 1991-2013), 11*(1), 5-22).

A point brought up during the discussion with the expert panel was how Singaporeans' cultural identity was tied to food and could create opportunities to facilitate greater social interactions and communal bonding.

"(I like) the concept of integrating the healthcare workstation and food station to re-structure volunteer and education spaces. (I think this is) culturally significant in Singapore (because we like to) bond over food."

Based on the discussion, the researcher conducted a review of Singapore's cultural identity regarding food culture. The review indicated that as a strategy to promote tourism and enhance Singapore's global image, the Singapore Tourism Board heavily emphasized food tourism to convey the image of Singapore as a metaphorical and literal melting pot of cultures (Henderson, 2004). Fusing traditional ethnic cuisines (such as Chinese, Malay or Indian food), some popular Singaporean dishes combine ingredients and food preparation techniques to produce an identity that is uniquely Singaporean (Huat & Rajah, 2001). Food has become a cultural medium for Singaporeans from different backgrounds to bond (Duruz & Khoo, 2014). Thus, providing spaces in the proposed Health Springs that allow for such familiar rituals of bonding could increase the opportunities for social interactions between older adults and housing residents in the community.

Design Workshops 3 and 4 Review

The third set of images for the proposed Health Springs was further developed, based on the expert panel's commentary in Design Workshop 2. Changes made to the proposed design of the Health Springs included the introduction of food and cooking elements to the healthcare workers' station located at the co-op, transforming it into the Community Kitchen, where housing residents and older adults could gather to exchange ideas on cooking and receive informal care from healthcare workers. A small café bistro was added to the outdoor garden to form a Garden Café, which would provide housing residents and older adults with opportunities to interact with each other in a natural setting. The images were presented to the expert panel during Design Workshop 3 and 4 can be seen in Figure III-13.

Figure III-13. Example of images from Design Workshops 3 & 4.

The proposed design increased the usage of column bays to demarcate spaces to allow for higher levels of visual connection in order to improve the line of sight of healthcare workers, as shown in Figure III-14. Based on the expert panel's comments on the potential hazard of angular corners and excessive use of walls, the design of the therapy pools was streamlined to consist of gathering spaces for small groups, and placed next to the main exercise pool, as shown in Floorplan V.03. The proposed design included a lookout point at the bathroom area, in addition to the pools and community kitchen. The final design of the Health Springs also included a transitional corridor that connected the therapy pool, exercise pool, garden café, and activity room, which borrowed elements from the entrance veranda (anjung) of traditional Malay housing, as shown in the internal render.
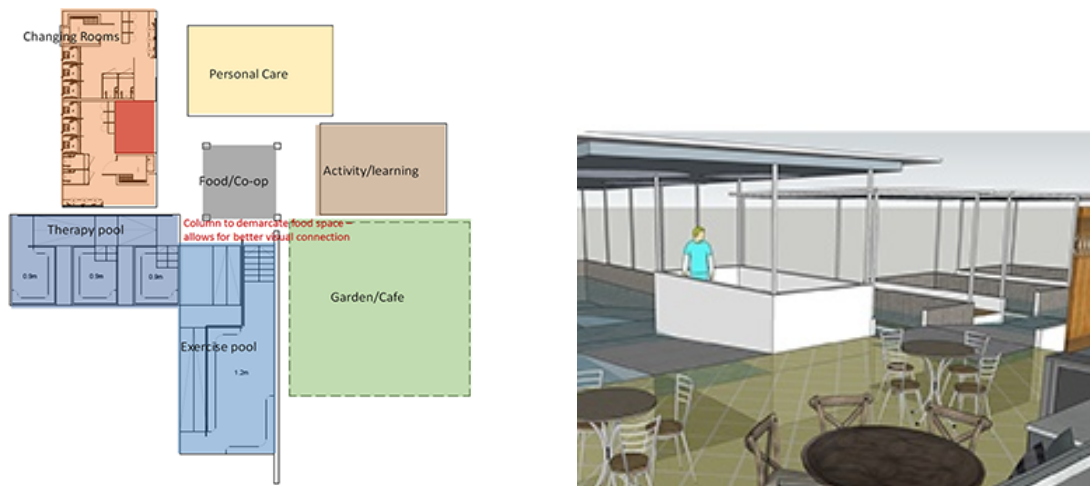
Figure III-14. Floorplan v.03 and Health Springs render V.03 showing higher levels of visual connection.

The comments from Design Workshop 3 focused on the detailing found on the interior of individual programmatic spaces (such as the orientation of chairs), as the expert panel felt

the overall layout of the proposed Health Springs had reached a general domain of acceptability. As such, Design Workshop 4 focused on providing architectural detailing that would enhance social interactions, functional autonomy of older adults, and mental wellbeing of possible users of the Health Springs.

The overall layout of the proposed Health Springs was finalized in Design Workshop 3 and Design Workshop 4 focused on improving architectural detailing (such as the roof and access ramps of the Exercise and Therapy Pools). At this stage, the terminology used for the room names were finalized. Table III-2 below demonstrates the process of terminology refinement over the series of workshops.

Table III-2. *Refinement of Room Terminology.*

Design Workshop 1	Design Workshop 2	Design Workshop 3&4
Outdoor activity space	Outdoor activity space	Garden cafe
Information and learning area	Information and learning room	Activity room
Community care zone	Community care room	Personal care room
Relaxation pool	Water exercise and relaxation area	Exercise pool
Exercise pool		Therapy pools
Assisted shower and changing area	Shower and changing rooms	Changing room
Healthcare worker station	Staff station	Community kitchen

After confirmation of the design detailing and terminology of spaces proposed at the Health Springs, a final set of images were rendered to be used in the preliminary survey. The final set of images were used to collect healthcare workers' opinions of the new programs and spaces to be adapted into public housing neighborhoods under the proposed Health Springs facility. The finalized design of the proposed Health Springs consisted of seven programmatic spaces that were derived from the focus group discussions and refined from the expert panel's commentary. The proposed Health Springs included: 1) a garden café, 2) an activity/learning room, 3) an exercise pool, 4) therapy pools, 5) a community kitchen, 6) a personal care room and 7) specialized bathing and changing area. The final image set is illustrated in Figure III-15. The final images of the proposed Health Springs re-imagines how the ground floor of public housing buildings could be designed to provide engaging experiences for older adults and housing residents. The images included detailing of plants and greenery, as well as culturally

relevant architectural elements and material, such as shophouse windows, wooden column, beam, and roof structure, similar to traditional Southeast Asian construction as seen in the Malay village house and Chinese house. The final set of images were used for the preliminary survey in Phase Two and in Phase Three survey.

Proposed layout of the
Health Springs at the ground floor of public housing buildings
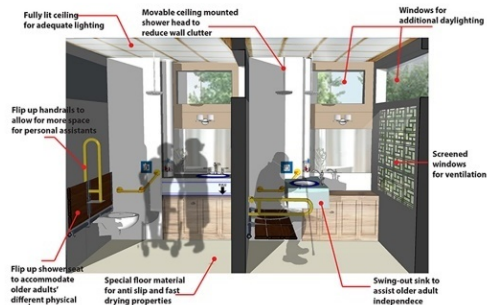
Figure III-15. The final images of the proposed Health Springs that re-imagines the ground floor of public housing buildings to support healthy aging.

Preliminary Survey

As the final stage of the design-based inquiry, the preliminary survey served to test the domain of acceptability reached by the expert panel in the development of the proposed Health Springs. Throughout the design workshops, the expert panel's commentary focused on developing a proposed Health Springs design to create spaces that offered meaningful, engaging activities for older adults and promote healthy aging. Emerging from the design workshops was the discussion on attracting a diverse mix of housing residents of all ages and older adults from different backgrounds to foster better social relations for older adults in their community beyond their family structure and reshape the public's perceptions of older adult care facilities. Creating multiple functions to enhance the overall use and usability of the proposed Health Springs became a main discussion point, motivating the expert panel to look at factors that influenced usability for older adults. Some of the factors included programs and meaningful cultural activities, environmental features that promoted safety and functional autonomy, and the presence of housing residents from different age groups.

The final set of images was used in the preliminary survey with healthcare workers, which was hosted online and advertised to the senior activity centers and the Falls Clinic. Healthcare workers were asked to provide their feedback on the finalized images of the proposed Health Springs based on perceived use and ability to support healthy aging. The response scale for questions related to the potential use of the proposed spaces in the Health Springs and perceived ability of individual spaces to support healthy aging was a 4-point Likert-type scale that ranged from "Not at All" to "Very Much" with a scoring range from 1 to 4. Data collected was consolidated on the Qualtrics online platform and downloaded in SPSS format.

For this preliminary survey, the researcher recruited a total of 40 healthcare workers from four senior activity centers, the Falls Clinic, and GERI. The total number of completed surveys was 36. Participants were largely female healthcare workers (77%) and majority were between 30 and 50 years old, as shown in Table III-3. About 30% of the participants had taken part in Phase One's focus group discussions.

Table III-3. *Healthcare Workers' Characteristics (n=40)*

Item	Scale	Proportion	Mean	SD
Gender	Binary 1= Female	0.77	NA	NA
Age Group	Categorical 1= 21-30yr	0.15	2.72	1.09
	2= 31-40yr	0.28		
	3= 41-50yr	0.30		
	4= 51-64yr	0.25		
	5= 65yr and older	0.25		
Participation in Focus Group	Binary (1= Yes)	0.28	NA	NA
How much do YOU worry about older adults falling at home?	Categorical 1= Not at all	0.05	3.28	0.94
	2= A little bit	0.18		
	3= Quite a bit	0.21		
	4= Very much	0.56		

SD: Standard deviation

Healthy Aging

Healthcare workers were asked for their opinions on the individual spaces in the proposed Health Springs. The survey aimed to test the perceived potential of individual spaces to support healthy aging. Based on the mean score, as shown in Table III-4, participating healthcare workers ranked the Garden Café, the Community Kitchen, and the Activity Room as the top three spaces that they believed had the highest potential to support healthy aging.

Table III-4. *How Much Do You Think the Following Spaces Could Support Healthy Aging? (n=36)*

	Percentage Frequency				Mean[1]	SD[2]
	Not at all =1	A little bit =2	Quite a bit =3	Very much =4		
Garden Café	-	0.03	0.21	0.76	3.74	0.50
Community Kitchen	-	-	0.31	0.69	3.69	0.47
Activity Room	-	-	0.35	0.65	3.65	0.48
Bathing Area	-	0.05	0.31	0.64	3.58	0.60
Personal Care Room	-	0.08	0.44	0.47	3.39	0.64
Therapy Pools	-	0.19	0.39	0.42	3.22	0.76
Exercise Pool	-	0.16	0.49	0.35	3.19	0.70

1. Mean score was tabulated from transforming the Likert-type scale into a 4-point rating.
2. SD= Standard Deviation.

Potential Use of Spaces

Due to the emphasis on the potential use of the overall Health Springs during the design workshops, this survey aimed to test the perceived potential usefulness of individual spaces. Based on the mean score as shown in Table III-5, participating healthcare workers identified the Garden Café, the Community Kitchen, and the Activity Room as the top three spaces as most useful.

Table III-5. *How Useful Would the Following Spaces be for Older Adults? (n=36)*

	Percentage Frequency				Mean[1]	SD[2]
	Not at all =1	A little bit =2	Quite a bit =3	Very Much =4		
Garden Café	-	0.03	0.18	0.79	3.76	0.49
Community Kitchen	-	0.03	0.36	0.31	3.58	0.55
Activity Room	-	0.05	0.35	0.59	3.54	0.61
Personal Care Room	-	0.06	0.47	0.47	3.42	0.60
Therapy Pools	-	0.28	0.31	0.41	3.14	0.83
Exercise Pool	0.05	0.24	0.43	0.27	2.92	0.86

[1]: Mean score was tabulated from transforming the Likert-type scale into a 4-point rating.
[2] SD: Standard Deviation.

Intergenerational Use of Spaces

Lastly, the survey aimed to test the perceived potential intergenerational use of individual spaces. Based on the combined mean score, as shown in Table III-6 which summed the total of mean scores for each age group), participating healthcare workers perceived the top three spaces with the highest potential for intergenerational to be the Garden Café, the Activity Room, and the Therapy Pools. As a further step, the researcher looked at the individual scores of the "children" age group category to examine which of the individual spaces had the highest potential of attracting children and possibly fostering intergenerational use of space. The individual spaces with the highest scores of children using the space were the Exercise Pool, Therapy Pools, and the Activity Room with mean scores of 3.23, 2.89, and 2.70 respectively as shown in Table III-6.

Table III-6. *How Likely Do You Think the Following Groups Would Use the Following Spaces (n=36)*

	Garden Café		Activity Room		Therapy Pools		Exercise Pool		Personal Care		Community Kitchen	
	Mean[1]	SD[2]	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Older adults (>/ 65yrs)	3.47	0.69	3.27	0.61	2.92	0.81	2.62	0.86	3.33	0.68	3.31	0.82
Adults (19-64 yrs)	3.11	0.83	3.13	0.92	3.25	0.81	3.05	0.85	3.11	0.85	3.11	0.95
Children (< 18 yrs)	2.58	0.79	2.70	1.02	2.89	0.95	3.23	0.74	2.44	0.88	2.22	1.05
Combined Score for 3 Age Groups	**9.16**		**9.1**		**9.06**		**8.9**		**8.88**		**8.64**	

[1]Mean score was tabulated from transforming the Likert-type scale into a 4-point rating.
[2]SD= Standard Deviation.

The preliminary survey results was an exploratory investigation to establish a heuristic connection between the proposed spaces of the Health Springs, the concept of healthy aging and potential use. In general, the feedback from healthcare workers who participated in the preliminary survey was mostly favorable to the proposed spaces developed during the design workshops. When averaging the scores of the proposed spaces, the mean score for the perceived potential to support healthy aging was 3.49 out of 4. Likewise, the mean score for the potential use of spaces was 3.39 out of 4. An interesting comparison was noted for the potential intergenerational use of the proposed spaces in the Health Springs. While the Garden Café, Activity Room, and Therapy Pools had a higher combined score for three age groups, the Exercise Pool had the highest potential of attracting children to use the Health Springs.

Discussion

The main goal of the design workshops created features that promoted opportunities for autonomy and health promotion, social connections with the family and community, and environmental features to improve safety and accessibility to care – the findings from Phase One. The expert panel conceptualized new spaces on the ground floor of public housing neighborhoods to bring new meaningful activities that would engage older adult residents. Emerging from the discussions with the expert panel, was the initiative to create a highly usable facility to attract a diverse mix of housing residents from different age groups and foster greater social interactions for older adults living in public housing.

The resulting design concept of the proposed Health Springs included a multi-use collection of individual spaces: 1) Garden Cafe, 2) Activity Room, 3) Exercise Pool, 4) Therapy Pools, 5) Community Kitchen, and 6) Personal Care Room. The proposed spaces were conceptualized to offer a variety of dynamic activities that could engage the older adults physically and socially and assist in creating community bonds outside the family structure.

With the new architectural spaces, for example, the Community Kitchen, older adults could get their meals prepared according to their specific health needs and learn about dietary control, in a casual setting that resembles more of a local coffee shop than a dietician's clinic. Creating spaces for informal learning could present a more attractive and accessible setting to older adult residents. The proposed spaces of the Health Springs can help older adult residents connect socially with other residents of different ages, beyond their own biological family. An example would be children using the Exercise Pool while older adults at the Community Kitchen overlooking the Exercise Pool would act as an additional pair of eyes that could promote the overall safety of the proposed Health Springs. Having a larger social network in the same housing estate can immeasurably improve quality of living for older adults and the overall community.

The preliminary survey conducted at the end of the design workshops established, to some extent, that the developed images had the potential to support healthy aging in public housing and the potential to be used by older adults and housing residents of other age groups.

Limitations and Further Developments

Design Workshops

A limitation of the design workshops was the manner in which the discussions with the expert panel were recorded. During the design workshops discussions, the researcher took down notes from the discussions on the presented images for compilation and development of the proposed Health Springs design. Audio recordings and transcribing of the discussions could be added as a future additional step to provide a more rigorous and structured content analysis of the design workshops. Using the Nvivo software and content analysis method in Phase One could help to strengthen and provide a more systematic review of the design workshops.

Limitations of Questions

The preliminary survey was an exploratory investigation to assess if healthcare workers felt the proposed facility could support healthy aging and attract the older adults and housing residents from different age groups to use the space. The questions developed in the preliminary survey were limited to capturing detailed and specific information on how and why participants felt the proposed Health Springs had the potential to support healthy aging and attract older adults and housing residents. In the next phase of the research, questions were developed to more accurately capture detailed components of healthy aging and the potential use of the Health Springs, including the various factors that influenced potential use as discussed in the design workshops. The survey in Phase Three intends to expand the scope of the survey to include housing residents – the secondary target group of potential users as identified during the design workshops to assess the proposed Health Springs potential to attract a variety of users. Furthermore, the survey in Phase Three will also include design and planning professionals who could help provide better evaluation of the potential usability of the proposed Health Springs.

Participant Bias

Participants of the preliminary survey were limited to healthcare workers from day centers, the Falls Clinic, and GERI. The healthcare workers who participated in the preliminary survey might have been familiar with the concept of healthy aging and could have had a predisposed bias toward spaces which could be beneficial to older adults. For the next phase of the research, a larger sample would be targeted, and the opinions of housing residents and older adults would be collected.

Summary

The design-based research of Phase Two developed a preliminary 3D model and potential facility design that would support healthy aging in public housing. Through the iterative design process, an innovative, dynamic community facility was developed to bring a new symbolic meaning and use of the ground floor in public housing and reshape the public's perception of spaces for older adults. Emerging from the discussions with the expert panel, was the initiative to create a highly usable facility to attract a diverse mix of housing residents from

different age groups and foster greater social interactions for older adults living in public housing. Through this phase's inquiry, several research themes were discussed, including the concept of usability, influences on usage, and aspects of healthy aging. These research themes were further explored the Phase Three of the research.

References

Addae-Dapaah, K., & Wong, G. K. M. (2001). Housing and the elderly in Singapore – financial and quality of life implications of ageing in place. *Journal of Housing and the Built Environment, 16*(2), 153-178. doi:10.1023/a:1017960600667

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher, 41*(1), 16-25.

Archer, L. B. (1970). An overview of the structure of the design process. In *Emerging methods in environmental design and planning* (pp. 285-307). Cambridge, MA: MIT Press.

Atkin, A. (2017). Peirce, Charles Sanders: Pragmatism | Internet Encyclopedia of Philosophy. Retrieved from http://www.iep.utm.edu/peircepr/

Baker, R., Holloway, J., Holtkamp, C. C., Larsson, A., Hartman, L. C., Pearce, R., . . . Wareing, L. A. (2003). Effects of multi-sensory stimulation for people with dementia. *Journal of Advanced Nursing, 43*(5), 465-477.

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1): Prentice-hall Englewood Cliffs, NJ.

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences, 13*(1), 1-14.

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine, 131*(3), 165-173.

Bay, J.-H. (2004). Sustainable community and environment in tropical Singapore high-rise housing: the case of Bedok Court condominium. *Architectural Research Quarterly, 8*(3-4), 333-343. doi:10.1017/S135913550400034X

Broadbent, G. (1996). A plain man's guide to the theory of signs in architecture. In K. Nesbitt (Ed.), *Theorizing a new agenda for architecture: an anthology of architectural theory 1965-1995* (pp. 122-140). New York: Princeton Architectural Press.

Burks, A. W. (1949). Icon, index, and symbol. *Philosophy and Phenomenological Research, 9*(4), 673-689.

Carr, S., & Lynch, K. (1968). Where Learning Happens. *Daedalus, 97*(4), 1277-1291.

Chua, B.-H. (1991). Modernism and the vernacular: Transformation of public spaces and social life in Singapore. *Journal of Architectural and Planning Research, 8*(3), 203-221.

Chua, B. H. (1988). Adjusting religious practices to different house forms in Singapore. *Architecture and Behavior, 4*(1), 3-25.

Clayton, M. J., Teicholz, P., Fischer, M., & Kunz, J. (1999). Virtual components consisting of form, function and behavior. *Automation in Construction, 8*(3), 351-367.

Clemens, E. L., & Hayes, H. E. (1997). Assessing and Balancing Elder Risk, Safety and Autonomy: Decision-Making Practices of Health Care Professionals. *Home Health Care Services Quarterly, 16*(3), 3-20. doi:10.1300/J027v16n03_02

Dewey, J. (1998). *The essential Dewey: Ethics, logic, psychology* (Vol. 2): Indiana University Press.

Duruz, J., & Khoo, G. C. (2014). *Eating together: Food, space, and identity in Malaysia and Singapore*: London: Rowman & Littlefield.

Henderson, J. C. (2004). Food as a tourism resource: A view from Singapore. *Tourism Recreation Research, 29*(3), 69-74.

Huat, C. B., & Rajah, A. (2001). Hybridity, ethnicity and food in Singapore. *Changing Chinese Foodways in Asia*, 161-197.

Hwang, H.-L., Lin, H.-S., Tung, Y.-L., & Wu, H.-C. (2006). Correlates of perceived autonomy among elders in a senior citizen home: A cross-sectional survey. *International Journal of Nursing Studies, 43*(4), 429-437.

James, W. (1975). *The meaning of truth* (Vol. 2): Harvard University Press.

Khol, D. G. (1984). *Chinese architecture in the Straits Settlements and Western Malaya: Temples*, *kongsis, and houses*. University of Michigan: Heinemann Asia

Knapp, R. G. (2013). *Chinese houses of Southeast Asia: The eclectic architecture of sojourners and settlers.* Tokyo: Tuttle Publishing.

Lynch, K. (1958). Environmental adaptability. *Journal of the American Institute of Planners, 24*(1), 16-24.

Maller, C., Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2006). Healthy nature healthy people: Contact with nature'as an upstream health promotion intervention for populations. *Health Promotion International, 21*(1), 45-54.

McAuley, E., Blissmer, B., Katula, J., Duncan, T. E., & Mihalko, S. L. (2000). Physical activity, self-esteem, and self-efficacy relationships in older adults: A randomized controlled trial. *Annals of Behavioral Medicine, 22*(2), 131.

Menec, V. H. (2003). The relation between everyday activities and successful aging: A 6-year longitudinal study. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 58*(2), S74-S82.

Morrow-Howell, N., Tang, F., Kim, J., Lee, M., & Sherraden, M. (2005). Maximizing the productive engagement of older adults. *Successful aging through the life span: Intergenerational issues in health*, 19-54.

Newman, S., & Hatton-Yeo, A. (2008). Intergenerational learning and the contributions of older people. *Ageing Horizons, 8*(10), 31-39.

Olsen, P. B., & Heaton, L. (2010). Knowing through design. In *Design Research* (pp. 97-112). NY: Routledge.

Peirce, C. S. (1902). Logic as semiotic: The theory of signs. *Philosophical writings of Peirce*, 100.

Pena, W. M., & Parshall, S. A. (2012). *Problem seeking: An architectural programming primer.* N.J.: John Wiley & Sons.

Perrig-Chiello, P., Perrig, W. J., Uebelbacher, A., & Stähelin, H. B. (2006). Impact of physical and psychological resources on functional autonomy in old age. *Psychology, Health & Medicine, 11*(4), 470-482.

Rapoport, A. (1990). *The meaning of the built environment: A nonverbal communication approach*: Tucson, AZ: University of Arizona Press.

Reed, S. K. (2013). *Thinking visually.* NY: Psychology Press.

Richard, L., Gauvin, L., Gosselin, C., & Laforest, S. (2008). Staying connected: Neighbourhood correlates of social participation among older adults living in an urban environment in Montreal, Quebec. *Health Promotion International, 24*(1), 46-57.

Rodiek, S. (2002). Influence of an outdoor garden on mood and stress in older persons. *Journal of Therapeutic Horticulture, 13*(1), 13-21.

Sanoff, H. (2016). *Integrating Programming, Evaluation and Participation in: A Theory Z Approach*: AveburyL Routledge.

Savage, V. (2001). Singapore shophouses: Conserving a landscape tradition. *SPAFA Journal (Old series 1991-2013), 11*(1), 5-22.

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health promotion, 10*(4), 282-298.

Teo, S. E., & Kong, L. (1997). Public housing in Singapore: interpreting'quality'in the 1990s. *Urban Studies, 34*(3), 441-452.

Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure–ground organization. *Psychological Bulletin, 138*(6), 1172.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5-23.

Weintraub, A. P. C., & Killian, T. S. (2007). Intergenerational Programming: Older Persons' Perceptions of Its Impact. *Journal of Applied Gerontology, 26*(4), 370-384. doi:10.1177/0733464807302671

WHO (2007). *Global age-friendly cities: A guide*: World Health Organization.

Zeisel, J. (2006). *Inquiry by design: Environment/behavior/neuroscience in architecture, interiors, landscape, and planning*. NY: W.W. Norton.

CHAPTER IV

PHASE THREE: ONLINE SURVEY WITH HOUSING RESIDENTS AND DESIGN

PROFESSIONALS

Study Design

As a final step in this exploratory sequential research, Phase Three was a cross-sectional study that investigated the potential application of the Health Springs concept by investigating the extent to which public housing residents might use the Health Springs facility in their neighborhoods. In Phase One, the researcher conducted focus group sessions with older adults and observed the importance of "Occupation" (i.e., purposeful activities) in framing the conventional Person-Environment fit. These findings were used to guide design workshops with healthcare professionals in Phase Two. The proposed Health Springs consisted of a collection of six diverse spaces with unique physical and programmatic features that were developed during the design workshops to encourage older adults' use of and engagement in activities. During Phase Two, the expert panel highlighted the need for the proposed Health Springs to appeal to a diverse range of housing residents from different age groups to create opportunities for social bonding beyond the older adult's family structure. Hence in Phase Three, a cross-sectional study was conducted to investigate older adults, housing residents, and design professionals opinions of the likely use of the Health Springs as a way to estimate the potential user demand for the Health Springs facility and provide better evaluation of its potential usability.

Phase Three included surveys of a larger, more representative, and more diverse population sample than the sample from the previous phases, that consisted of adult housing residents from public housing neighborhoods, a subsample of older adults from senior day centers, and design/planning professionals from architectural firms. The goal was to examine the intended use of the proposed Health Springs, and how it is influenced by the overall perceived usability, expected health outcomes associated with the use, and the likely use of individual spaces while controlling for individual sociodemographic factors. The measure of usability refers to the assessment of a user's experience with a product in terms of efficiency,

effectiveness, and satisfaction (ISO/TC 159/SC 4, 1998; Rich & McGee, 2004). It is the "perception of how consistent, efficient, productive, organized, easy to use, intuitive, and straightforward it is to accomplish tasks" (McGee, 2003). Expectations of usability is a main factor in influencing users' perception of actual usability of a product (Rich & McGee, 2004).

Conceptual Framework and Study Domains

A conceptual framework was developed to guide the research activities in Phase Three. It was developed based on two relevant theories, including Bandura's Social Cognitive Theory and the Reach, Efficacy, Adoption, Implementation, Maintenance (RE-AIM) evaluation model.

RE-AIM Model

The RE-AIM evaluation model was published in 1999 as a framework to evaluate the public health impact of health promoting interventions (Glasgow, Vogt, & Boles, 1999). Its evaluation criteria was specifically developed for public health interventions in community settings to assess the interventions within the dynamics and challenges of real-world settings instead of the rigorously controlled environments of clinical experiments (Glasgow et al., 1999). A systematic review indicated that the RE-AIM model has been used in the evaluation of 71 public health studies (Gaglio, Shoup, & Glasgow, 2013). 18 of the studies were in community-based settings with research areas including physical activity, health promotion, disease management, dementia etc. (Gaglio et al., 2013). An advantage of the RE-AIM evaluation model is its ability to cover various stages of intervention phases, from planning to testing and final assessments (Glasgow et al., 1999). Hence, the RE-AIM evaluation model was appropriate for developing the Phase Three framework that investigates the potential use of the Health Springs within the public housing community.

RE-AIM model outlines five key dimensions in the evaluation process of a health program: 1) Reach (the number, proportion and representativeness of individuals willing to participate), , 2) Efficacy (positive and negative outcomes of the program, including level of participant satisfaction), 3) Adoption (the representativeness of settings where the program takes place), 4) Implementation (the level of execution rated against the program's goals), and 5) Maintenance (a long term measure of the program's ability to sustain behavioral change) (Glasgow et al., 1999). Phase Three intended to assess the potential use of the proposed Health

Springs in public housing settings by surveying a diverse sample of housing residents and design professionals. Hence, three dimensions of the RE-AIM evaluation model (Reach, Efficacy, and Adoption) were adopted to evaluate the proposed Health Springs for its potential impacts.

Based on the RE-AIM evaluation model, the Phase Three survey needed to assess the extent to which survey participants could imagine themselves using the Health Springs in their public housing neighborhood. The survey was developed to evaluate the potential demand of the proposed Health Springs from different types of housing residents and older adults. The Reach component of the proposed Health Springs was determined through the overall likelihood of using the Health Springs and the descriptive analysis of participants' characteristics. The research also needed to measure the extent that expected positive and negative health outcomes and level of participant satisfaction could influence participants' use of the Health Springs – the overall Efficacy of the Health Springs. The component of participants' expected satisfaction was determined with the perceived usability of the Health Spring, detailed in the following paragraph. Lastly, the research needed to measure the representativeness of settings where the Health Springs would be implemented, for example the adoption of the Health Springs into public housing settings and the feasibility of using individual spaces in the Health Springs in public housing settings (Adoption). Phase Three conceptual framework did not include the dimensions of Implementation and Maintenance as the research phase was set within the limits of feasibility testing of the Health Springs and not in real-world post-occupancy evaluations.

Social Cognitive Theory, Perceived Usability, and Expected Health Outcomes

Social cognitive theory focuses on the creation of a supportive social environment that reinforces positive behavioral change to improves self-efficacy in performance (Bandura, 1989; LaMorte, 2016). It addresses two types of expectancies that regulate human behavior in the promotion of public health interventions, which are efficacy expectations and outcome expectancies (Bandura, 2004) as illustrated in Figure IV-1 (Bandura, 1977). Efficacy expectations refer to the belief in one's abilities to meet certain levels of performance (Bandura, 2004). Bandura further claims that self-efficacy is a measure of interpersonal barriers to executing one's goals (Bandura, 2004 p.145). This definition of self-efficacy can be linked to the study

domain of perceived usability, which is the "perception of how consistent, efficient, productive, organized, easy to use, intuitive, and straightforward it is to accomplish tasks" (McGee, 2003).

Outcome expectations refer to the expected results accrued from an individual's actions. Bandura describes outcome expectations in three components: physical (positive physiological effects), social (positive interactions as an outcome), and self-evaluative (positive and negative internalized reflection as a result of an action). In Phase Three of this study, the researcher focused on expected improvements to physical activity, social interactions, and mental wellbeing as the main outcome expectations that may affect potential use of the Health Springs in public housing. These expected health improvements were discussed and highlighted during the design workshops in Phase Two and were further tested in Phase Three.
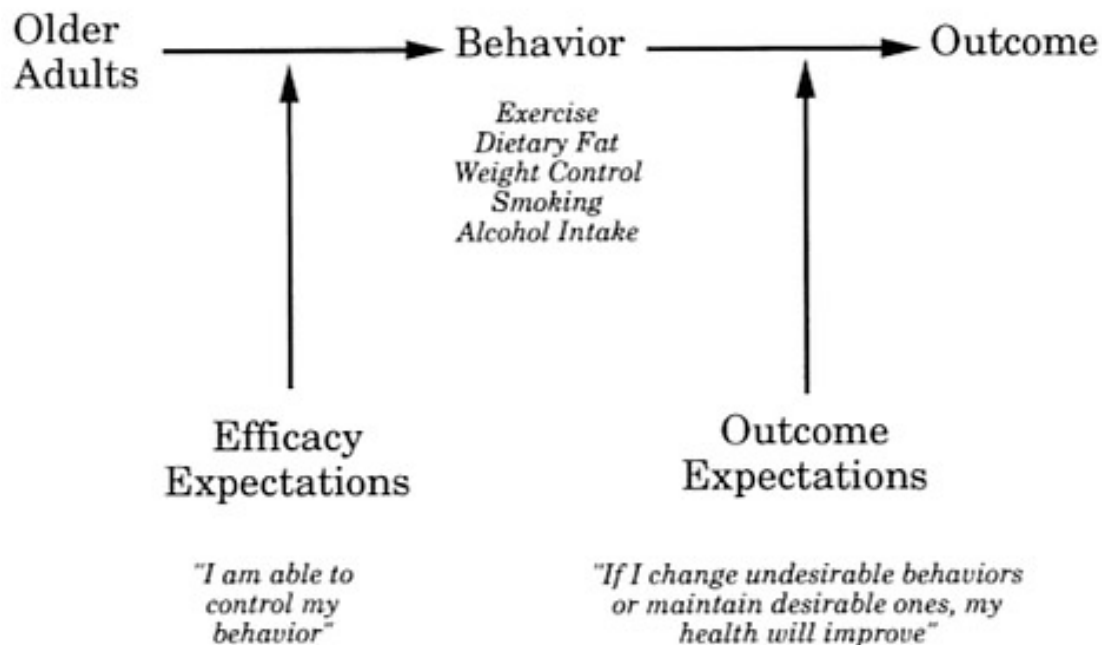
Figure IV-1. Illustration of relationship between outcome expectations, results, and behavior. (Reprinted from "Self-efficacy and health behavior among older adults," Grembowski et al., 1993. *Journal of Health and Social Behavior*, 89-104)

Proposed Model for This Study

Based on these two theories, a conceptual framework (Figure IV-2) was developed using efficacy and outcome expectations of the Social Cognitive Theory and the dimensions of Reach, Efficacy, and Adoption from the RE-AIM model to study how perceived usability, expected health outcomes, and the likely use of individual spaces in the Health Springs might affect the

overall likelihood of using the Health Springs, while controlling for individual characteristics and attitudes.
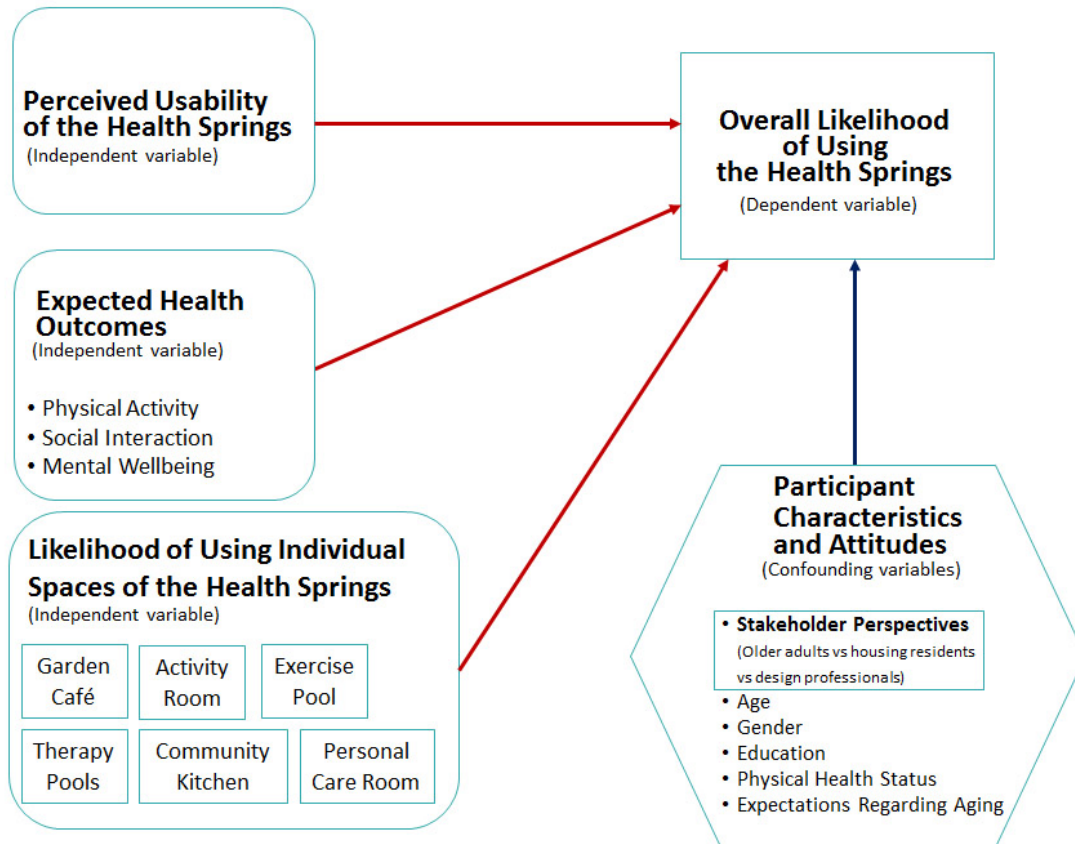
Figure IV-2. Conceptual framework and the identified study areas for Phase Three.

Specific Objectives

Based on the conceptual framework, Phase three aims   to study the relationships between the identified study variables and the overall likelihood of using the Health Springs. The specific objectives are:

Objective ONE: To explore participants' likely use of the proposed Health Springs.

Objective TWO: To examine the impact of perceived usability on the likely use of the proposed Health Springs, while controlling for personal factors. A comparison analysis was conducted examine the difference between stakeholders' perspectives on perceived usability.

Objective THREE: To examine the impact of expected health outcomes on the potential use of the proposed Health Springs, while controlling for personal factors. A comparison analysis was

conducted to examine the difference between stakeholders' perspectives on expected health outcomes.

Objective FOUR: To examine which of individual spaces within the Health Springs influenced the potential use of the proposed Health Springs, while controlling for personal factors. A comparison analysis was conducted to examine the difference between stakeholders' perspectives on their likely usage of individual spaces.

Objective FIVE: To examine the impact of perceived usability of the Health Springs, expected outcomes, and type of individual spaces on the overall likelihood of using the Health Springs, while controlling for personal factors.

Study Questions and Variables

Key study questions for Phase Three emerged from the design workshops and beta survey of Phase Two. The main question for evaluating the feasibility of the proposed Health Springs design was tied to the overall likely use of the facility. Factors that influenced the overall likely use of the Health Springs included potential users' perceived usability of the proposed Health Springs, expected health outcomes, and likelihood of using different spaces in the Health Springs.

Likelihood of Using the Proposed Health Springs

The main outcome variable in Phase Three was the overall likelihood of using the proposed Health Springs in public housing settings. This variable directly evaluates the potential of the Health Springs as a community facility that could promote heathy aging in Singapore's public housing neighborhoods and emerged during Phase Two design workshops discussions. By asking study participants how likely they would use the proposed Health Springs, the research gained insight to the possible reach of the facility in changing the lifestyles of people in the community.

Perceived Usability

Perceived usability was an independent variable used to measure of the overall acceptability of the proposed Health Springs intervention and its influence on the overall likelihood of using the Health Springs. Usability refers to the objective ability to utilize a space or program, as well as the subjective measure of effectiveness, efficiency, and user satisfaction

(Iwarsson & Ståhl, 2003; Steinfeld & Danford, 1999). A wellness facility (like the proposed Health Springs) or program that is not usable or user-friendly can be perceived as a barrier to health. During the Phase Two design workshops, careful design considerations were made to ensure the proposed Health Springs was safe and accessibile. Hence, perceived usability was measured as a means of evaluating the efficacy of the proposed Health Springs in public housing neighborhoods.

Expected Health Outcomes

Positive expected health outcome associated with the proposed Health Springs could act as a motivator to encourage participants to engage in activities at the facility and was an independent variable to measure the influence of expected health outcomes on overall likelihood of using the Health Springs. Older adults' feedback from the focus group sessions in Phase One, indicated a strong relationship between outcome expectations and behavioral change. The identified domains of healthy aging included physical activity, social interactions, and mental wellbeing. These domains were identified in Chapter One introduction and discussed during the focus group discussions as well as the design workshops. Therefore, Phase Three studied the influence of expected health outcomes on the overall likelihood of using the Health Springs.

Individual Spaces and Likely Use

Over the course of the design workshops, six different social spaces were proposed to encourage different types of physical activity, social interaction, and promote the mental wellbeing of potential users. These spaces were the Garden Café, an Activity Room, an Exercise Pool, Therapy Pools, a Community Kitchen, and a Personal Care Room. The proposed location for these individual spaces was the ground floor of public housing neighborhoods in Singapore. As independent variables, the research explored the potential of adapting the proposed individual spaces into participants' residential community and investigated which of the six individual spaces had influence on the overall likely use of the Health Springs. To measure which of the individual spaces were attractive to potential users, the research investigated the likely use of individual spaces.

Participants Characteristics and Attitudes

In Phase Two, the research used the social ecological theory to engage multiple perspectives while developing the proposed Health Springs design. Following through with this approach, in Phase Three, the researcher surveyed a larger population group from a diverse background, with varying age, gender, education, physical health status, and expectations regarding aging. As confounding variables, the different backgrounds of the participants may influenced their perceptions on perceived usability of the proposed Health Springs, expected health outcomes, and likely use of individual spaces. Hence, the research recruited housing residents from different age groups as well as design professionals for their input regarding the proposed design and perceived usability of the Health Springs.

Method

Surveys

The main purpose of a survey is to produce a statistical estimate of the characteristics related to a group of people (Fowler Jr, 2013). An extrapolation of the results was used to predict the response of the larger target population (Fowler Jr, 2013). Using surveys in the final phase of this sequential exploratory study would assess the concepts generated in Phases One and Two of the research. The survey (Appendix E) included survey questions supplemented by visual images of spaces within the proposed Health Springs that were developed in Phase Two's design workshops. The main purpose of using visual images was to establish heuristic connections between the proposed spaces and the study variables. The visual images helped participants create association of certain elements in the visual field based on underlying qualitative characteristics (Wagemans et al., 2012). The survey would serve as an evaluation of the proposed Health Springs as a stepping stone to achieve the goal of promoting healthy aging to older Singaporeans living in public housing.

Survey Development

As an extension of the preliminary survey in Phase Two, the Phase Three survey measured the outcome variable (i.e., overall likelihood of using the proposed Health Springs), the independent variables (perceived usability, expected health outcomes, and likelihood of using individual spaces in the Health Springs) and the confounders (age, gender, education,

physical health status, and expectations regarding aging). In order to ensure validity and reliability of the survey instrument, the researcher adopted validated instruments that can appropriately capture some of the study variables, including "Short Form 12 Health Survey" (SF-12), "Expectations Regarding Aging" (ERA-12), "Systems Usability Scale" (SUS), and "Credibility/Expectancy Questionnaire". Questions from these survey instruments were tailored to the perceived use and expected health benefits of the Health Springs. A breakdown of the variables are listed in Table IV-1.

Table IV-1.
Study and Corresponding Measures

Variable	Scale of measurements	Reliability and/or validity of original survey item	Source of survey items
Dependent Variable			
Likelihood of using the Health Springs	4-pt likert type scale. 1= not at all, 4= extremely likely	Test-retest reliability score: 0.91	Developed by researcher in Phase Two design workshops.
Independent Variables			
Perceived usability of the Health Springs	5-pt Likert type scale. 1= Strongly disagree, 5= Strongly Agree Continuous scale: 1-100	Split half reliability score: 0.911[1]	Adapted from Systems Usability Scale (SUS) (Brooke, 1996)
Expected health outcomes • physical activity • social interactions • mental wellbeing	Rank from 1 to 10, 1= Not at all, 10= Very Much	Test-retest reliability score: 0.82[1]	Adapted from Credibility/Expectancy Questionnaire (Devilly & Borkovec, 2000)
Likely use of individual spaces of the Health Springs	4-pt likert type scale. 1= not at all, 4= extremely likely	Test-retest reliability score: 0.46	Developed by researcher in Phase Two design workshops.
Confounding Variables			
Age	Continuous scale	Not applicable	The researcher
Gender	Binary Scale 1= male		
Education	5 level continuous 0= others 1 = primary 2= secondary 3= polytechnic 4 = tertiary		
Physical health status	Continuous scale: 1-20	Test-retest reliability score: 0.89[1]	Adapted from Short Form 12 Health Survey (SF-12) (Lam et al., 2005)
Expectations Regarding Aging	Continuous scale: 0-100	Internal consistency reliability score >0.7[1]	Adapted from Expectations Regarding Aging (ERA-12) . (Joshi et al., 2010)
Stakeholder perspectives (housing residents vs. design professionals)	Binary scale 1= housing residents	Not available	Not available

1. Values indicating Cronbach's alpha scores of original instruments.

Measuring Dependent Variable

Overall Likelihood of Using the Health Springs

This survey measured the overall likelihood of using the Health Springs and thereby estimate the potential of the facility in changing the lifestyles of people in the community and promoting healthy aging in public housing neighborhoods. In order to capture this outcome variable, participants were asked "Overall, how likely would you use the Health Springs as you get older?" The response scale was a 4-pt Likert-type scale ranging from "1= Extremely likely, 2= Moderately likely, 3= A little likely, 4= Unlikely/Not at all". This question was presented after a visual image and description of the proposed Health Springs was presented to the survey participants.

Measuring Independent Variables

Perceived Usability

The Systems Usability Scale (SUS) is a survey that assesses the usability of a given product or service (Bangor, Kortum, & Miller, 2008). It evaluates the effectiveness, efficiency, and satisfaction of a product using simple and quick measures (Brooke, 1996). The SUS tool was developed for flexible adaptation has been used in about 200 studies to assess a wide variety of products and, including studies on cell phones, websites, and a virtual reality rehabilitation system (Bangor et al., 2008; Kizony, Weiss, Shahar, & Rand, 2006). In a study of older adults with limitations to activities of daily living, a home-based virtual reality rehabilitation system was designed to promote older adults' functional ability and participation in community life. The SUS tool was used to assess the usability of the virtual reality system and provided an accurate measure of participant's reaction to the virtual reality product (Kizony et al., 2006). This study sets a precedent for the Phase Three survey, which used visual images in the survey to create a virtual perception of the proposed Health Springs. Hence, the SUS tool was considered an adequate instrument to measure perceived usability of the Health Springs.

The SUS tool consists of a 10-item Likert-type scale that produces a composite score from 0 to 100, with higher scores indicating better usability (Bangor et al., 2008). The included items are illustrated in the Table IV-2. A split half reliability analysis produced a value of 0.91, suggesting that the usability score of the SUS tool provides a strong estimate of usability and

participant satisfaction (Bangor et al., 2008). Thus, the researcher incorporated the SUS tool as a means of measuring the independent variable, perceived usability, of the proposed Health Springs.

Table IV-2.
Detailed Questions for the Systems Usability Scale (SUS) for Measuring Perceived Usability.

	Original SUS tool	Question adapted from the SUS tool	Response scale
1.	I think that I would like to use this system* frequently	I would like to use the Health Springs center frequently (at least once a week)	
2.	I found the system unnecessarily complex	I find the Health Springs center unnecessarily complex	
3.	I thought the system was easy to use	I think the Health Springs center would be easy to use	
4.	I think that I would need the support of a technical person to be able to use this system	Based on my current health, I would need the support of a caregiver to be able to use the Health Springs center	5-pt Likert type scale.
5.	I found the various functions in this system were well integrated	I think the Health Springs center is well-integrated into the neighborhood	1= Strongly disagree, 2= Disagree 3= Neither agree
6.	I thought there was too much inconsistency in this system	I think there is too much conflicting features in the Health Springs center	nor disagree 4= Agree
7.	I would imagine that most people would learn to use this system very quickly	I imagine that most people will learn to use the Health Springs very quickly	5= Strongly Agree
8.	I found the system very cumbersome to use	I find the Health Springs hazardous to use	
9.	I felt very confident using the system	I would feel very confident to use the Health Springs	
10.	I needed to learn a lot of things before I could get going with this system	I need to learn a lot of things before I can go to the Health Springs center	

*The term 'this system' was replaced with 'the Health Springs center' in all ten statements for the Health Springs survey.

Expected Health Outcomes

The research used the Credibility/Expectancy Questionnaire to measure participants' anticipated improvements to health that were associated with the proposed Health Springs. The Credibility/Expectancy questionnaire is a scale used to measure outcome expectancy and therapy credibility in clinical studies (Devilly & Borkovec, 2000). It has been used to evaluate and improve the design of clinical therapy and intervention programs (Devilly & Borkovec, 2000). Expectancy has been shown to predict actual therapy outcomes (Devilly & Borkovec, 2000). The expectancy component of the credibility/expectancy questionnaire consists of three items. Two of the items use a rating scale of 0% to 100% while one item uses a rating scale of 1 to 9, as shown in the table below (Devilly & Borkovec, 2000). A test-retest reliability test of the expectancy factor for the credibility/expectancy questionnaire produced an alpha of 0.82 (Devilly & Borkovec, 2000). The high reliability scores indicate that the expectancy questionnaire provides an accurate and consistent measure of participants' opinions regarding health promotion programs and can be used to evaluate the proposed Health Springs facility. For this study's Phase Three survey, the expectancy component of the credibility/expectancy questionnaire was incorporated and adapted to assess expectations related to improvements in physical activity, social interactions, and mental wellbeing that would result from using the proposed Health Springs, as shown in Table IV-3.

Table IV-3.

Questions Used to Measure Expected Health Outcomes.

Original Questions	Adapted Questions
By the end of the therapy period, how much improvement in your trauma symptoms do you think will occur? 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%	With the Health Springs Center in your neighbourhood, how much improvement do you think will occur in the elderly's overall health? Physical activity Social interactions Mental wellbeing Not at all Somewhat Very much 1 2 3 4 5 6 7 8 9 10
At this point, how much do you really *feel* that therapy will help you to reduce your trauma symptoms? Not at all Somewhat Very much 1 2 3 4 5 6 7 8 9	Not applicable to Health Springs survey.
By the end of the therapy period, how much improvement in your trauma symptoms do you really *feel* will occur? 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%	With the Health Springs Center in your neighbourhood, how much improvement to your overall health do you feel will occur? Your physical activity Your social interactions Your mental wellbeing Not at all Somewhat Very much 1 2 3 4 5 6 7 8 9 10

Types of Individual Spaces of the Health Springs and Likely Use

Six individual spaces were developed during Phase Two to encourage different types of physical activity and social interaction, and promote the mental wellbeing of potential users. These spaces were the Garden Café, an Activity Room, an Exercise Pool, Therapy Pools, a Community Kitchen, and a Personal Care Room. The researcher wanted to know which of the individual spaces had an influence on overall use of the Health Springs, and thereby understand the potential of adapting the proposed individual spaces into public housing neighborhoods. To measure which individual spaces appealed to participants preferences, participants were presented a visual image and description of the individual space and were asked, "How likely would you take part in activities at the (individual space) as you get older?" for each of the six individual spaces. The response scale was a 4-point Likert-type scale ranging from "1= Extremely likely, 2= Moderately likely, 3= A little likely, 4= Unlikely/Not at all".

Measuring Confounding Variables

Physical Health Status

The Short Form 12 Healthy Survey (SF-12) was adopted into the survey for the proposed Health Springs to collect information of the participant's physical health status. SF-12 is an abbreviated version of the formal 36 item SF-36 Health Survey that covers 12 main points assessing for physical and mental health (Ware Jr, Kosinski, & Keller, 1996). In the SF-12, the physical health score is a composite score derived from six questions pertaining to physical health. The SF-12 have been incorporated in numerous clinical surveys as a routine assessment of patient physical health. A Singaporean study showed that the physical health score from the SF-12 was significantly related to healthy aging (Gandek et al., 1998; T. Ng, Broekman, Niti, Gwee, & Kua, 2009). A test-retest reliability of the physical health sub-section of the SF-12 was 0.890, indicating that the SF-12 was a consistent and accurate measure of participants' physical health status (Ware Jr et al., 1996). The Phase Three survey adapted four out of the six questions (Table IV-4) in the physical health component of the SF-12 whereas two of the original questions (regarding pain and limitations to work) were not relevant to this study and were thus not included.

Table IV-4.

Questions Used to Measure Physical Health Status

Original questions from SF-12	Adapted questions from the SF-12 for Singaporean context	Response scale
In general, would you say your health is…	In general, your health is…	Excellent, Very good, Good, Fair, Poor
Does your health limit you in performing

    Moderate physical activities

    Climbing several flights of stairs | Does your current health typically restrict you in these activities? If so, how much?

    Daily activities (e.g moving a table, household chores)

    Climbing several flights of stairs, taking the bus or MRT (public train system)… |

Yes a lot,   Yes a little, No not at all

Yes a lot,   Yes a little, No not at all |
| As a result of your physical health, during the past 4 weeks
    Have you accomplished less than you would like?
    Have you been limited in any kind of work or other activities | In the past 4 weeks, do you have any problems with your work or other activities because of your physical health? | Yes,   No |
| During the past 4 weeks, how much did pain interfere with your normal work? | Not used. | Not used. |

Expectations Regarding Aging

The 12-Item Expectations Regarding Aging Survey (ERA-12) was adapted for the survey of the proposed Health Springs to collect information of the participant's opinions and attitudes towards aging. ERA-12 is an abbreviated version of the formal 38-item Expectations Regarding Aging Survey and consists of three subsections that measure expectations regarding physical health, mental health, and cognitive function, as shown in the Table IV-5 (Sarkisian, Steers, Hays, & Mangione, 2005). An internal consistency reliability test conducted for the ERA-12 reported 0.89 for Cronbach's alpha, indicating that the overall summed score for the ERA-12 was an accurate estimation of participants' expectations regarding aging (Sarkisian et al., 2005). In a study in Singapore, the ERA-12 was tested with middle-aged Singaporeans (between the ages of 41 to 62 years old) and the Cronbach alpha for internal consistency reliability exceeded 0.7 (Joshi, Malhotra, Lim, Ostbye, & Wong, 2010). Hence, the ERA-12 was considered an appropriate measure for participants' attitude towards aging and was incorporated in this Phase Three study.

Table IV-5.
Questions for Measuring Expectations Regarding Aging.

	Original questions for ERA-12	Adapted questions for ERA-12 with wording modified for Singapore context	Response scale
	Expectations regarding physical health		
1.	When people get older, they need to lower their expectations of how healthy they can be.	People need to lower their expectations of how healthy they can be as they get older.	4-pt Likert type scale. 1= Definitely false 2= Somewhat false 3= Somewhat true 4= Definitely true
2.	The human body is like a car: when it gets old, it gets worn out.	The human body is like a car: when it gets old, it gets worn out.	
3.	Having more aches and pains is an accepted part of aging.	Having more aches and pains is an accepted part of aging.	
4.	Every year that people age, their energy levels go down a little more.	After the age of 65, people's energy levels go down a little more each year.	
	Expectations regarding mental health		
5.	I expect that as I get older I will spend less time with friends and family.	I will spend less time with friends and family as I get older.	
6.	Being lonely is just something that happens when people get old.	Being lonely is something that happens when people get old.	
7.	As people get older they worry more.	People worry more as they get older.	
8.	It's normal to be depressed when you are old.	It is normal to be depressed when people get old.	
	Expectations regarding cognitive health		
9.	I expect that as I get older I will become more forgetful.	I will become more forgetful as I get older.	
10.	It's an accepted part of aging to have trouble remembering names.	It's expected to have trouble remembering names as part of aging.	
11.	Forgetfulness is a natural occurrence just from growing old.	Forgetfulness is a natural occurrence from growing old.	
12.	It is impossible to escape the mental slowness that happens with aging.	It is impossible to escape the mental slowness that happens with aging.	

Pre-testing

Before the formal survey, the instrument was tested and refined through cognitive interviews with 5 to 10 volunteers from similar background of the three population groups. From the cognitive interviews, the original wording used in several of the instruments were re-phrased for clarity, using words with more direct meaning, and framed in the Singaporean context. For example, in the original SF-12 the statement, "Does your health limit you in climbing several flights of stairs" was adapted to "Does your current health typically restrict you

in climbing several flights of stairs, taking the bus or MRT (public train system)" Participants from the cognitive interviews gave feedback that it was necessary to frame the questions with references that Singaporean older adults would relate to.

A test-retest pilot test was also conducted with 15 volunteers who had a similar background as the three population groups. To assess the reliability of the survey instrument, each participant was asked to complete the same survey again two weeks after the first survey was administered. The test retest results for the overall likelihood of using the proposed Health Springs was 0.91, while the Cronbach's alpha for the likely use of individual spaces was 0.46. As a survey instrument that is in the developmental stages of measuring use and usability for architectural design and planning the reliability scores were deemed acceptable and no changes were made to the questions.

Study Sample and Settings

Two different population groups were sampled for this Phase Three, including (1) adult housing residents and (2) design professionals. Adult housing residents (21 years and older) were sampled as residents who may use the Health Springs in their communities as they get older or as caregivers for seniors. Additional sampling efforts were conducted for older housing residents aged 65 and above, to ensure they were sufficiently represented. Design professionals were invited to participate in the survey because of their professional expertise and potential impacts on features or public housing, and their responses would be compared with those from housing residents.

Based on the General Household Survey (2015), the total public housing population in Singapore was 981,000 households. Based on a 95% confidence level with a margin of error of +/- 5%, the sample size needed for housing residents was 380 participants. For the calculation of the design and planning professional population sample, the research gathered data from the Board of Architects for the number of registered architects in Singapore. Approximately 1,500 architects were registered, out of which, the research estimated 60% were working on public sector projects based on the profile of construction developments in Singapore for 2018 (Building Construction Authority [BCA], 2019). The estimation reduced the sample pool to 900 registered architects. Based on the types of building developments awarded in 2018, the

approximate number of registered architects with experience in public housing design and/or healthcare facilities was 250 architects. Using a 95% confidence level and a margin of error of +/- 5%, the ideal sample size targeted for design and planning professionals was 150 participants.

Inclusion and Exclusion Criteria

Housing residents were eligible for inclusion if they were aged 21 and older, lived in public housing in Singapore, and were able to read and write in either English or Chinese. Participants who were not considered eligible for the study were elderly participants who were institutionalized for long term care. Planning and design professionals eligible for inclusion were those over the age of 21, who lived in public housing in Singapore and were familiar with the planning, design, or development of public housing estates and/or healthcare projects related to older adults' care or senior living.

Recruitment for Phase Three drew from multiple locations and diverse groups of people from Singapore. For the two different groups of targeted participants, different recruitment settings were used.

Selection and Recruitment of Housing Residents

The residential distribution for public housing in Singapore is classified into four levels, including five main regions with a total of 29 residential towns. Each residential town has approximately 10 public housing districts, each district consist of 3 to 5 public housing neighborhoods with 10 to 15 public housing buildings. For the recruitment of housing residents in Phase Three, the researcher approached the Housing Development Board (HDB), which is the government agency in charge of the management of public housing and the associated residential committees of each residential town in Singapore. The HDB agency assisted in selecting and coordinating participating residential committees and a convenient sample was shortlisted from four residential towns located in four of the five different regions of Singapore as illustrated in Table IV-6 and Figure IV-3. The residential towns selected closely mirrored the national statistics in terms of the percentages of both the general and older adult populations living in public housing (DOS, 2018). The convenience sample pool provided by HDB gave the researcher access to residential committees that operated at the town level and had an

outreach of approximately 1,500 households. The survey link was advertised on the social

media webpages of the four public housing residential committee.
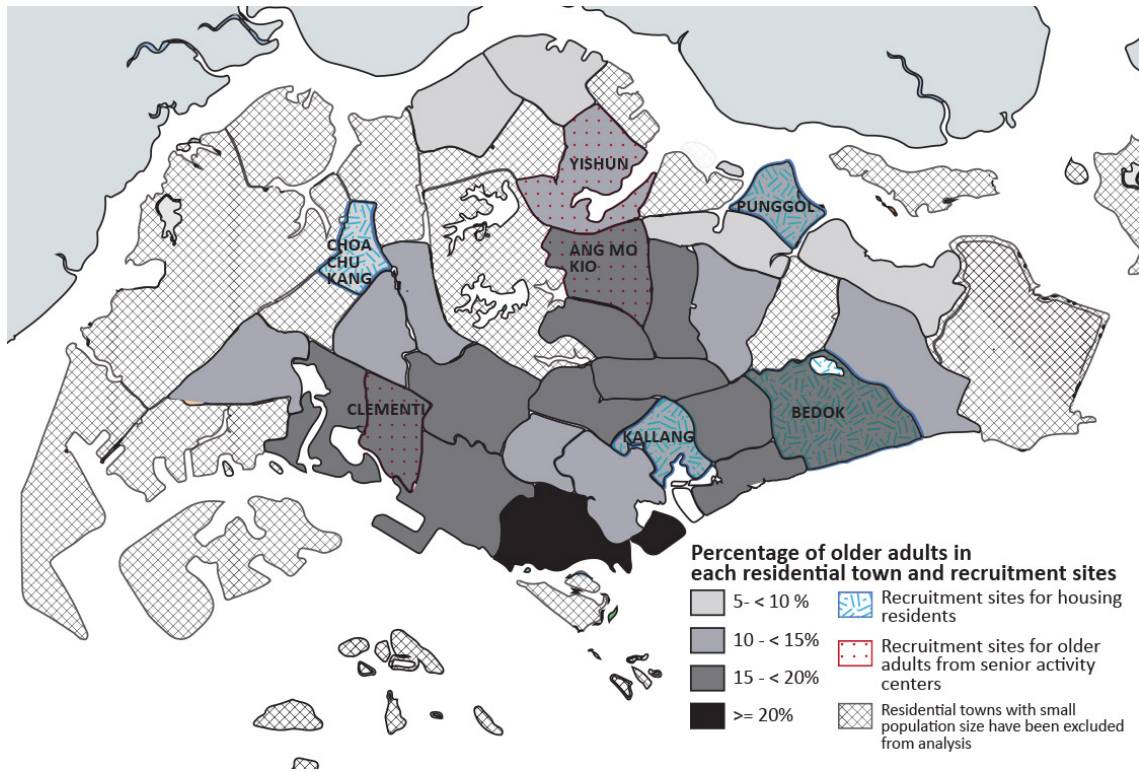
Figure IV-3. Percentage of older adults in residential towns and locations of recruitment sites redrawn from Population Trends, 2018. (Reprinted from *Population Trends, 2018*, p.25. DOS, 2018, Singapore: Ministry of Trade & Industry)

Table IV-6.
Population Statistics of Selected Residential Towns Where the Online Survey was Distributed to Housing Residents by Residential Committees (DOS, 2018).

Region	Residential town	Total Resident Population in Residential town	Total HDB† Dwelling Population in Residential town	% of Population in HDB Dwelling	Number of Older Adults (65 and older) in Residential town	% of Older Adults per Residential town
	Total in Singapore	**3,994,280**	**3,149,250**	**78.8**	**547,860**	**17.4**
North	Bedok*	281,300	180,880	64.3	48,790	27.0
West	Choa Chu Kang*	187,510	167,220	89.2	17,320	10.4
Central	Kallang*	101,420	80,330	79.2	19,790	24.6
North-East	Punggol*	161,570	140,490	87.0	10,910	7.8

* Selected residential towns where the online survey was distributed by residential committees.
† HDB: Refers to public housing buildings that are under the government agency the Housing Development Board in charge of the management of all public housing in Singapore.

Additional sampling of community-dwelling older adults was also conducted to ensure their sufficient representation in the survey responses. For this purpose, a small number of printed copies of the survey were distributed at four senior activity centers from three public housing estates, which were distinct from the recruitment sites of other housing residents. The additional sampling of older adults was intended to reduce selection bias from the method of online recruitment, which senior adults may have been less likely to access. This additional sampling was conducted at the same senior activity centers used in Phase One. The Geriatric Education and Research Institute (GERI) assisted in coordinating with these senior activity centers. Table IV-7 shows the description of the residential towns from where older adults in senior activity centers were recruited for the survey.

Table IV-7.
Population Statistics of the Public Housing Residential Towns Where Older Adults from Senior Activity Centers were Surveyed (DOS, 2018).

Region	Residential town	Total Resident Population in Residential town	Total HDB† Dwelling Population in Residential town	% of Population in HDB Dwelling	Number of Older Adults (65 and older) in Residential town	% of Older Adults per residential town
	Total in Singapore	**3,994,280**	**3,149,250**	**78.8**	**547,860**	**17.4**
Central	Ang Mo Kio*	165,710	134,890	81.4	32,530	24.1
West	Clementi*	93,000	69,400	74.6	17,260	24.9
North	Yishun*‡	214,940	193,960	90.2	24,680	12.7

* Recruitment sites for senior activity centers
† HDB: Refers to public housing buildings which are under the government agency the Housing Development Board in charge of the management of all public housing in Singapore.
‡ Of the four senior activity centers visited, two centers were located in Yishun town.

Selection and Recruitment of Design Professionals

For design professionals, five companies and agencies with experience in design, planning and development of public housing and/or healthcare projects were recruited for participation. Companies with experience in healthcare projects were included in the study as the design professionals with healthcare background could provide insights to the health aspects of the proposed Health Springs for older adults in public housing. Most of the companies had between 20 and 60 years of experience in designing, planning and developing

public housing and public housing neighborhood estates. From the five companies contacted, there were approximately 250 design professionals who were considered eligible to participate based on their experience with public housing and/or healthcare projects related to older adult care and healthy aging.

Survey Administration

The survey took approximately 15 to 20 minutes to complete. The distribution procedure varied across population groups and was administered in three steps. The first step was distributing printed copies of the survey to older adults at the four senior activity centers in July 2018. A printed version was used for this subgroup as it is typically easier for older adults to complete compared to digital version. The researcher arranged a time and day with the facility administrator to conduct the survey during a one-time visit. Before the visits, the researcher enlisted the facility administrator to shortlist eligible participants based on the inclusion criteria of the study. During the visit, shortlisted eligible participants were approached individually and briefed on the information of the study. Due to the nature of recruitment, informed consent was required from participants. Upon obtaining a signed consent form, the participant was enrolled in the study and the survey was conducted in a private area of the senior center by the researcher. Prior to the start of the survey, older adult participants were given the option of completing either the English or Mandarin version of the printed survey.

The second step was administering the same survey online at the four selected public housing estates. The survey link was active over a six-week period during the months of July to September 2018. Flyers were broadcasted on the residential committee's social media page each week to raise awareness of the survey amongst housing residents of the estate. The online survey platform used was Qualtrics. Information about the study was included at the beginning of the survey and participants had to give their electronic consent and confirm that they met the inclusion criteria in order to access the survey. To ensure a higher participation rate, both online surveys and fliers were developed in both English and Mandarin as these are the two commonly spoken languages in Singapore.

The third step was distributing the online survey at five design professional companies. The survey link was distributed through a recruitment email sent by a company representative

over a period of 6 weeks between the months of August and October 2018. The recruitment email was distributed weekly to raise awareness of the survey amongst the design professionals. The online survey was hosted on Qualtrics and was accessed through a specific web-link that was included in a recruitment email. Information about the study was included at the beginning of the survey and participants had to give their electronic consent and confirm that they met the inclusion criteria in order to access the survey. Only the English-language version of the survey was distributed to design and planning professionals. This version was mostly the same as the survey used for housing residents but had slight modifications and additional questions pertaining to participants' backgrounds in design for public housing and/or healthcare design.

Small incentives and a drawing for a prize were used to improve participation from all groups. A separate identification log with participants' names, email addresses, and home addresses, was created specifically for participants interested in taking part in the drawing. The information collected was used for contacting the participants of the drawing and was not linked to the participant's survey response to ensure data anonymity.

IRB Approval

As an international study, the researcher received IRB approval from both Singapore's National Health Group and Texas A&M University. For older adults at senior activity centers, informed consent was obtained before the start of the survey from participants who were eligible. For the online version of the survey, a waiver of documentation for informed consent was obtained. All identifying information was coded to protect participants' confidentiality.

Results

Collecting and Validating Data

Data collected from the printed survey were entered into the corresponding online surveys and were consolidated on Qualtrics online platform. The research used the Texas A&M University campus site license for the Qualtrics survey application. Qualtrics is a preferred tool for campus surveys because it meets stringent information security requirements not found in most free online survey tools. The consolidated data were downloaded in SPSS format and analyzed in JMP Pro 14.0 provided by Texas A&M University. A total of 432 participants were

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received and screened, and 361 participants were eligible. Participants were considered eligible if they gave consent to take part in the survey, were over the age of 21, and were either residents from public housing or design professionals familiar with public housing design or healthcare projects related to older adults' care. Of the total of 361 eligible participants, 271 survey responses were considered as valid for analysis. Data were deemed valid if the respondent completed the questions related to perceived usability of the Health Springs, expected health outcomes from possible use of the Health Springs, likelihood of using the individual spaces, and the overall likelihood of using the Health Springs. This is illustrated in Figure IV-4.

Total Screened
(n= 432)

Housing Residents	Design Professionals
n= 322	n= 110

Total numbers choosing not to participate n= 54

Enrolled
"Yes" for consent **(n= 378)**

n= 276	n= 102

Total numbers not eligible n= 17

Eligible
Meets inclusion criteria **(n= 361)**

n= 260	n= 101

Total numbers deemed invalid n= 90

Total Valid Surveys
Complete responses for 1) perceived usability, 2) expected health outcomes, 3) likelihood of using individual spaces and, 4) overall likelihood of using the Health Springs **(n= 271)**

n= 188	n= 83

Figure IV-4. Process of screening valid survey with an acceptable level of completeness.

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Out of the 271 accepted surveys, a missing value report was generated to check the missing data from the participants' responses as not all of the questions required compulsory responses. The missing value table reported below (Table IV-8) indicates the number of missing information from the different variables. Overall, three out of 17 variables were missing information, the missing data was mainly information related to participants' characteristics. The percentage of incomplete surveys ranged from 2.21% to 5.54% of the total valid surveys.

For missing values from the question related to gender, a "missing" category was created and used as a different level, in order to retain the responses collected for the independent and dependent variables. For continuous data with missing values, like education and physical health status, the researcher used multiple imputation analysis to provide estimates for the missing values. The following section describes how the missing data for these variables were treated for further analysis.

Table IV-8.
Report of Variables with Missing Values.

Variable Type	Question		Data Type	Number of Missing Value	% of missing value (out of 271)
Dependent Variable	Overall Likelihood of Using the Health Springs*		Categorical	0	0
Independent Variable	Perceived Usability of the Health Springs*		Continuous	0	0
	Expected Health Outcomes from using the Health Springs*	Physical Activity	Continuous	0	0
		Social Interactions	Continuous	0	0
		Mental Wellbeing	Continuous	0	0
	Likely Use of Individual Spaces of the Health Springs	Garden Cafe	Continuous	0	0
		Activity Room		0	0
		Exercise Pool		0	0
		Therapy Pools		0	0
		Community Kitchen		0	0
		Personal Care Room		0	0
Confounding Variable	Participants Characteristics	Age*	Continuous	0	0
		Gender	Categorical	15	5.54
		Education	Continuous	6	2.21
		Physical Health Status	Continuous	14	5.17
		Expectations Regarding Aging*	Continuous	0	0
		Stakeholders Perspectives*	Categorical	0	0

*Questions that required compulsory responses to proceed in the survey.

Methods of Analyses

The objectives of Phase Three was to explore participants' likely use of the proposed Health Springs and examine the impact of perceived usability, expected health outcomes, and likely use of individual spaces on the likely use of the proposed Health Springs, while controlling for personal factors. Furthermore, the research compared stakeholders' perspectives for the independent variables of perceived usability, expected health outcomes, and likely use of individual spaces. The steps taken for data analysis included 1) cleaning of the data, 2) conduct a descriptive analysis of the variables, 3) conduct a bivariate analysis between the independent and dependent variables, 4) conduct a ordinal logistic multi-regression analysis for the impact of the independent variables on the likely use of the proposed Health Springs.

An ordinal logistic regression was used as the survey used a 4-pt Likert-type scale to collect the data for the dependent variable, the overall likelihood of using the Health Springs. Ordinal logistic regression does not require assumptions of typical linear regression model, such as linearity, normality, and homoscedasticity thus it was more appropriate for this analysis. The researcher tested there were no multicollinearity between the independent variables and the data had proportional odds to ensure the assumptions for an ordinal model were met. When testing for the multicollinearity, the variance inflation factor score was less than 5 for all variables, indicating collinearity was not an issue. Similarly, prior to conducting the multi-regression analysis, the researcher first used the Lack of Fit test to test for proportional odds.

Overall Likelihood of Using the Health Springs

Data Cleaning

For the overall likelihood of using the Health Springs, participants were asked the question, "Overall, how likely would you use the Health Springs as you get older?". The response scale was a 4-point Likert-type scale ranging from "Extremely likely" to "Unlikely/Not at all", each point was scored from 1 to 4. Due to the distribution of responses, the categories of "Unlikely/Not at all" and "A little likely" were combined into a new category "A little likely/Not at all" for further regression analysis (Table IV-9).

Table IV-9.

Treatment of the Responses Collected for Overall Likelihood of Using the Health Springs (n=271)

Measurement Scale	Original Responses		Measurement Scale	Transformed Responses	
	%	N		%	N
Extremely likely	29.9	81	Extremely likely	29.9	81
Moderately likely	51.3	139	Moderately likely	51.3	139
A little likely*	15.4	42	A little likely/Not at all	18.8	51
Unlikely/not at all*	3.3	9			

* The observations from "A little likely" and "Unlikely/not at all" were combined into one categorical response "A little likely/Not at all" for further regression analysis.

Descriptive Analysis

Phase Three wanted to measure participants' overall likelihood of using the Health Springs to explore the potential reach of the proposed health facility in public housing neighborhoods. Participants were asked, "Overall, how likely would you use the Health Springs as you get older?" Of the collected responses (Table IV-10), 29.9% of participants indicated they were extremely likely to use the Health Springs while 51.3% reported they were moderately likely to use the proposed Health Springs.

Table IV-10.

Responses for Overall Likelihood of Using the Health Springs (n=271)

Transformed Responses		
Measurement Scale	%	N
Extremely likely	29.9	81
Moderately likely	51.3	139
A little likely/Not at all*	18.8	51

* The observations from "A little likely" and "Unlikely/not at all" were combined into one categorical response "A little likely/Not at all" for further regression analysis.

Objective ONE: To Explore Participants' Likely Use of the Proposed Health Springs

Data Cleaning

Participants' characteristics included data that covered age, gender, education, physical health status, expectations regarding aging, and the perspective of the participant (housing resident or design professional). Of the six variables, physical health status and expectations regarding aging were captured through adapted survey items and as an overall score. For physical health status, participants were asked to answer five questions adapted from the Short Form 12 Health Survey pertaining to their physical health. The data were entered into the Short

Form 12 Health Survey scoresheet, using an algorithm[6] to calculate the physical health subscore of each participant (Sriram & Svirbely, 2000). The physical health subscore ranged from 0 to 20. Due to the distribution of participant's self-reported physical health status being left skewed (Figure IV-5), the researcher used a Box Cox transformation to treat the data for normality to control for multicollinearity between variables.
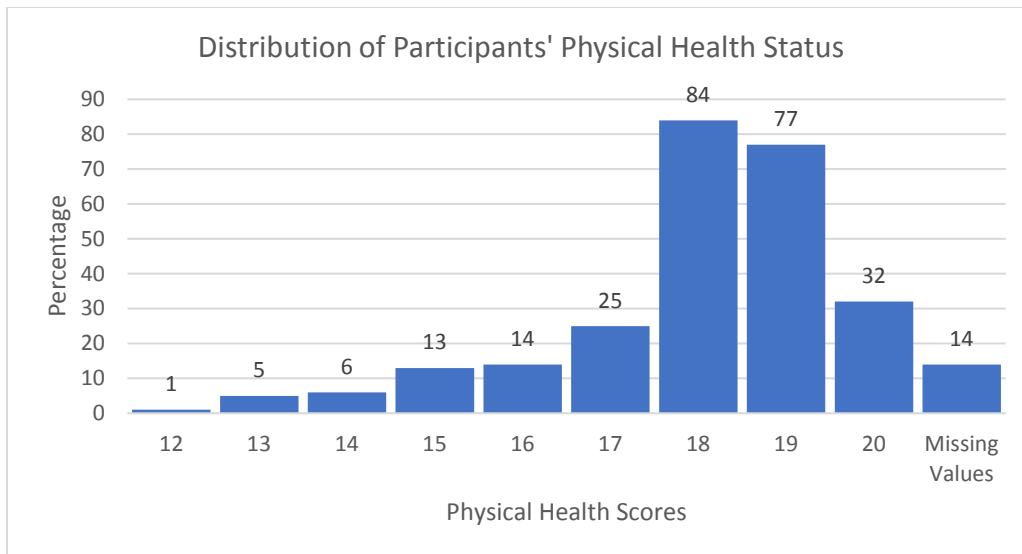
Figure IV-5. Distribution of participants' physical health status scores.

For participants' attitudes towards aging, the survey used twelve questions adapted from the 12-point Expectations Regarding Aging instrument. The response scale was a 4-pt Likert scale ranging from "Strongly Disagree" to "Strongly Agree". Each point was scored from 1 to 4. The data were converted into a continuous scale by summing all the points for each response, subtracting 12, multiplying by 25 and dividing by 9 to come up with a range from 0 to 100 score (Sarkisian et al., 2005). The data were transformed for normality using a log transformation to control for multicollinearity between variables.

Descriptive Analysis

The study recruited approximately 146 adult residents of public housing, which included 10 older adults over the age of 64. The study also recruited 42 older adults who lived in public

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[6] The algorithm involved two steps that includes 1) creating an indicator variable for response categories – for example assessing limitations in moderate activities were recoded into a binary "yes" for limitations and "no" for not at all and 2) multiplying the indicator variables by respective physical regression weight and summing the scores. (Sriram & Svirbely, 2000).

housing neighborhoods through the visits to the four senior activity centers, making a total of 188 housing residents of different ages. Approximately 83 professionals with backgrounds in architecture, planning and/or developers background were recruited.

Out of the total of 271 valid responses, the mean age of the participant was 47 years old, with the average education level that ranged from secondary school to polytechnic education. The distribution between male and female participants was relatively equal with 46.3% males and 53.7% female participants, as show in Table IV-11. The overall physical health subscore was relatively high with the mean scoring of 18 out of 20. As shown in Table IV-12, overall score distribution for expectations regarding aging was an average score of 38.9 out of 100, with higher scores indicating higher overall expectations regarding aging and lower scores indicating lower expectations.

Table IV-11.
Participants Characteristics (n=271)

Item	Scale	%	Mean	SD
Age	Continuous		46.6	17.5
Gender	Categorical		-	-
	1= Male	43.9		
	2= Female	50.9		
	3= Missing	5.2		
Education	Continuous	-	2.9	1.4
	0= Others			
	1= Primary			
	2= Secondary			
	3= Polytechnic			
	4= Tertiary			
Physical Health Status Scores	Continuous	-	18.0	1.6
Stakeholder Type	Binary		-	-
	1= Housing Residents	69.3		
	2= Design Professionals	30.6		

*SD: Standard deviation.

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Table IV-12.
Participants' Attitudes Regarding Aging Using the Expectations Regarding Aging Instrument (n=271)

Item	Scale[d]	Mean	SD
Expectations Regarding Aging [a] (ERA-12)	Mental health [b] scale	51.7	21.6
	Cognitive function scale	36.7	21.3
	Physical health scale	27.5	21.2
	Global Mean Scoring [c]	**38.9**	**14.2**

[a] Likert scale of 1-4 converted to a continuous variable from 0-100.
[b] Mental health includes statements regarding subjective wellbeing, resilience, and loneliness etc.
[c] Global Mean Scoring is the cumulation of each statement rating that includes the mental health scale, cognitive function and physical health scale.
[d]: All three sub-scales had the same score range from 0 – 100.

The breakdown in Table IV-12 showed that Singaporeans had lower expectations towards their physical health and cognitive function as they age. However, with regards to mental health, Singaporeans had higher expectations and did not perceive aging to affect their social interactions with people, choosing "Somewhat false" and "Definitely false" for statements such as "I will spend less time with friends and family as I get older" and "It is normal to be depressed when people get old".

Bivariate Analysis

A detailed bivariate analysis was conducted to study the relationship between each of the confounding variables and the outcome variable of the overall likelihood to use the Health Springs. As shown in Table IV-13, participant's physical health status scores were marginally significant in predicting the overall likelihood of use. With regards to the age of the participants, the analysis indicated that participants who were younger were likely to use the proposed Health Springs. Another observation was that participants who had lower scores for expectations regarding aging were more likely to use the Health Springs.

Table IV-13.
Bivariate Analyses Between Participants' Characteristics and the Overall Likelihood Of Using the Health Springs (n=271)

Participants Characteristics	β	p	N
Age	-0.0002	0.79	271
Gender	0.38	0.83	256*
Education	0.05	0.58	271
Physical Health Status	0.15	0.06†	271
Expectations Regarding Aging	-0.11	0.62	271
Stakeholder Type			271
[housing resident]	0.67	0.71	

†: 0.05 < p < 0.1
*: Listwise deletion excluded 15 cases missing gender information for this bivariate analysis

Multi-regression Analysis

This study analyzed the impact of participants' characteristics and attitudes toward the main outcome variable—the overall likelihood of using the Health Springs. For the ordinal logistic regression, the 15 cases missing gender information were excluded and the resulting sample size for this regression was 256 participants. The regression results showed that participants' characteristics were not significant in predicting the overall likelihood of using the Health Springs (Table IV-14). The base model of the analysis indicated that participants' characteristics explained 1% of the variance of the likelihood of using the Health Springs.

Table IV-14.
Ordinal Logistic Model Predicting Overall Likelihood of Using the Health Springs Using Participant Characteristics and Attitudes (n=256)

	Base Model		
	β	p	Variance Inflation Factor (VIF)
Participants' Characteristics			
Age	0.002	0.82	1.54
Gender [Male]	-0.05	0.71	1.11
Education	0.08	0.48	1.79
Physical Health Status[(trans)]	0.17	0.05*	1.16
Expectations Regarding Aging (ERA-12) [a]	-0.24	0.32	1.04
Stakeholder Perspective [housing resident]	0.18	0.22	1.25
R^2 (u)		0.01	

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***<.0001, †: 0.05 < p < 0.1
[a]: Scores for ERA-12 were log transformed for normality.
[(trans)]: Scores for physical health status were transformed using Box Cox transformation.

Objective TWO: *To Examine the Impact of Perceived Usability on the Likely Use of the Proposed*

Health Springs

Data Cleaning

A key independent variable that could influence the overall likelihood of using the Health Springs was its perceived usability. Participants' overall perceived usability of the Health Springs were derived from ten questions adapted from the Systems Usability Scale (SUS). The response scale was a 5-point Likert-type scale ranging from "Strongly Disagree= 1," "Disagree= 2," "Neither Agree nor Disagree= 3," "Agree= 4," "Strongly Agree= 5." From the ten questions, a global score was generated to produce the overall SUS score that ranged from 0 to 100. The ten questions were divided into five (odd numbered) positive statements and five (even numbered) negative statements regarding usability that to reduce bias from the participants. The total score of the odd numbered statements had 5 points subtracted from them while the total score of the even numbered statements were subtracted from 25. The resulting scores were added together and multiplied by 2.5 to obtain the overall perceived usability score that ranged from 0 to 100 (Brooke, 1996). The resulting data was normalized via log transformation to control for multicollinearity between variables.

Descriptive Analysis

Using the adapted Systems Usability Scale (SUS) tool to calculate perceived usability, the mean participant score was 67.6 out of 100 (SD= 11.5). The distribution of the perceived usability score is illustrated in Figure IV-6. Based on the adjective ratings of the SUS scale (as illustrated in Figure IV-7) this placed the perceived usability of the Health Springs relatively close to the "Good" rating and in the "High Marginal" of the acceptability ratings.
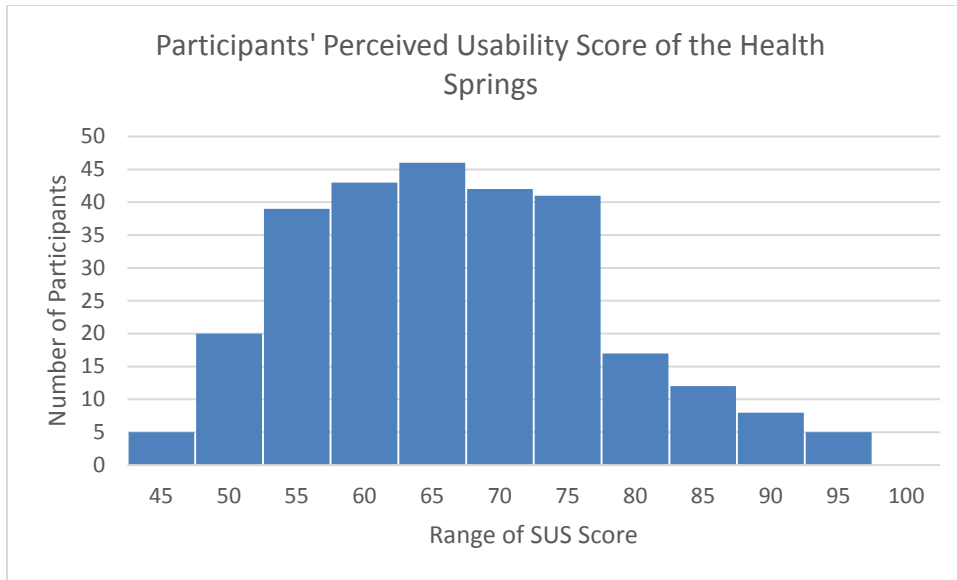
Figure IV-6. Distribution of participants' perceived usability scores for the Health Springs. (n=271)
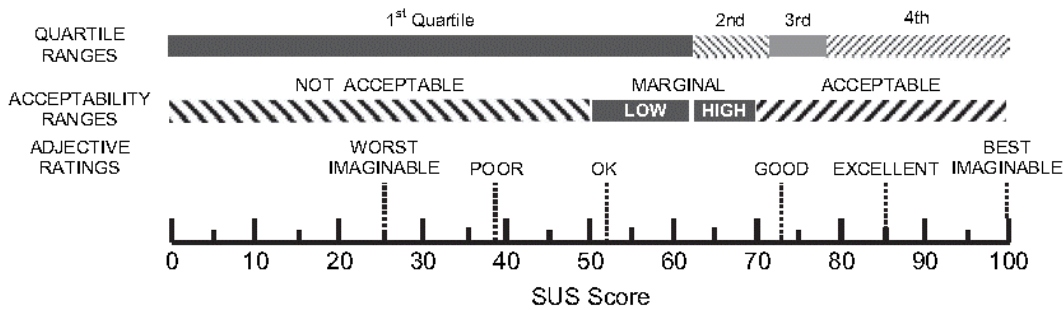
Figure IV-7. Comparison of mean System Usability Scale (SUS) scores by quartile, adjective ratings, and the acceptability of the overall SUS Score. (Reprinted from "An empirical evaluation of the system usability scale," by Bangor et al., 2008. *International Journal of Human–Computer Interaction, 24*(6), 574-594).

Table IV-15 further illustrates the detailed breakdown of the SUS rating, with the descriptive statistics indicating that participants generally perceived the proposed Health Springs as somewhat usable. Combining the percentages for "Agree" and "Strongly Agree", most participants agreed that the proposed Health Springs would be easy to use (76%), its proposed location at the ground floor was well integrated into the public housing neighborhood (81.5%), and could imagine themselves using the Health Springs at least once a week (69.1%).

Table IV-15.

Detailed Breakdown of SUS Ratings for the Perceived Usability of the Proposed Health Springs (n=271)

		Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
				Frequency (%)		
Positive Statements on Aspects of Perceived Usability						
1	I think that I would like to use the Health Springs Center frequently (at least once a week)	5.2	4.8	21.0	**51.3**	17.8
3	I think that the Health Springs Center would be easy to use	1.5	1.8	20.7	**63.5**	12.5
5	I find the Health Springs Center is well integrated in the neighborhood	0	1.9	16.7	**48.9**	32.6
7	I imagine that most people will learn to use the Health Springs Center very quickly	0.7	4.1	25.1	**57.9**	12.2
9	I would feel very confident to use the Health Springs Center	1.5	4.8	22.5	**56.8**	14.4
Negative Statements on Aspects of Perceived Usability						
2	I find the Health Springs Center unnecessarily complex	12.5	**49.1**	29.9	7.7	0.7
4	Based on my current health, I would need the support of a caregiver to be able to use the Health Springs Center	**29.9**	26.9	22.5	17.3	3.3
6	I think there is too many conflicting features in the Health Springs Center	11.4	**43.9**	36.5	7.4	0.7
8	I find the Health Springs Center will be hazardous to use	14.8	**43.9**	34.3	5.2	1.8
10	I need to learn a lot of things before I can go to the Health Springs Center	10.3	**38.4**	26.6	21.4	3.3

Bivariate Analysis

A detailed bivariate analysis was conducted to study the relationship between each of the 10 aspects of perceived usability score and the outcome variable of the overall likelihood to use the Health Springs. The results in Table IV-16 showed that each item had a significant bivariate relationship with overall likelihood of use, except item 4 "I would need the support of a caretaker to use the Health Springs". The top three significant items for predicting overall likelihood of use was confidence, perceived ease of use, and perceived presence of safety and health hazards. These findings were consistent with the researcher's theoretical framework based on Bandura's theory of self-efficacy – where greater levels of self-efficacy (confidence) leads to higher levels of performance (the likely use of the Health Springs). The findings also

confirmed Rich's expectations of usability (the ease of use and lack of hazards) as a main factor in influencing user's perception of using the actual product (Rich & McGee, 2004). Comparatively, the role and support of the caregiver was not significant in predicting participants' likelihood of using the Health Springs. Though not explored in this study, more investigation and research is needed to examine how the role of caregivers can influence user experience and increase the likelihood of using health facilities.

Table IV-16.

Bivariate Analyses Between Individual Systems Usability Scale Items for the Perceived Usability and the Overall Likelihood of Using the Health Springs (n=271)

SUS item [a]		β	p
3	I think that the Health Springs Center would be easy to use	1.29	<.0001***
9	I would feel very confident to use the Health Springs Center	1.14	<.0001***
8	I find the Health Springs Center will be hazardous to use	-0.70	<.0001***
2	I find the Health Springs Center unnecessarily complex	-0.70	<.0001***
1	I think that I would like to use the Health Springs Center frequently (at least once a week)	0.59	<.0001***
7	I imagine that most people will learn to use the Health Springs Center very quickly	0.75	<.0001***
6	I think there is too many conflicting features in the Health Springs Center	-0.66	<.0001***
5	I find the Health Springs Center is well integrated in the neighborhood	0.50	0.002**
10	I need to learn a lot of things before I can go to the Health Springs Center	-0.23	0.05*
4	Based on my current health, I would need the support of a caregiver to be able to use the Health Springs Center	-0.10	0.32

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***: p < 0.001, †: 0.05 < p < 0.1
a: Items are ordered by goodness of fit in descending order.

Multi-Regression Analysis

An ordinal logistic regression was conducted to analyze the impact of perceived usability on the overall likelihood of use in the Health Springs, while controlling for personal factors. The 15 cases missing gender information were excluded, reducing the sample size for this regression to 256 participants. First, in order to assess whether the proportional odds assumption of the ordinal logistic model was met, the researcher conducted the Lack of Fit test, which has rigorous criteria and in general tends to reject the proportional odds assumption

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more often that is warranted (Agresti, 2002). This test used the ordinal model as the Fitted model (null hypothesis) and the nominal model as the Saturated model. Comparing the ordinal response model to the nominal response model, the Lack of Fit test showed that the comparison was non-significant *(p= .93)* indicating no evidence that the proportional odds assumptions was violated. The high P-value supports the goodness of fit of the proportional odds model. Thus, the ordinal regression model was appropriate.

To assess if perceived usability was significant in influencing the overall likely use of the proposed Health Springs, a Likelihood ratio test was conducted by comparing the fitted model (503 degrees of freedom [DF]) to the saturated model (510 DF). The null hypothesis assumed that fitted model would be equal to the saturated model, thus non-significant in influencing overall likely use. When conducting the Likelihood ratio test statistic, the model fit reduced the -LogLikelihood of 261.61 for the fitted model to 228.01 for the saturated model. This reduction yielded a likelihood ratio chi-square statistic for the whole model of 67.20 with 7 degrees of freedom χ^2 (7, *N*= 256) = 67.20, *p* < .0001. The reduction indicates that fitted model was significantly different from the saturated model and rejected the null hypothesis. Perceived usability was significant in influencing the overall likely use of the proposed Health Springs, controlling for participants' characteristics.

The covariate of perceived usability had parameter estimates that were furthest from 1.0 with a p-value that indicate strong statistical significance in predicting the outcome variable (*β*= 6.17, *p* <.0001). Perceived usability and overall likelihood of use were positively related. (*β*= 6.17*, SE*= 0.87*,* 95 *CI*= 4.53, 7.92). Participants' who perceived the Health Springs as more usable, would be more likely to use the Health Springs, this aligns with the research's theory that perceived usability could be an indicator of interpersonal barriers to one's goals and can be utilized to predict an individual's likely behavior. Comparing Model 1 (that includes perceived usability in the analysis) to the base model in Table IV-17 with only participant characteristics, the covariate of perceived usability explains 12% of variance predicting participants' likelihood of using the Health Springs.

Table IV-17.
Ordinal Logistic Regression for Perceived Usability Predicting Participants' Likelihood of Using the Health Springs (n=256)

	Base Model		Model 1	
	β	*p*	*β*	*p*
Participants' Characteristics				
Age	0.002	0.82	0.002	0.82
Gender [Male]	-0.05	0.71	-0.08	0.52
Education	0.08	0.48	-0.05	0.71
Physical Health Status	0.17	0.05*	0.11	0.20
Expectations Regarding Aging [a]	-0.24	0.32	-0.46	0.07†
Stakeholder Perspective [housing resident]	0.18	0.22	0.22	0.13
Perceived usability score [a]	NA	NA	6.17	<.0001***
R^2 (u)		0.01		0.13

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***<.0001, †: 0.05 < p < 0.1
[a] : Perceived usability score and expectations regarding aging was log transformed for normality.

Comparing Perceived Usability Scores in Different Stakeholder Groups

To ensure that the proposed design concept of the Health Springs matched the possible end user experience, perceived usability scores between older adults, housing residents, and design professionals were compared for similarities. Ideally, to ensure that the design of the Health Springs was potentially usable to older adults, perceived usability scores between older adults and design professionals should not be statistically different. Design professionals group had highest scorings for the perceived usability of the proposed Health Springs (M= 69.7, SD= 11.4) compared to housing residents group (M= 67.5, SD= 11.4), while the older adults group had the lowest mean score of 64.2 for perceived usability (M= 64.2, SD= 11.5) (As shown in Table IV-18). The study wanted to compare if there was significant statistical difference between the stakeholders' perspectives on the perceived usability of the Health Springs.

Table IV-18.
Comparing Perceived Usability Scores from Different Stakeholders' Perspectives. (n= 271)

	Mean	**SD**	**Lower CI**	**Upper CI**	**n (%)**
Older Adults	64.2	11.5	60.9	67.5	50 (18.5)
Housing Residents	67.5	11.4	65.6	69.4	138 (50.9)
Design Professionals	69.7	11.4	67.2	72.2	83 (30.6)
Overall	**67.6**	11.5	66.2	69.0	271

A oneway analysis of variance (ANOVA) was conducted to compare the effect of participant group type on the perceived usability scoring in older adults, housing residents, and design professionals. Table IV-19 shows there was a significant effect of the participant group type on perceived usability score for the three participant groups [$F(2, 268) = 3.67$, $p = 0.03$].

Table IV-19.
Oneway Anova Testing for Difference in Perceived Usability Scores Between the Stakeholder Groups (n= 271)

	df	Sum of Squares	Mean Square	F	Sig.
Between groups	2	0.22	0.11	3.67	0.03*
Within groups	268	7.96	0.03		
Total	270	8.18			

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***<.0001, †: 0.05 < p < 0.1
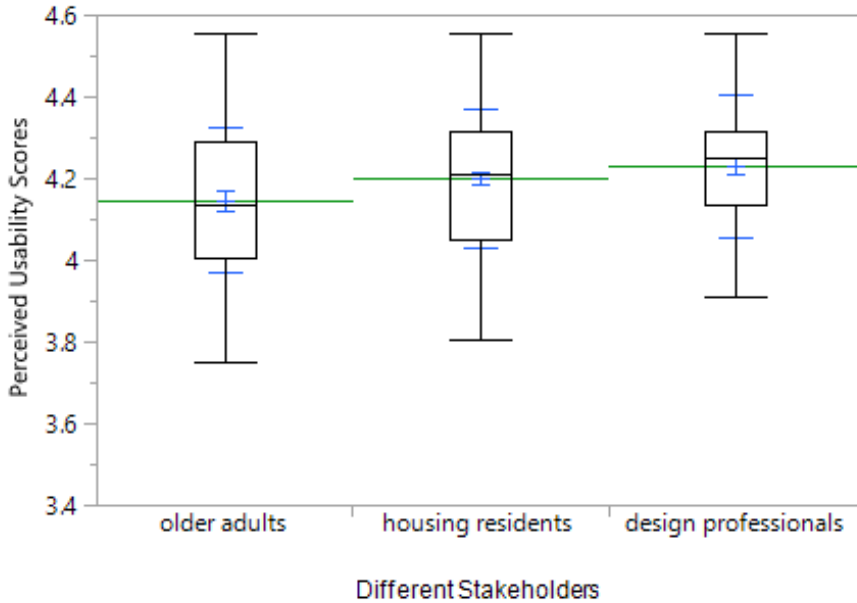
Figure IV-8. Boxplot showcasing the difference in mean distribution for perceived usability scores between the different stakeholder groups.

Table IV-20.
Ordered Differences Report Comparing the Mean for Perceived Usability Between Different Stakeholders Groups. (n=271)

Level	- Level	Difference	p-Value
Design professionals	Older adults	0.08	0.02*
Housing residents	Older adults	0.05	0.17
Design professionals	Housing residents	0.03	0.38

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***<.0001, †: 0.05 < p < 0.1

Post hoc comparisons was conducted using the Tukey HSD test to generate an ordered differences report. The results in Table IV-20 indicated that the mean score for the design professionals group (M= 4.23, SD= 0.18) was significantly higher than the mean score from the older adults group (M= 4.15, SD= 0.18). However, the housing residents group (M= 4.20, SD= 0.16) did not significantly differ from either design professionals and older adults groups. A boxplot diagram in Figure IV-8 also indicated significantly different statistical mean in perceived usability scores between design professionals and older adults. Overall, different stakeholders' perspective has an effect on the perceived usability score of the Health Springs, with the biggest difference in perceived usability occurring between older adults and design professionals. One possible measure to foster similar usability scores between design professionals and older adults would be to involve end users during the planning and design of other similar facilities targeting healthy aging.

Objective THREE: To Examine the Impact of Expected Health Outcomes on the Potential Use of the Proposed Health Springs

Data Cleaning

Under the premise of the Health Springs in their public housing neighborhood, participants were asked to estimate the level of improvement they expect to occur in three health outcomes in terms of 1) physical activity, 2) social interactions, and 3) mental wellbeing. For each expected health outcome, participants were asked to provide estimates for improvements at two tiers, including at his/her personal level and for older adults in general. Hence, the overall score of participants' expected health outcomes arising from potential use of the Health Springs was derived from a total of six questions adapted from expectancy component of the Credibility/Expectancy questionnaire.

Each question was from a scale of 1 to 10 (1= Not at all, 10= Very Much). For each health outcomes, the data input for the two tiers (of personal and general perspectives) was summed up and given a standardized Z-scoring. In the original credibility/expectancy questionnaire, the construct of "expectation" was based on what an individual "thinks would happen" and what one "feels would happen" - with "thinking" being associated with a more objective assessment of a general concept (Devilly & Borkovec, 2000). In the adapted questions, the first tier related

to personal expectations of improved health outcomes were framed to asked participants what they "feel" would happen, while the second tier related to older adults' general health outcomes were framed to ask participants what they "think" would happen. Hence, to calculate the overall expectancy score, scores for the two tiers (personal and general perspectives) were combined and given a standardized Z-scoring (Devilly & Borkovec, 2000).

Descriptive Analysis

Based on the aggregated scores in Table IV-21, participants indicated that they expected the proposed Health Springs to provide the greatest improvements to mental wellbeing (M= 14.60, SD= 3.02), followed by social interactions (M= 14.58, SD= 3.25), and lastly physical activity (M= 13.97, SD= 3.12). Figure IV-9, Figure IV-10, and Figure IV-11 describe the distribution of the z-scores for physical activity, social interactions, and mental wellbeing. While the distribution response for physical activity, social interactions, and mental wellbeing were slightly left-skewed, the boxplots indicate that the observations were mostly equally distributed on either end of the scales. Hence, no log transformation were applied to the data.

Table IV-21.
Overall Results for Participants' Expected Improvements to Health Outcomes with the Health Springs in the Public Housing Neighborhood (n=271)

Combined Score	Mean	SD
Physical Activity	13.97	3.12
Social Interactions	14.58	3.25
Mental Wellbeing	14.60	3.02
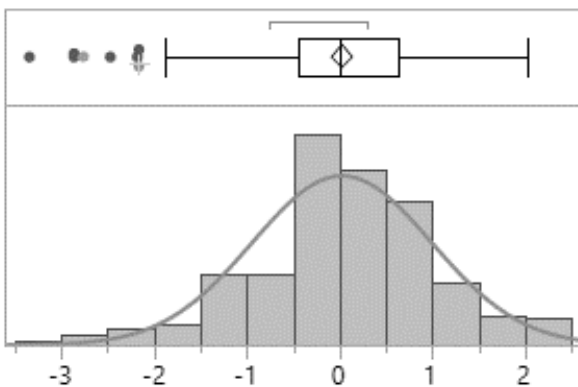
Figure IV-9. Standard normal distribution of z-scores for participants' expected improvements to physical activity. (N=271, M= .03, SD= .97, p= .0002)

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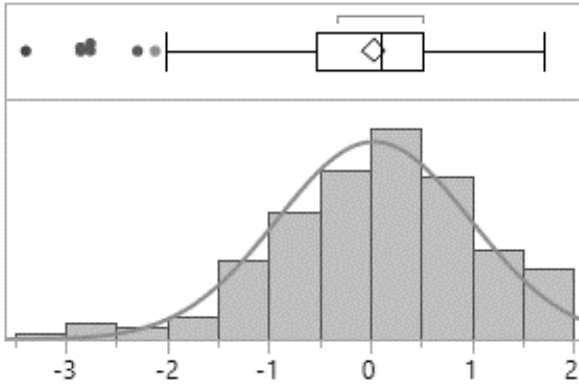
Figure IV-10. Standard normal distribution of z-scores for participants' expected improvements to social interactions. (N=271, M= .03, SD= .95, p< .0001)
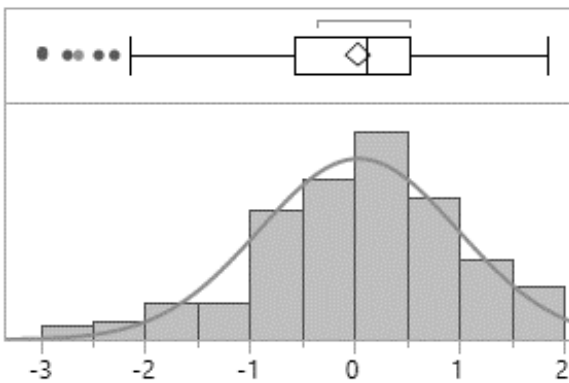
Figure IV-11. Standard normal distribution of z-scores for participants' expected improvements to mental wellbeing. (N=271, M= .04, SD= .95, p< .0001)

Participants felt that with the proposed Health Springs in their public housing neighborhood, the health outcome with the highest level of improvement at a personal level was mental wellbeing (M= 7.18, SD= 1.81), followed by social interactions (M= 6.95, SD= 2.06), and physical activity (M= 6.65, SD= 2.04). Comparatively in Table IV-22, when predicting the level of improvements in health outcomes for older adults, participants thought the proposed Health Springs would provide greatest improvements to older adults' social interactions (M= 7.59, SD= 1.64), followed by mental wellbeing (M= 7.35, SD= 1.74), and lastly physical activity (M= 7.29, SD= 1.60).

Of the three types of expected health outcomes, in general, participant's expectations towards older adults' health improvements were higher than their expectations towards their individual health improvements, as shown in Table IV-22. Of the three expected health

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outcomes related to healthy aging, expectations for improvement in mental wellbeing had the highest combined mean score of 14.2 (M= 14.23, SD= 3.38).

Table IV-22.

The Mean and Standard Deviation of Scores for Expected Health Outcomes. (n= 271)

With the Health Springs in your neighborhood,

	How much improvement in the following do you feel will occur?		How much improvement in the following do you think will occur for older adults?	
	Mean	*SD*	*Mean*	*SD*
Physical Activity	6.65	2.04	7.29	1.60
Social Interactions	6.95	2.06	7.59	1.64
Mental Wellbeing	7.18	1.81	7.35	1.74

Bivariate Analysis

Bivariate analyses were conducted between each of the three aspects of expected health outcomes (physical activity, social interactions, and mental wellbeing) and the outcome variable of the overall likelihood to use the Health Springs. The results in Table IV-23 showed that expected health outcomes for both individual and older adults in the community was significant in predicting overall likelihood of use. Using a Goodness of Fit report, the bivariate analysis of the covariates indicated that perceived direct improvements to an individual's physical activity was the strongest predictor for using the proposed Health Springs (β= 0.47, p< .0001). Comparatively, when anticipating possible improvements to older adults' health, mental wellbeing was ranked higher than physical activity and social interactions in predicting the likely use of the proposed Health Springs (β= 0.39, p< .0001). These findings confirm Bandura's social cognitive theory of outcome expectations, where expected outcomes acts as motivators that encourage individuals to modify their behavior to produce positive results. In this case, the anticipation of improved physical activity and mental wellbeing motivated participants' likely use of the Health Springs. These findings are valuable to the design of healthy aging facilities, as the results suggests that to encourage greater use of healthy aging facilities in Singapore, implicit design details could convey opportunities of improvements to physical activity and mental wellbeing.

Table IV-23.

*Detailed Breakdown of Bivariate Analysis of Expected Individual and Predicted Older Adults'
Health Outcomes Influencing the Overall Likelihood of Using the Health Springs (n=271)[a]*

	β	p
Expected improvement to **individual's**		
Physical activity	0.47	<.0001***
Mental wellbeing	0.44	<.0001***
Social interactions	0.35	<.0001***
Expected improvement to **older adults'**		
Mental wellbeing	0.39	<.0001***
Physical activity	0.37	<.0001***
Social interactions	0.35	<.0001***

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***: p < 0.001, †: 0.05 < p < 0.1
a: Items are ordered by goodness of fit in descending order.

Multi-regression Analysis

Examining the relationship between expected health outcomes and the overall

likelihood of using the proposed Health Springs facility, the research conducted an ordinal

logistic regression analysis for expected health outcomes predicting overall likelihood of use. As

the first step, the research tested for proportional odds assumptions by using the Lack of Fit

test to show whether an ordinal model fit the data well. The Lack of Fit test has rigorous criteria

for meeting the proportional odds assumptions and tends to reject the proportional odds

model assumption more often that is warranted (Agresti, 2002). Comparing the ordinal

response model to the nominal response model, the Lack of Fit test indicated that the

comparison was non-significant, (p= .87). The high P-value supports the goodness of fit of the

proportional odds model, failing to reject the null hypothesis (the ordinal response model) and

indicating there were proportional odds to run an ordinal regression analysis.

The research used an ordinal logistic regression to analyze the impact of expected

health outcomes (physical activity, social interactions, and mental wellbeing) on the overall

likelihood of using the Health Springs while controlling for participants' characteristics. A

Likelihood ratio test was used to compare the fitted model (501 DF) to the saturated model

(510 DF). When conducting the Likelihood ratio test statistic, the model fit reduced the -

LogLikelihood of 261.61 for the fitted model to 232.84 for the saturated model. This reductions

yielded a likelihood ratio chi-square statistic for the whole model of 57.55 with 9 degrees of freedom χ^2 (9, *N*= 256) = 57.55, *p* < .0001. The results indicate that fitted model was significantly different from the saturated model and that expected health outcomes were significant in influencing the overall likely use of the proposed Health Springs, when controlling for participants' characteristics.

The ordinal logistic regression model in Table IV-24 used three aspects of expected health outcomes (physical activity, social interactions, and mental wellbeing) to predict overall likely use of the Health Springs while controlling for participants' characteristics. Out of the three aspects of expected health outcomes, the expected outcome in terms of physical activity was significant in influencing the overall likely use (*β*= 0.66, *p*= .003). Mental wellbeing was marginally significant (*β*= 0.44, *p*= .08), while the impact of social interactions on the overall likelihood of use was insignificant (*β*= 0.00001, *p*= .99).

Physical activity and overall likelihood of use were positively related (*β*= .66, *SE*= 0.28, 95 *CI*= .22, 1.10). The results suggest that participants who expected older adults' physical activities as well as their own physical activity to improve with the introduction of the proposed Health Springs were more likely to use the facility. Comparing Model 1 (that includes expected health outcomes in the analysis) to the base model with only participant characteristics, the three covariates of expected health outcomes explained 10% of variance predicting participants' likelihood of using the Health Springs.

Table IV-24.

Ordinal Logistic Regression for Expected Health Outcomes Predicting Participants' Likelihood of Using the Health Springs (n=256)

	Base Model		Model 1	
	β	*p*	*β*	*p*
Participants' Characteristics				
Age	0.002	0.82	-0.007	0.42
Gender [Male]	-0.05	0.71	-0.03	0.82
Education	0.08	0.48	0.05	0.65
Physical Health Status	0.17	0.05*	0.16	0.07†
Expectations Regarding Aging [a]	-0.24	0.32	-0.42	0.10
Stakeholder Perspective [housing resident]	0.18	0.22	0.17	0.27
Expected Health Outcomes				
Physical Activity	NA	NA	0.66	0.003**
Social Interactions	NA	NA	0.00001	0.99
Mental Wellbeing	NA	NA	0.44	0.08†
R^2 (u)		0.01		0.11

*: $0.01 < p < 0.05$, **: $0.001 < p < 0.01$, ***$<.0001$, †: $0.05 < p < 0.1$
[a] : Expectations regarding aging was log transformed for normality.

Comparing Expected Health Outcomes in Different Stakeholder Groups

To ensure that the proposed design concept of the Health Springs matched the possible end user experience, expected improvements to health outcomes (physical activity, social interactions, and mental wellbeing) between older adults, housing residents, and design professionals were compared for similarities. Ideally, to ensure that the design concept and intention of the proposed Health Springs could maximize potential health benefits for older adults, expected health outcomes scores between older adults and design professionals should not be statistically different.

Out of the three stakeholder groups surveyed, the older adults group had highest scorings for the anticipated improvements to health outcomes with the proposed Health Springs located in their public housing neighborhood. The older adults average scores for physical activity, social interactions, and mental wellbeing in Table IV-25 were (M= 14.83, SD= 3.50), (M= 14.86, SD= 3.76), and (M= 15.05, SD= 3.50) respectively. Comparatively, the design professionals had the lowest scorings of anticipated improvements to health outcomes

associated with the proposed Health Springs. The design professionals average scores for physical activity, social interactions, and mental wellbeing were (M= 13.30, SD= 3.45), (M= 14.23, SD= 3.45), and (M= 14.22, SD= 3.23). A oneway analysis of variance (ANOVA) was conducted to see if there was significant statistical difference between the stakeholders' perspectives on expected health outcomes associated with the proposed Health Springs.

Table IV-25.

Comparing Expected Health Outcomes from Different Stakeholders' Perspectives. (n=271)

	Mean	SD	Lower CI	Upper CI	n (%)
Physical Activity					
Older Adults	14.83	3.50	13.84	15.82	50 (18.5)
Housing Residents	13.95	2.70	13.49	14.40	138 (50.9)
Design Professionals	13.30	3.45	12.55	14.06	83 (30.6)
Social Interactions					
Older Adults	14.86	3.76	13.79	15.93	50 (18.5)
Housing Residents	14.53	2.98	14.03	15.03	138 (50.9)
Design Professionals	14.23	3.45	13.47	14.98	83 (30.6)
Mental Wellbeing					
Older Adults	15.05	3.50	14.05	16.04	50 (18.5)
Housing Residents	14.48	2.78	14.01	14.95	138 (50.9)
Design Professionals	14.22	3.23	13.51	14.92	83 (30.6)

SD: Standard deviation

Results from the ANOVA in Table IV-26 indicated there was a significant effect of the participant group type on expected health outcome score for physical activity between the three participant groups [$F(2, 268) = 3.95$, *p*= 0.02]. For social interactions and mental wellbeing, the difference between the mean for the three different stakeholders were nonsignificant. A further comparison study was conducted for the expected improvements to physical activity score between the three participant groups to analyze the variances.

Table IV-26.

Oneway Anova Testing for Difference in Expected Health Outcomes Scores Between the Stakeholder Groups (n= 271)

	df	Sum of Squares	Mean Square	F	Sig.
Physical Activity					
Between groups	2	7.21	3.61	3.95	0.02*
Within groups	268	244.91	0.91		
Total	270	252.12			
Social Interactions					
Between groups	2	2.34	1.17	1.29	0.28
Within groups	268	242.30	0..90		
Total	270	244.64			
Mental Wellbeing					
Between groups	2	3.92	1.96	2.20	0.11
Within groups	268	238.42	0.89		
Total	270	242.34			

*: $0.01 < p < 0.05$, **: $0.001 < p < 0.01$, ***: $<.0001$, †: $0.05 < p < 0.1$
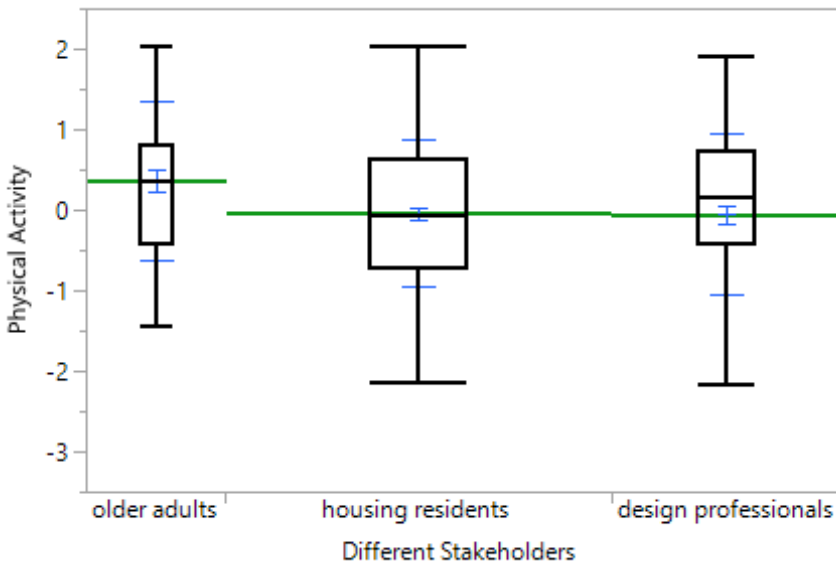
Figure IV-12. Boxplot showcasing the difference in mean distribution for expected improvements to physical activity scores between the different stakeholder groups.

Table IV-27.

Ordered Differences Report Comparing the Mean for Expected Improvements to Physical Activity Between Different Stakeholders Groups. (n=271)

Level	- Level	Difference	p-Value
Older adults	Design professionals	0.43	0.04*
Older adults	Housing residents	0.42	0.02*
Housing residents	Design professionals	0.01	1.00

*: $0.01 < p < 0.05$, **: $0.001 < p < 0.01$, ***: $<.0001$, †: $0.05 < p < 0.1$

Post hoc comparisons was conducted using the Tukey HSD test to generate an ordered differences report for the expected improvements in physical activity for the three participant groups. The results in Table IV-27 and Figure IV-12 indicated that the mean score for the older adults group (M= 0.37, SD= 0.99) was significantly different from the design professionals group (M= -0.06, SD= 0.10) and the housing residents group (M= -0.05, SD= 0.91). In general, compared to design professionals and housing residents, older adults had significantly higher anticipation scores regarding their improvements to their physical activity with the Health Springs in the public housing neighborhood. The findings suggests that older adults perceived more positive health benefits from the proposed Health Springs than design professionals and housing residents. Using the Health Springs as a case study, outcome expectations (especially anticipated improvements to physical activity) is shown to be significant in predicting the likely use of the proposed Health Springs. Thus, it is important that design professionals understand, recognize, and establish the significance of the older adults' outcome expectations when designing future facilities that support healthy aging. Failing to recognize the significance of older adults' outcome expectations may lead to a mis-match in the design of health facilities that may not provide the adequate social and environmental opportunities that attract older adults. The research can infer that in the design of healthy aging facilities in Singapore, design professionals could aim to ensure opportunities for improved physical activity meets the outcome expectations of older adults.

Objective FOUR: To Examine the Impact of the Likely Use of Individual Spaces on the Potential Use of the Proposed Health Springs

Data Cleaning

For the likelihood of using individual spaces of the Health Springs, participants answered the question, "How likely would you take part in activities at the (individual space) as you get older?" for six individual spaces, the Garden Café, the Activity Room, the Exercise Pool, Therapy Pools, the Community Kitchen, and the Personal Care Room. The response scale was a 4-pt Likert-type scale ranging from "Extremely likely" to "Unlikely/Not at all", each point was scored from 4 to 1. The categories of "Unlikely/Not at all" and "A little likely" were combined into a single response, "A little likely/Not at all" due to the distribution of responses, which would

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allow for an even proportion of responses to fulfil future regression analysis. The transformed responses were given a 3 point scale of "Extremely likely= 3", "Moderately likely= 2", and "A little likely/Not at all= 1" (Table IV-28).

Table IV-28.
Distribution of Participants Response to "How Likely Would You Take Part in Activities at the (Individual Space) as You Get Older?".

		Original Responses		Transformed Responses		
	Scale of Measurement	Percent (%)	n=		Percent (%)	n=
Garden Cafe	Extremely likely	26.6	72	Extremely likely	26.6	72
	Moderately likely	50.6	137	Moderately likely	50.6	137
	A little likely*	17.0	46	A little likely/Not at all	22.9	62
	Unlikely/not at all*	5.9	16			
Activity Room	Extremely likely	27.3	74	Extremely likely	27.3	74
	Moderately likely	53.1	144	Moderately likely	53.1	144
	A little likely*	14.0	38	A little likely/Not at all	19.6	53
	Unlikely/not at all*	5.5	15			
Exercise Pool	Extremely likely	24.7	67	Extremely likely	24.7	67
	Moderately likely	35.4	104	Moderately likely	35.4	104
	A little likely*	18.1	49	A little likely/Not at all	36.9	100
	Unlikely/not at all*	18.8	51			
Therapy Pools	Extremely likely	39.1	106	Extremely likely	39.1	106
	Moderately likely	38.4	104	Moderately likely	38.4	104
	A little likely*	11.8	32	A little likely/Not at all	22.5	61
	Unlikely/not at all*	10.7	29			
Community Kitchen	Extremely likely	26.2	71	Extremely likely	26.2	71
	Moderately likely	42.4	115	Moderately likely	42.4	115
	A little likely*	22.6	61	A little likely/Not at all	31.5	85
	Unlikely/not at all*	8.9	24			
Personal Care Room	Extremely likely	33.6	91	Extremely likely	33.6	91
	Moderately likely	43.5	118	Moderately likely	43.5	118
	A little likely*	12.9	35	A little likely/Not at all	22.9	62
	Unlikely/not at all*	10.0	27			

* The observations from "A little likely" and "Unlikely/not at all" were combined into "A little likely/Not at all" for further regression analysis.

Descriptive Analysis

Table IV-29 further illustrates the detailed breakdown of participants' responses to the likely use of individual spaces of the proposed Health Springs. The descriptive statistics indicated majority of the participants were likely to use the individual spaces of the proposed Health Springs, with the Therapy Pools having the highest mean score of likely use (M= 2.17, SD= 0.77) and the Exercise Pool having the lowest mean score of likely use (M= 1.88, SD= 0.78).

Table IV-29.
Distribution of Participants' Response for Likely Use of Individual Spaces Ranked from Highest Mean Score in Descending Order. (n=271)

	Extremely Likely	Moderately Likely	A Little Likely/ Not at All*	Mean	SD
	Frequency (%)				
Therapy Pools	39.1	38.4	22.5	2.17	0.77
Personal Care Room	33.6	43.5	22.9	2.11	0.75
Activity Room	27.3	53.1	19.6	2.08	0.68
Garden Cafe	26.6	50.6	22.9	2.04	0.70
Community Kitchen	26.2	42.4	31.5	1.95	0.76
Exercise Pool	24.7	38.4	36.9	1.88	0.78

SD: Standard deviation.
* The observations from "A little likely" and "Unlikely/not at all" were combined into one categorical response "A little likely/Not at all" for further regression analysis.

Bivariate Analysis

Bivariate analyses were conducted to study the relationship between the likely use of each of the six individual spaces and the outcome variable of the overall likelihood to use the Health Springs. The Pearson's chi-square test was used to test for independence between the covariates of the individual spaces and the outcome variable of overall likely use of the proposed Health Springs. The results of the Pearson chi-square test, as shown in Table IV-30, indicated that the p-values of all six individual spaces were significant in predicting the overall likely use of the proposed Health Springs.

Table IV-30.

Detailed Breakdown of Bivariate Analysis of the Likely Use of Individual Spaces Predicting the Overall Likelihood of Using the Health Springs (n=271)[a]

	DF	N	β	p
Garden Cafe	4	271	71.74	<.0001***
Therapy Pools	4	271	63.57	<.0001***
Personal Care Room	4	271	61.44	<.0001***
Activity Room	4	271	51.25	<.0001***
Exercise Pool	4	271	49.51	<.0001***
Community Kitchen	4	271	27.69	<.0001***

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***: p < 0.001, †: 0.05 < p < 0.1
a: Items are ordered by goodness of fit in descending order.

Multi-Regression Analysis

The research used the Lack of Fit test to detect if the proportional odds assumption was met and to show whether the ordinal model fits the data well. The Lack of Fit test used the ordinal model as the Fitted model (null hypothesis) and the nominal model as the Saturated model. The Lack of Fit test has rigorous criteria for meeting the proportional odds assumptions and tends to reject the proportional odds model assumption more often that is warranted (Agresti, 2002). Comparing the ordinal response model to the nominal response model, the Lack of Fit test showed that the comparison was non-significant *(p= .96)*. The high P-value supports the goodness of fit of the proportional odds model. Thus, failing to reject the null hypothesis, the assumption for proportional odds holds and the ordinal regression model was appropriate.

The research proceeded to conduct an ordinal logistic regression to analyze the impact of likely use of individual spaces on the overall likelihood of use in the Health Springs, controlling for participants' characteristics. A Likelihood ratio test was conducted to test the null hypothesis by comparing the fitted model (498 degrees of freedom, DF) to the saturated model (510 DF). The null hypothesis assumed that fitted model would be equal to the saturated model. When conducting the Likelihood ratio test statistic, the model fit reduced the -LogLikelihood of 261.61 for the fitted model to 222.59 for the saturated model. This reduction yielded a likelihood ratio chi-square statistic for the whole model of 78.06 with 12 degrees of freedom $\chi 2$ (12, N= 256) = 78.06, p < .0001. The reduction indicates that fitted model was

significantly different from the saturated model and the likely use of individual space was significant in influencing the overall likely use of the proposed Health Springs, controlling for participants' characteristics.

The research conducted an ordinal logistic regression model for the likely use of the six individual spaces predicting overall likely use of the proposed Health Springs while controlling for participants' characteristics, as shown in Table IV-31. Of the six individual spaces, the likelihood of using the Garden Café was significant in influencing the overall likely use of the proposed Health Springs (β= 0.77, *p*= .0008). The likelihood of using the Personal Care Room was also significant for predicting the overall likelihood of using the proposed Health Springs (β= 0.59, *p*= .005).

Likely use of the Garden Café and Personal Care Room were positively associated with the overall likelihood of using the Health Springs. Comparing Model 1 (that included the likely use of the six individual spaces in the analysis) to the base model with only participant characteristics, the six covariates of the individual spaces contributed to 14% of variance predicting participants' likelihood of using the Health Springs. These findings are valuable as they confirm the conceptual framework's measure of adopting the individual spaces of the proposed Health Springs into public housing settings. The results suggest that the overall use of possible healthy aging facilities would be promoted with the inclusion of a Garden Café and a Personal Care Room in the proposed design.

Table IV-31.

Ordinal Logistic Regression for Perceived Usability Predicting Participants' Likelihood of Using the Health Springs (n=256)

	Base Model		Model 1	
	β	*p*	*β*	*p*
Participants' Characteristics				
Age	0.002	0.82	0.01	0.57
Gender [Male]	-0.05	0.71	-0.04	0.77
Education	0.08	0.48	0.02	0.84
Physical Health Status	0.17	0.05*	0.13	0.16
Expectations Regarding Aging [a]	-0.24	0.32	-0.21	0.42
Stakeholder Perspective [housing resident]	0.18	0.22	0.09	0.57
Garden Café	NA	NA	0.77	0.0008***
Activity Room	NA	NA	0.03	0.90
Exercise Pool	NA	NA	0.35	0.11
Therapy Pools	NA	NA	0.31	0.14
Community Kitchen	NA	NA	0.08	0.68
Personal Care Room	NA	NA	0.59	0.005**
R^2(u)		0.01		0.15

***: $0.0001 < p < 0.001$, **: $0.001 < p < 0.01$, *: $0.01 < p < 0.05$, †: $0.05 < p < 0.1$
[a]: Expectations regarding aging was log transformed for normality.

Comparing Likely Use of Individual Spaces Between Different Stakeholder Groups

To ensure that the proposed design concept of the Health Springs matched the possible end user experience, the likely use of individual spaces between older adults, housing residents, and design professionals were compared for similarities. Ideally, to ensure that the intended potential use of the proposed Health Springs would be maximize through the likely use of individual spaces, the scores between older adults and design professionals should not be statistically different.

Out of the three stakeholder groups surveyed in Table IV-32, the housing residents group had highest total mean scores for likely use of the individual spaces (M=12.6, SD= 0.67 - 0.78) while older adults had the lowest total mean scores for likely use of the individual spaces (M= 11.42, SD= 0.77 - 0.89). A oneway analysis of variance (ANOVA) was conducted to see if

there was significant statistical difference between the stakeholders' perspectives on likely use of the individual spaces in the proposed Health Springs.

Table IV-32.
Comparing Scores for Likely Used of Individual Spaces from Different Stakeholders' Perspectives. (n=271)

	Older Adults (n=50)		Housing Residents (n=138)		Design Professionals (n=83)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Garden Cafe	2.00	0.83	2.04	0.69	2.05	0.64
Activity Room	2.04	0.81	2.14	0.67	2.00	0.60
Exercise Pool	1.68	0.77	1.98	0.78	1.83	0.76
Therapy Pools	2.16	0.89	2.24	0.73	2.05	0.75
Community Kitchen	1.80	0.81	1.97	0.75	2.00	0.73
Personal Care Room	1.74	0.85	2.23	0.69	2.12	0.71
Total Mean Scores	11.42		12.6		12.05	

Results from the ANOVA in Table IV-33 indicated there was a significant effect of the participant group type on likely use of the personal care room between the three participant groups [$F(2, 268) = 8.46$, *p*= 0.0003]. For the other five individual spaces (the Garden Café, Activity Room, Exercise Pool, Therapy Pools, and Community Kitchen), the difference between the mean for the three different stakeholders were nonsignificant. A further comparison study was conducted for the scoring of the likely use of the Personal Care Room between the three participant groups to analyze the variances.

Table IV-33.

Oneway Anova Testing for Difference in Scores for Likely Use of the Six Individual Spaces Between the Stakeholder Groups (n= 271)

	df	Sum of Squares	Mean Square	F	Sig.
Garden Cafe					
Between groups	2	0.08	0.04	0.08	0.92
Within groups	268	133.55	0.50		
Total	270	133.63			
Activity Room					
Between groups	2	1.07	0.53	1.15	0.32
Within groups	268	124.30	0.46		
Total	270	125.37			
Exercise Pool					
Between groups	2	3.52	1.76	2.97	0.05
Within groups	268	159.45	0.59		
Total	270	162.98			
Therapy Pools					
Between groups	2	1.89	0.95	1.61	0.20
Within groups	268	157.64	0.59		
Total	270	159.53			
Community Kitchen					
Between groups	2	1.39	0.70	1.21	0.30
Within groups	268	153.88	057		
Total	270	155.28			
Personal Care Room					
Between groups	2	8.90	4.45	8.46	0.0003***
Within groups	268	140.99	0.53		
Total	270	149.90			

***: $0.0001 < p < 0.001$, **: $0.001 < p < 0.01$, *: $0.01 < p < 0.05$, †: $0.05 < p < 0.1$
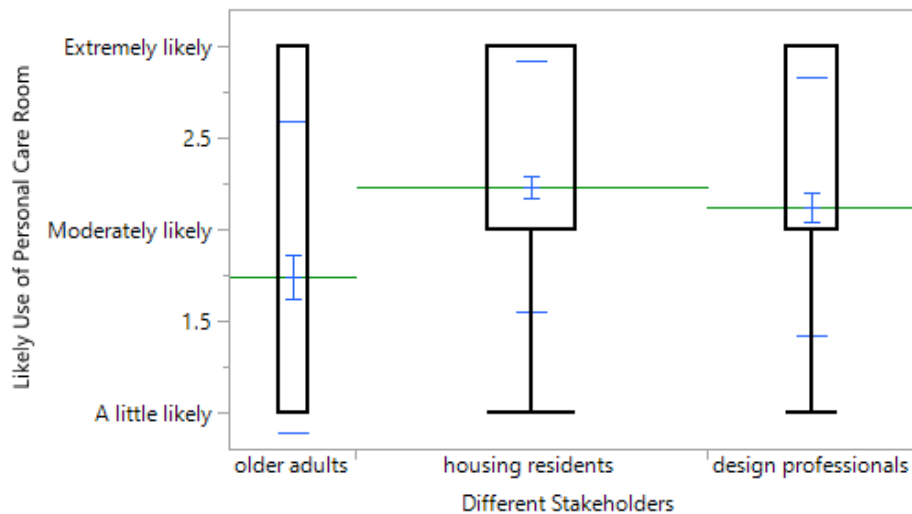

Figure IV-13. Boxplot showcasing the difference in mean distribution for likely use of the Personal Care Room between the different stakeholder groups.

Table IV-34.
Ordered Differences Report Comparing the Mean for Likely Use of the Personal Care Room between Different Stakeholders Groups. (n=271)

Level	- Level	Difference	p-Value
Housing residents	Older adults	0.49	0.0002**
Design professionals	Older adults	0.38	0.0103*
Housing residents	Design professionals	0.11	0.5114

*: 0.01 < p < 0.05, **: 0.001 < p < 0.01, ***<.0001, †: 0.05 < p < 0.1

Post hoc comparisons was conducted using the Tukey HSD test to generate an ordered differences report for the scores of likely use for the Personal Care Room for the three participant groups. The results in Table IV-34 indicated that the mean score for the housing residents group (M= 2.23, SD= 0.69) was significantly different from the design professionals group (M= 2.12, SD= 0.71) and the housing residents group (M= 1.74, SD= 0.85). Compared to design professionals and older adults, housing residents had significantly higher scores on the likely use of the Personal Care Room, while the older adults had to lowest mean score of likely use, as shown in Figure IV-13. The findings suggest that programmatic function of the Personal Care room requires further discussion and development to improve the likely use from older adults.

Of the two individual spaces that indicated significance in predicting perceived usability from the earlier multi-regression (Garden Café and Personal Care Room) the Garden Café showed no statistical significant difference in the mean scores of likely use between the three stakeholder groups. The findings suggest that the programmatic functions of the Garden Café was found acceptable by participants from different backgrounds.

Objective FIVE: To Examine the Impact of Perceived Usability of the Health Springs, Expected Outcomes, and Likelihood of Using Individual Spaces on the Overall Likelihood of Using the Health Springs

As a final step, the research conducted an ordinal logistic regression analysis to use the different independent variables to predict the overall likelihood of using the Health Springs, while controlling for participants' characteristics. In the full model of Table IV-35, perceived usability, expected improvements to physical activity, and the likely use of the Garden Café and the Personal Care Room were significant in predicting the overall likelihood of use of the proposed Health Springs. In the analysis of the full model, of the three independent variables

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(perceived usability, expected health outcomes, and likely use of individual spaces), perceived usability was the strongest predictor of overall likely use of the Health Springs (p< .0001). The combination of all independent variables explained 21% of the variance in predicting the overall likelihood of using the Health Springs.

Table IV-35.

Comparing the Different Independent Variables Predicting Participants' Likelihood of Using the Health Springs (n=256)

	Base Model		Model 1		Model 2		Model 3		Full Model	
	β	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*
Participants' Characteristics										
Age	0.002	0.82	0.002	0.82	-0.007	0.42	0.01	0.57	-0.001	0.91
Gender	-0.05	0.71	-0.08	0.52	-0.03	0.82	-0.04	0.77	-0.05	0.70
Reference Category [Male]										
Education	0.08	0.48	-0.05	0.71	0.05	0.65	0.02	0.84	-0.08	0.56
Physical Health Status	0.17	0.05*	0.11	0.20	0.16	0.07†	0.13	0.16	0.12	0.20
Expectations Regarding Aging [la]	-0.24	0.32	-0.46	0.07†	-0.42	0.10	-0.21	0.42	-0.44	0.11
Stakeholder Perspective [housing resident]	0.18	0.22	0.22	0.13	0.17	0.27	0.09	0.57	0.17	0.28
Perceived Usability [a]	-	-	6.17	<.0001***	-	-	-	-	4.43	<.0001***
Expected Health Outcomes										
Physical Activity	-	-	-	-	0.66	0.003**	-	-	0.32	0.19
Social Interactions	-	-	-	-	0.0001	0.99	-	-	-0.17	0.52
Mental Wellbeing	-	-	-	-	0.44	0.08†	-	-	0.31	0.25
Likely use of										
Garden Café	-	-	-	-	-	-	0.77	0.0008**	0.80	0.0009**
Activity Room	-	-	-	-	-	-	0.03	0.90	-0.10	0.71
Exercise Pool	-	-	-	-	-	-	0.35	0.11	0.21	0.37
Therapy Pools	-	-	-	-	-	-	0.31	0.14	0.04	0.87
Community Kitchen	-	-	-	-	-	-	0.08	0.68	-0.06	0.78
Personal Care Room	-	-	-	-	-	-	0.59	0.005**	0.50	0.02**
R^2(u)		0.01		0.13		0.11		0.15		0.22

*: $0.01 < p < 0.05$, **: $0.0001 < p < 0.01$, ***$<.0001$, †: $0.05 < p < 0.1$

[a] : Expectations regarding aging and perceived usability scores was log transformed for normality.

Discussion

Phase Three was the last step in the exploratory sequential research that aimed to measure the overall likelihood of using the proposed Health Springs and the extent to which perceives usability, expected health outcomes, and the likely use of individual influenced overall use of the proposed Health Springs. In surveying housing residents and design professionals, the overall perceived usability of the proposed Health Springs was rated between "Okay" and "Good" with a usability score of 67.6 out of 100. Generally, most participants perceived that the proposed Health Springs was easy to use, well integrated into the public housing neighborhood and could imagine themselves using the proposed Health Springs at least once a week.

In measuring the extent to which expected health outcomes influenced overall likely use of the proposed Health Springs, the overall expected health outcomes accounted for 10% of the variance in predicting likely use, after controlling for participants' characteristics. Expectations towards improvements in physical activity was significant in predicting likely use of the Health Springs. The findings suggest that implicit design details which convey opportunities for improvements to physical activity could encourage greater use of new facilities that promote healthy aging in Singapore.

Of the six individual spaces, the likely use of the Garden Café and Personal Care Room were significant in influencing the overall likely use of the proposed Health Springs. The findings suggest that the Garden Café and Personal Care Room were individual spaces that could be adapted into public housing settings. Overall use of a future community facility that promotes healthy aging in a public housing setting would benefit with the inclusion of a Garden Café and a Personal Care Room in the proposed design.

The research conducted an ordinal logistic regression analysis for all three independent variables of perceived usability, expected health outcomes, and likely use of individual spaces predicting of the overall likelihood of using the Health Springs. In the full model analysis, perceived usability was the strongest predictor of likely use of the Health Springs, followed by the likely use of the Garden Café and the Personal Care room. The findings of the individual models suggests that in designing facilities to support healthy aging, designers could consider

the measures of perceived usability, likely use of programmatic functions, and anticipated improvements in physical health as factors to creating a highly usable space.

In comparing responses from design professionals, housing residents, and older adults, design professionals had a higher perceived usability mean score (M= 69.7) than older adults (M= 64.2) and the mean scores tested were significantly different. Ideally, to ensure that the design of the Health Springs was potentially usable to older adults, perceived usability scores between older adults and design professionals should not be statistically different. Comparing perceived usability scores between design professionals and older adults during the planning and design stage of other similar facilities could be used as a measure to ensure proposed design concepts match the end use experience.

On the other hand, when comparing expected health outcomes, design professionals' expectations scores were lower than older adults for all three health aspects of physical activity, social interactions, and mental wellbeing. When tested for statistical difference, the mean scores for expected improvement to physical activity differed between older adults and design professionals were significantly different. The research can infer that in the design of future healthy aging facilities in Singapore, architects and designers could aim to ensure opportunities for improved physical activity meets the outcome expectations of older adults.

Limitations and Future Developments

A limitation of Phase Three's study was the premise that the measurements for overall likelihood of using the Health Springs and its relationships to perceived usability, expected health outcomes, and likely use of individual spaces were based on a theoretical simulation of the proposed Health Springs design instead of a tangible built project. While the study in Phase Three serves as a preliminary measure for predicting overall likely use for future healthy aging facilities in public housing neighborhoods, accuracy of the measurements for actual use would improve with comparisons to data collected from a built project. Future explorations of the relationship between overall likely use, perceived usability, expected health outcomes, and likely use of individual spaces in the proposed Health Springs could involve a post-occupancy evaluation for comparison of results.

Another limitation of the study was the specific scope of measuring the relationships between independent variables and overall likely use of the proposed Health Springs. The research does not measure if the relationship between the variables exist in other architectural context or project. For example, the results from this study indicated that expected health outcomes played a significant role in predicting likely use of the proposed Health Springs, but the complexity of the relationship is not fully explored within the scope of this research. For future architectural design projects related health, users' expectations towards health outcomes could become a future design factor for consideration.

Summary

The quantitative survey of Phase Three served as the final stage for testing and evaluating the proposed design of the Health Springs and its various features. The findings of the survey indicated that the design of the proposed Health Springs had an acceptable level of usability and could support participants' expectations towards improvements in their physical activity, and mental wellbeing. The overall results suggest that the proposed Health Springs could bring a new symbolic meaning to the ground floor of public housing buildings and could provide the community with the resources to improve aspects of their lifestyle pertaining to healthy aging.

References

Agresti, A. (2002). *Building and applying logistic regression models.* NJ: John Wiley & Sons.

Building Construction Authority [BCA], (2019). *Contracts Awarded And Progress Payments Certified By Sector And Development Type, Annual*. Retrieved from: https://www.tablebuilder.singstat.gov.sg/publicfacing/createDataTable.action?refId=14792

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist, 44*(9), 1175.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143-164.

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. *International Journal of Human–Computer Interaction, 24*(6), 574-594.

Brooke, J. (1996). SUS - A quick and dirty usability scale. *Usability Evaluation in Industry, 189*(194), 4-7.

Devilly, G. J., & Borkovec, T. D. (2000). Psychometric properties of the credibility/expectancy questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 31*(2), 73-86.

DOS. (2018). *Population Trends, 2018*. (ISSN 2591-8028). Singapore: Ministry of Trade & Industry, Republic of Singapore. Retrieved from https://www.singstat.gov.sg/-/media/files/publications/population/population2018.pdf.

Fowler Jr, F. J. (2013). *Survey research methods.* Thousand Oaks, CA: SAGE publications.

Gaglio, B., Shoup, J. A., & Glasgow, R. E. (2013). The RE-AIM framework: A systematic review of use over time. *American Journal of Public Health, 103*(6), e38-e46.

Gandek, B., Ware, J. E., Aaronson, N. K., Apolone, G., Bjorner, J. B., Brazier, J. E., . . . Sullivan, M. (1998). Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International Quality of Life Assessment. *Journal of Clinical Epidemiology, 51*(11), 1171-1178.

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health, 89*(9), 1322-1327.

Grembowski, D., Patrick, D., Diehr, P., Durham, M., Beresford, S., Kay, E., & Hecht, J. (1993). Self-efficacy and health behavior among older adults. *Journal of Health and Social Behavior*, 89-104.

ISO/TC 159/SC 4 Ergonomics of human-system interaction (Subcommittee). (1998). *Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs).: Guidance on Usability*. International Organization for Standardization.

Iwarsson, S., & Ståhl, A. (2003). Accessibility, usability and universal design - positioning and definition of concepts describing person-environment relationships. *Disability and Rehabilitation, 25*(2), 57-66.

Joshi, V. D., Malhotra, R., Lim, J. F., Ostbye, T., & Wong, M. (2010). Validity and reliability of the expectations regarding aging (ERA-12) instrument among middle-aged Singaporeans. *Annals of the Academy of Medicine Singapore, 39*(2), 394-398.

Kizony, R., Weiss, P. L. T., Shahar, M., & Rand, D. (2006). TheraGame: A home based virtual reality rehabilitation system. *International Journal on Disability and Human Development, 5*(3), 265-270.

LaMorte, W. W. (2016). *The social cognitive theory*. Boston University School of Public Health. Retrieved from http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories5.html

McGee, M. (2003). Usability magnitude estimation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 47(4), pp. 691-695. Thousand Oaks, CA: SAGE Publications.

Ng, T., Broekman, B. F. P., Niti, M., Gwee, X., & Kua, E. (2009). Determinants of Successful Aging Using a Multidimensional Definition Among Chinese Elderly in Singapore. *The American Journal of Geriatric Psychiatry, 17*(5), 407-416.

Rich, A., & McGee, M. (2004). Expected usability magnitude estimation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting.* 48(5), pp. 912-916. Thousand Oaks, CA: SAGE Publications.

Sarkisian, C. A., Steers, W. N., Hays, R. D., & Mangione, C. M. (2005). Development of the 12-Item Expectations Regarding Aging Survey. *The Gerontologist, 45*(2), 240-248. doi:10.1093/geront/45.2.240

Steinfeld, E., & Danford, G. S. (1999). Theory as a basis for research on enabling environments. In *Enabling Environments* (pp. 11-33). Boston, MA: Springer.

Svirbely, J.R. & Sriram, M.G. (2002). *The Medical Algorithms Project.* Retrieved from www.laterlifetraining.co.uk › 2011/12 › SF12_Scoring_Spreadsheet

Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure–ground organization. *Psychological Bulletin, 138*(6), 1172.

Ware Jr, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Medical Care*, 220-233.

CHAPTER V

CONCLUSION

Growing old in Singapore's current public housing poses both an environmental and social challenge for older housing residents. In contemporary social conditions, older Singaporeans are less likely to receive direct care from their family and may have to depend on the community for assistance, but barriers prevent older Singaporeans from accessing care within their immediate public housing neighborhood. Older Singaporeans are at risk of social isolation due to the lack of engaging, meaningful activity spaces that can be reached easily and safely from their own homes. Because they typically spend so much time alone in non-retrofitted, outdated public housing settings, older Singaporeans are vulnerable to environmental hazards that could potentially contribute to poor physical health. A new architectural strategy can help revitalize the existing unused space on the ground floor of public housing buildings, providing a place for older Singaporeans to stay engaged, and participate in community and wellness activities.

With the increasing demands' of an aging population in Singapore, the primary goal of this research was to develop an innovative prototype of community facilities (Health Springs) located at the ground floor of public housing buildings in Singapore. By increasing the opportunities for social, health and wellness activities, these multi-faceted wellness centers could potentially enrich the lives of older residents, and improve overall public health and well-being.

Because the research attempted to address the infrastructural demands of an aging Singaporean population by producing an architectural design solution, an exploratory sequential research method was used to guide the research. This method collected qualitative data in the beginning to inform later stages of the research which includes a quantitative assessment. This method enabled the researcher to develop a rigorous investigation of social, environmental, and behavioral factors that influences the interaction between older adults and the public housing environment, by comparing the findings from the different phases.

Meeting the Study's Aims and Significance

This study was structured into three phases with three broad aims: 1) analyze the contextual issues faced by older Singaporeans in public housing, 2) develop new design strategies for a proposed community facility (Health Springs) to address the needs of older adults and promote healthy aging in public housing, and 3) evaluate potential application of the Health Springs into public housing settings by measuring its likely use.

Aim One: Understand the Problem

Phase One used focus group discussions with 16 healthcare workers and 22 older adults to study the environmental challenges older adults experienced with functional activities in their homes (such as bathing, cooking, etc.), environmental and social issues related to caregiver assistance, and innovative design strategies that could alleviate environmental and social stressors. Phase One set out with three specific objectives:

1. Understand perceptions of P-E fit through the experience of users (older adults and caregivers) on aging in public housing, in relation to falls and habitual physical and social activity.

2. Understand current design issues, specifically the shortcomings of existing bathroom design strategies used in response to aging.

3. Explore alternative design and social features that promote healthy aging for the new community facility (Health Springs) located in public housing.

Phase One Findings

The findings from the focus group discussions and brief survey indicated a need to create opportunities that increased autonomy and health promotion, increased social connections (family and community), and improved environmental features for accessibility and safety. This study supported the social cognitive theory as outlined in Chapter Two, which emphasizes that health-seeking behavior is influenced by self-efficacy and social support (Bandura, 1977; Bandura & Walters, 1977). In this study, older adults' attitudes exhibited positive health-seeking behaviors to maintain their health, aligning with Bandura's theory of self-efficacy. The findings from the study's focus group discussions also indicated that support

from the family was not sufficient to enable older adults to age in place and social support needed to extend beyond the family structure.

Autonomy and Health Promotion

Functional autonomy was valued by older adults, who indicated in the brief survey that bathroom modifications and educational programs were preferred over caregiver assistance, as primary strategies to assist with fall prevention. The focus group discussions reiterated that both these preferred strategies afforded older adults more autonomy while engaging in functional activities, compared with needing assistance from a caregiver. Regarding health promotion, healthcare workers' reflected that opting for a community-based setting for new design strategies would provide the additional benefits of increased social interaction, enhanced mental wellbeing, and improved cognitive function. The research findings suggest that currently available prosthetic aids and home modifications cannot adequately support the autonomy of older adults in terms of their health-related behaviors. The findings align with existing literature on home modifications in Singapore that focuses on the physical functional ability of older adults, instead of providing a holistic strategy to cope with aging in place (MOH, 2016; P. Teo, 1997). The Health Springs intersects home safety features with health promoting activities and programs to provide older adults with greater choice and control over their health outcomes.

Family, Community, and Social Connections

The focus group discussions emphasized that for older adults to age in place successfully, the system of care needed to extend beyond the family structure. Family caregivers were often burdened with the lack of time, separate living arrangements, and inadequate training to attend to older adults' needs. The findings from the focus group discussions support the existing knowledge base on the changing social demographics in Singapore and the increasing burden of care on family members (W. K. M. Lee, 1999; G. Liu et al., 2015; Ramesh, 1992). Older adults were responsive to the idea of a community-based healthy aging facility. Some of their comments suggested that this proposed community setting for aging resonated with older adults' past experiences in village life, where their everyday interaction extended beyond the immediate family to the larger community.

Environmental Features for Accessibility, and Safety

The focus group discussions found that the configurations and spatial constraints of public housing units created additional challenges for caregivers and hindered their ability to provide assistance to older adults. This provides additional support to the existing literature, which found that physical features such as unsafe flooring and dim lighting can compound stress for older adults (Addae-Dapaah & Wong, 2001). Older adults and healthcare workers cited limited space within public housing units as a primary factor in fall prevention and caregiver assistance, while lack of accessibility was the main barrier to community resources such as existing senior activity centers. In discussing new social and design features for the proposed Health Springs, older adults tended to prioritize safety over privacy, typically choosing features that had a larger group setting; some mentioned that the benefits of a communal watch could reduce the likelihood of falls.

Aim Two: Create a Solution

Subsequently in Phase Two, design workshops with 12 healthcare experts incorporated the findings from Phase One into the design of the proposed Health Springs. The design workshops capitalized on the existing underused space of public housing ground floor to introduce new, safe, and more accessible means of fostering health promotion, social connections, and enhanced mental wellbeing for older adults living in public housing. Phase Two set out with two specific objectives:

1. Organize and review focus group information using an established design programming matrix ("Problem Seeking" by Pena & Parshall, 2012) to establish factors that promote healthy aging and potential use of the proposed Health Springs.

2. Explore a new typology of community facility by developing a 3D simulated model that represents the Person-Environment-Occupation interaction in the Health Springs and to test the overall acceptability of the 3D model.

Phase Two Findings

Phase Two used the theories of social ecological theory and design-based research to guide the research investigation. A primary strategy of social ecological theory is to use a multiple behavioral, organizational, and community planning perspectives to develop health

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promoting initiatives (Stokols, 1996). Phase Two achieved this by enlisting the help of an expert panel of healthcare professionals from a diverse background of geriatric and community care to assist with the planning of the proposed Health Springs. The "goal-oriented problem-solving activity" of design-based research through a reflective iteration process (Archer, 1970; Olsen & Heaton, 2010; Zeisel, 2006) was achieved through a series of design workshops.

The series of design workshops reflected both of these theoretical approaches, by synergizing the diverse perspectives of older adults and healthcare professionals to develop the concept of the proposed Health Springs integrated into the community of public housing buildings and testing the emerging results in reiterative cycles. This approach made it possible to develop and detail the design concepts for the proposed Health Springs, in ways that were grounded in the contextual needs of Singaporean older adults and healthcare professionals. The design workshops conceptualized six new meaningful activity spaces in the proposed Health Springs, that could be adapted into the ground floor of existing public housing buildings and engage older housing residents. These spaces consisted of a Garden Café, an Activity Room, an Exercise Pool, Therapy Pools, a Community Kitchen, and a Personal Care Room.

The Health Springs Conceptual Model

Using digital software, a photo-realistic virtual model of the envisioned Health Springs was developed to form a clearer mental image of how the ground floor of public housing buildings could be transformed and used to promote healthy aging, summarized in Figure V-1 below. The findings of the design workshops and preliminary survey aligned with the existing literature on the benefits of diverse social programs that foster higher levels of social interactions (Weintraub & Killian, 2007). The expert panel in Phase Two focused on issues that could potentially make the proposed Health Springs a highly usable facility in order to attract a diverse mix of housing residents from different age groups and promote opportunities for physical activity, social interaction, and mental wellbeing. This design-based method enabled this study to produce an architectural solution for real-life situations and provided strong support for the feasibility of the proposed Health Springs, and its potential to support healthy aging for older adults.
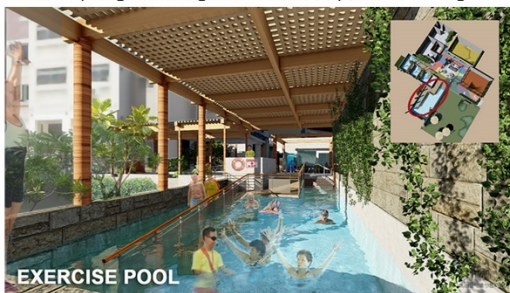
Figure V-1. A photo-realistic virtual model of the envisioned Health Springs demonstrating how the ground floor of public housing buildings could be transformed and used to promote healthy aging.

In the proposed Health Springs, the holistic collection of the six activity spaces were conceived to create dynamic levels of play between physical activities, social interactions, and activities that promote mental wellbeing. For example, at the Health Springs, after a yoga class at the Activity Room, older adults could get their lunch prepared according to their specific health needs and learn about dietary control at the Community Kitchen, while planning for a

dip in the Therapy Pools with friends and neighbors afterward. In another scenario, older adults could have lunch at the Community Kitchen, while overlooking the children's swimming class at the Exercise Pool, providing additional oversight to promote the overall safety of the Health Springs.

Spaces for informal learning at the Health Springs could present an inviting and accessible setting for older residents, to help them connect socially with residents of different ages, beyond their own biological family. Having a larger social network in the same housing estate can immeasurably improve quality of living for older adults and the overall community. With the conceived images of the proposed Health Springs, the exploration leading into Phase Three focused on investigating the potential usage of the space.

Aim Three: Evaluate the Health Springs

Through surveying about 270 housing residents, older adults, and design professionals, Phase Three studied the potential use of the Health Springs facility in public housing neighborhoods and how it is influenced by the overall perceived usability, expected health outcomes associated with usage, and the likely use of individual spaces and features. Phase Three was guided by three specific objectives:

1. Investigate the likely use of the proposed Health Springs.

2. Examine the relationships between perceived usability, expected health outcomes, and the likely use of individual spaces in the Health Springs with overall use of the Health Springs.

3. Compare the opinions of two population groups (housing residents and design/ planning professionals) regarding their opinions on the likely use of the proposed Health Springs.

Phase Three Findings

Phase Three used the evaluation model, the Reach, Efficacy, Adoption, Implementation, Maintenance (RE-AIM) model and social cognitive theory to guide the research investigation. In this investigation, the research connects perceived usability, expected health outcomes from using the proposed Health Springs, and likely use of individual proposed spaces to the potential demand for the proposed community facility for the purpose of improving future architectural design solutions. A search of existing architectural design-based research did not present

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previous studies connecting perceived usability, expected health outcomes, and use of individual spaces to the overall use of a proposed architectural design.

Evaluating the overall likely use of the proposed Health Springs, the results showed that the reach of the Health Springs was high with 81.2% of surveyed participants reported being likely to use the proposed Health Springs. The sample of survey participants represents diverse age groups ranging from 21 to 93 year olds, reflecting that the proposed Health Springs was acceptable to a diverse group of participants from different age groups – not only older adults. Of the total number of participants, 18.5% were older adults, 50.9% were housing residents, and 30.6% were design professionals. The gender distribution between participants were 46.3% males and 53.7% females. Likewise, participants' physical health status ranged from 12 to 20 points out of a total of 20, indicating that the activities in the proposed Health Springs was attractive to people from with different physical health status. The representativeness of participants fulfils the design workshop goal of developing a space of multi-use and function for a diverse group of housing residents, including younger working adults, older housing residents, men and women alike from with different physical health status. Regression analysis was conducted to study the relationships between the overall likely use of the proposed Health Springs and perceived usability, expected health outcomes, and likely use of individual spaces, while controlling for personal factors.

Perceived Usability

The overall perceived usability of the proposed Health Springs was rated relatively "Good" with a usability score of 67.6 out of 100. Generally, most participants perceived the proposed Health Springs as easy to use (76%), well integrated into the public housing neighborhood (81.5%), and they could imagine themselves using the proposed Health Springs at least once a week (69.1%). The study found that perceived usability of the Health Springs was strongly significant in predicting the overall likely usage of the proposed Health Springs ($p < .0001$). Defining efficacy expectations as the belief in one's abilities to meet certain levels of performance (Bandura, 2004), the survey findings were generally consistent with the researcher's theoretical framework based on Bandura's theory of self-efficacy, where greater levels of self-efficacy (confidence) lead to higher levels of performance (the likely use of the

Health Springs). The findings also confirmed Rich and McGee's expectations of usability (the ease of use and lack of hazards) as a main factor in influencing user's perception of using the actual product (Rich & McGee, 2004). To ensure that the proposed design concept of the Health Springs matched the possible end user experience, perceived usability scores between older adults, housing residents, and design professionals were compared for similarities. One possible measure to foster similar usability scores between design professionals and older adults would be to involve end users during the planning and design of other similar facilities targeting healthy aging.

Expected Health Outcomes

The descriptive statistics of participants' anticipation for improved health outcomes in relation to physical activity, social interactions, and mental wellbeing associated with the proposed Health Springs indicated the strongest anticipated improvements to be in mental wellbeing with a mean score of 14.6 out of 20 (M= 14.6, SD= 3.02). Regression analysis conducted on expected health outcomes predicting the likely use of the proposed Health Springs showed that expectations toward improvements in physical activity (p=.003) are significant in predicting likely use of the Health Springs. These findings align with Bandura's social cognitive theory of outcome expectations, where expected outcomes act as motivators that encourage individuals to modify their behavior to produce positive results. In this case, the anticipation of improved physical activity seemed to be a motivating factor for participants' likely use of the Health Springs. Furthermore, the findings suggest that implicit design details which convey opportunities for improvements to physical activity and mental wellbeing could encourage greater use of new facilities that promote healthy aging in Singapore.

Likely Use of Individual Spaces

Of the six individual spaces, the likely use of the Garden Café (p= .0007) and Personal Care Room (p= .009) were significant in influencing the overall likely use of the proposed Health Springs, suggesting that the Garden Café and Personal Care Room are spaces that could be most feasibly adapted into public housing settings. When designing a community facility at the ground floor of public housing buildings, the inclusion of a Garden Café and a Personal Care Room could attract more older adults and housing residents to use the space compared to the

other proposed programs. A Garden Café and a Personal Care Room could alter the way older adults and housing residents use and perceive the existing ground floors of public housing buildings.

The survey findings indicated that the design of the proposed Health Springs had an acceptable level of usability and could support participants' expectations towards improvements in their physical activity, and mental wellbeing. The overall findings suggest that the design of the proposed Health Springs could bring a new symbolic meaning to the ground floor of public housing buildings and could provide the housing community with the resources to improve aspects of their lifestyle pertaining to healthy aging.

Integrated Interpretation of the Findings and Implications for Practice

As a concluding step in the mixed-method research, this chapter conducted a cross analysis of information collected from the three sequential phases to form an integrated interpretation of the findings. Because each phase of the exploratory sequential research was structured upon findings from the previous phase, a summation of the individual phases' findings is needed to extract the main lessons of the whole study.

Table V-1 demonstrates the sequential relationship of the three phases' aims and findings, as well as the integrated interpretation. In attempting resolve each phase's specific aims and achieve the research's main goal of developing a proposed healthy aging community facility at the ground floor of public housing buildings (Health Springs), two main understandings emerged from the overall investigation: perceived usability and spaces designed with Law's Person-Environment-Occupation dynamics.

Perceived Usability

In designing a community facility to promote healthy aging, a few recurring issues were discussed throughout the discourse of the three phases, namely, importance of accessibility, safety, and usefulness to older adults. Through comparing and analyzing the findings from all three phases, it became apparent that the measure of perceived usability can be used as a broad 'litmus test' at the design stage of any future healthy aging facility, to assess these three issues.

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Accessibility

In Phase One, there was a need for greater access to community resources for older adults. As a solution in Phase Two, the ground floor location of public housing buildings was a proposed site for the Health Springs and a collection of diverse activity spaces was developed in close proximity, to promote mobility and accessibility. The final phase utilized the Systems Usability Scale (SUS), an overall measure of perceived usability, to assess whether participants felt the proposed Health Springs would be well integrated into the neighborhood, and if they would use the proposed Health Springs at least once a week.

Safety

During the focus group discussions, older adults and healthcare workers highlighted space constraints and social isolation as limiting factors in caregiver assistance. As a solution in the design workshops, the Health Springs provided a communal setting that broadened the of space for eldercare beyond the constraints of the individual home and included the support of a communal watch. Also, in Phase Three, the SUS tool was used to measure whether participants felt the Health Springs presented minimal environmental hazards, if they found the Health Springs unnecessarily complex, and if they needed the support of a caregiver to use the space.

Usefulness

As a new type of community facility that aims to engage older adults in meaningful, health-promoting activities while fostering greater social connections in their public housing neighbourhood, the proposed Health Springs intends to be culturally relevant to a wide range of potential users. Phase Three assessed the overall likelihood of using the proposed Health Springs, with 81.2% of participants reporting they were likely to use the space. The SUS tool also assessed whether participants felt the proposed Health Springs would be easy to use, and if they felt confident about the idea of using the space.

Expectation of usability is a main factor in influencing users' perception of the actual usability of a product (Rich & McGee, 2004). Hence, the measure of perceived usability is a tool that could help healthcare architects and planners broadly estimate the potential levels of accessibility, safety, and usefulness in a facility design from the users' perspective. The novel

use of perceived usability on an architectural design in the planning stage can be complemented with a post occupancy evaluation to encourage greater evidence-based design.

Designing with the Person-Environment-Occupation Framework

The primary goal of the research was to promote healthy aging for older Singaporeans living in public housing, through creating a space that facilitated informal learning and opportunities to improve possible health outcomes. As an overarching theoretical model introduced in Chapter One, the Person-Environment-Occupation framework was used to guide the structure of the research. Law's Person-Environment-Occupation framework had an additional dimension of "occupation" added to Lawton's person-environment fit theory. Including the function of meaningful activity in the original person-environment fit model creates "the dynamic experience of a person engaged in purposeful activities and tasks within an environment" (Law et al., 1996) pg. 16). Hence, in comparing the findings through all three phases, the Person-Environment-Occupation framework was critical in creating meaningful health-promoting spaces that allowed a dynamic interaction between physical activities, social interactions, and activities for mental wellbeing.

Expected Health Outcomes

Older adults in the focus groups expressed motivation to seek health-promoting activities to cope with the changes related to aging. In Phase Two, coordinated collective of diverse, multi-functional spaces was developed to provide opportunities for improving physical activity, social interaction, and mental wellbeing. The Phase Three results indicated that participants' expectations of improvements in their physical activity and mental wellbeing were significant in predicting likely usage of the Health Springs.

Informal Learning

In the focus groups, older adults expressed interest in informal learning environments with friends and family, to help gain insight on various aspects of aging. During the design workshops, the spaces of the Health Springs were proposed as casual settings to promote education and exchange of ideas through common interests. The final survey results indicated this point, through participants' expressed interest in using the Garden Café and a Personal Care Room – that may promote the physical, social, and mental aspects of healthy aging

through increasing everyday access to nature and the shared experiences of physiotherapy and hydrotherapy sessions. From a cross analysis of the findings, this study identified a three-pronged approach that healthcare architects and planners can use as a holistic strategy to conceive meaningful spaces that are likely to engage older adults. Enlisting older adults in the participatory planning stage to identify needs, utilizing the Person-Environment-Occupation framework to develop spatial programs, and measuring expected health outcomes to predict likely use of a space will help healthcare architects collect rich ethnographic data during the early stages of design and streamline the design focus.

Based on the cross analysis of the findings as shown in Table V-1, the measure of perceived usability, the Person-Environment-Occupation framework, and the measure of expected health outcomes are recommended as additional parameters to be considered by healthcare architects and planners when developing healthy aging facilities during the design and planning stage.

Table V-1.
Cross Analysis and Integration of Findings.

Phase One Focus Group Discussions	Phase Two Design workshops	Phase Three Surveys	Integrated Interpretation
Qualitative	*Qualitative*	*Quantitative*	
Environmental Features, Safety, and Accessibility			**Perceived Usability**
1. Participants reported limited space in public housing units as a challenge to functional activities, fall prevention, and caregiver assistance.	1. Focused on integration of proposed Health Springs into existing ground floor of public housing by implementing housing grid layout and connecting with the existing community garden and fitness corner at the ground floors for expansion of larger event space.	1. 81.2% of participants were likely to use the Health Springs. The mean perceived usability score is 67.6 out of 100, which is considered relatively good. In examining perceived usability predicting the overall likely use of the proposed Health Springs: 76% of participants found the Health Springs easy to use (p<.0001) and 58.7% of participants felt the proposed Health Springs design presented minimal environmental hazards (p<.0001).	The measure of perceived usability was a litmus test for the design of a healthy aging community facility that was safe, accessible, and useful to older Singaporeans living in public housing. Accessible: There was a need for greater access to community resources for older adults. As a solution, the ground floor location of public housing buildings was a proposed site for the Health Springs and a collection of individual spaces were suggested to enhance proximity. The final phase used the Systems Usability Scale (SUS) to measure whether participants felt the proposed Health Springs were well integrated into the neighborhood.
2. Older adults and healthcare workers cited accessibility as an environmental barrier to existing senior activity centers.	2. Located the proposed Health Springs near elevator cores for accessibility and established proximity between activity zones and relaxation areas.	1. 81.5% of participants found the proposed Health Springs well integrated into the public housing neighbourhood (p= .002). 69.1% of participants felt they would use the Health Springs at least once a week if located at the ground floor of public housing buildings (p<.0001).	Safety: Space constraints limited caregiver assistance. As a solution, the Health Springs provided a communal setting that afforded expansion of space for eldercare beyond the constraints of the home and the support of a communal watch. The SUS tool was used to measure whether participants felt the Health Springs presented environmental hazards.
3. Older adults cited the benefits of a communal watch to improve fall prevention and were willing to compromise some privacy for safety.	3. Increased the visibility within the proposed Health Springs by using column bays and railings instead of walls to demarcate spaces. Created spaces for informal	3. 56.8% of participants did not feel the need for caregiver support to use the Health Springs (p= 0.32) and 61.6% of participants did not feel the proposed design of the	

Table V-1. *Continued*
Cross Analysis and Integration of Findings.

Phase One Focus Group Discussions	Phase Two Design workshops	Phase Three Surveys	Integrated Interpretation
	learning that included more community involvement and openness of information accessibility. Integrated the staff care area with a food kiosk to re-structure volunteer and educational spaces without resembling hospital care.	Health Springs was complex (p<.0001).	Usefulness: As a new type of community facility that aimed to support healthy aging in public housing, the proposed Health Springs intended to be culturally relevant to a wide range of potential users. Phase Three measured the overall likely use of the proposed Health Springs with 81.2% of participants likely to use the space.
Autonomy and Health Promotion			**Person-Environment-Occupation Places**
1. Fear of falls motivated older adults to seek health-promoting activities that enabled them to cope with physiological changes related to aging. Both older adults and healthcare workers showed a strong preference for spaces that incorporated plants and greenery.	1. Design workshops proposed environmental features and social activities that targeted the engagement of older adults' physical capabilities and dexterity. Incorporated proposed design features that used natural landscaping (such as plants and water elements) to develop a unique design characteristic for the proposed Health Springs and create opportunities for access to nature and reduce stress.	In examining expected health outcomes predicting the overall likely use of the proposed Health Springs: 1. Anticipated improvements to physical activity was strongly significant (p= 0.003) and anticipated improvements to mental wellbeing was somewhat significant (p= 0.08). Expected health outcomes accounted for 11% of the variance in predicting likely use of the Health Springs, suggesting design details that create opportunities for improvements to physical activity and mental wellbeing will encourage greater use of community facilities that promote healthy aging in public housing buildings.	Creating meaningful health-promoting spaces that allows a dynamic interaction between physical activities, social interactions, and activities for mental wellbeing is achieved through Law's model of the Person-Environment-Occupation framework. Expected health outcomes: Older adults from the focus groups expressed motivation to seek health-promoting activities to cope with the changes related to aging. The Phase Three results indicated that participants' expectations of improvements in their physical activity and mental wellbeing were significant in predicting likely use of the Health Springs. Informal learning: Older adults from the focus groups sought an informal learning
2. Participants preferred educational programs and	2. Proposed activities were designed to be culturally relevant	2. General descriptive results on participants' likely use of	environment to gain insights on aspects

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Table V-1. *Continued*
Cross Analysis and Integration of Findings.

Phase One Focus Group Discussions	Phase Two Design workshops	Phase Three Surveys	Integrated Interpretation
environmental modifications compared to caregiver assistance as they afforded older adults the ability to retain their functional autonomy.	to increase sense of ownership and belonging for older Singaporeans. Six new individual spaces were proposed to feature in the Health Springs design at the ground floor of public housing buildings. Results of preliminary test's conceptual images perceived to support healthy aging (% Very Much): Garden Café: 76% Activity Room: 65% Exercise Pool: 35% Therapy Pools: 42% Community Kitchen: 69% Personal Care Room: 47%	individual spaces (% extremely & moderately likely): Garden Café: 77.2 Activity Room: 80.4 Exercise Pool: 63.1 Therapy Pools: 77.5 Community Kitchen: 68.6 Personal Care Room: 77.1 Out of the six individual spaces, the likely use of the Garden Café (M= 2.04, SD= 0.70, p= .0007) and Personal Care Room (M= 2.11, SD= 0.75, p= .009) are significant in predicting the overall likely use of the proposed Health Springs.	of aging with friends and family. The proposed spaces of the Health Springs targeted education and exchange of ideas through common interests in a casual setting. The survey results indicated that in participants' possible interest in potential use of the Garden Café, Personal Care Room, and Therapy Pools which may promote aspects of healthy aging.

Table V-1. *Continued*
Cross Analysis and Integration of Findings.

Phase One Focus Group Discussions	Phase Two Design workshops	Phase Three Surveys	Integrated Interpretation
Family, Community, and Social Connections			
1. Family caregivers were often burdened with the lack of time, separate living arrangements, and inadequate training to attend to older adults' needs. For older adults to age in place, the system of care needed to extend beyond the family. Healthcare workers and older adults preferred a community-based setting to reap the additional benefits of increased social interactions with friends and family, improved mental wellbeing and cognitive function.	1. Design workshops proposed spaces that encouraged social interactions with people who had similar interests or groups of friends. Adaptable and flexible spaces were created for programs to expand into large event activities areas and encourage use at different times. Activity types that encouraged multi-generational use were proposed. Results from preliminary test for perceived intergenerational use (mean score upon 16): Exercise Pool (12.13), Therapy Pools (11.95), Activity Room (11.8), Garden Café (11.74), Personal Care room (11.32), Community Kitchen (10.86)	1. The mean score for total expected improvements to social interactions was 14.58 out of 20. When predicting improvements to older adults' health, participants felt older adults' social interactions (M= 7.59, SD= 1.64) would improve the most compared to physical activity (M= 7.29, SD= 1.60) and mental wellbeing (M= 7.35, SD= 1.74).	

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Limitations of the Study and Future Research

While this research developed the proposed Health Springs as a possible strategy to support healthy aging in Singapore's public housing, a limitation of the study was the contextual focus on Singapore's cultural setting. The specific nature of public housing in Singapore limited the study's ability to test for generalizability to other urban settings. In this research, the overall method of investigation was sectioned into three main parts, starting with an ethnographic study, followed by two stages of design review and evaluation that critically analyzed the findings from the first part of the study. Future research for healthy aging in other urban settings could adapt the methods used in the study to develop a similar, culturally relevant community facility that supports sustainable, meaningful, and mindful aging in place strategies.

A limitation of overall study was the premise that the measurements for likely use of the proposed Health Springs and their relationships to perceived usability, expected health outcomes, and likely use of individual spaces were based on a theoretical simulation instead of a tangible built project. While the study serves as a preliminary measure for predicting likely use for future intervention in public housing neighborhoods, the accuracy of the measurements would improve with a built project. Future explorations of the relationship between likely use, perceived usability, expected health outcomes, and likely use of individual spaces for the Health Springs could involve a post-occupancy evaluation for comparison of results.

A significant finding of the study was the impact of perceived usability, expected improvements in health outcomes (physical activity and mental wellbeing), and likely use of the Garden Café, Personal Care Room, and Therapy Pools on the overall likely use of the Health Springs. However, the study was limited in testing the generalizability and repeatability of the findings. Based on the cross analysis of the findings, this research recommends the measure of perceived usability, Person-Environment-Occupation framework, and the measure of expected health outcomes as additional design parameters to be considered by healthcare architects and planners when designing future healthy aging facilities.

Summary

This study took a sequenced, exploratory, design-based approach to understand the challenges older Singaporeans faced while living in public housing. Through exploring perceived

environmental and social barriers, this project developed the concept of the Health Springs wellness center - a new type of community facility to be introduced at the underutilized ground floor space of public housing buildings that could improve and maintain the quality of life for older housing residents.

The data collected from the focus group sessions was highly valuable to the research as it presented an environmental and phenomenological context and holistic appreciation of an older person's life experiences. At each phase of its development, the research was evaluated in a reiterative manner by the key stakeholders who might conceivably be involved in the future design, health planning, and potential use of this type of facility: older adults, healthcare workers and experts, housing residents, and design professionals.

From the focus group discussions, three overarching topics of 1) Autonomy and Health Promotion, 2) Family, Community, and Social Connection, and 3) Environmental Features, Accessibility, and Safety guided the design workshops. In Phase Two, a conceptual 3D model of a potential facility design that could respond to the three identified needs of older adults was developed within the ground floor setting of a public housing building. The proposed Health Springs was a collection of six diverse, multi-functional spaces that encouraged the dynamic interactions of physical activities, social interactions, and activities for mental wellbeing.

With the conceived images of the proposed Health Springs, the exploration leading into Phase Three focused on investigating the potential use of the space. Through a survey assessment, the findings indicated that the design of the proposed Health Springs had an acceptable level of usability and could support participants expectations towards improvements in their physical activity, and mental wellbeing.

Through the exercise of exploratory, design-based investigation, the research's theoretical contribution to architectural methodologies is establishing the connection between the measures of the overall likely use of a space, perceived usability, expected health outcomes, and the likely use of individual spaces. Developing novel methods of measuring potential use of a space and its influencing factors related to usability and health outcomes at the conceptual stage of design, this study has explored the possibilities for future planning

considerations that could improve the quality of both the design and design process of future healthcare projects.

The main real-world contribution of this research is the conceptual development of the Health Springs wellness center, intended to address the issues of aging in Singapore's public housing. By taking advantage of the unoccupied areas that typically exist at the ground floor of public housing buildings, these multi-function wellness centers could be developed cost-effectively and administered by the housing authorities that currently manage the buildings, with assistance from local volunteers. The Health Springs centers could be designed in response to the specific conditions of different buildings and neighborhoods, with residents of all ages participating in the planning process and possibly involved in the future operations. This new approach to community wellness could potentially provide a focal point for residents, help reshape the public's perception of spaces for older adults, and forge unique identities of individual public housing buildings. Above all, these easily accessible centers could become a life-sustaining resource for socially isolated older adults, helping to improve their physical and mental wellbeing, in a context responsive to the local climate and cultural traditions.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143-164.

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1): Prentice-hall Englewood Cliffs, NJ.

Law, M., Cooper, B., Strong, S., Stewart, D., Rigby, P., & Letts, L. (1996). The person-environment-occupation model: A transactive approach to occupational performance. *Canadian Journal of Occupational Therapy, 63*(1), 9-23.

Lee, W. K. M. (1999). Economic and social implications of aging in Singapore. *Journal of Aging & Social Policy, 10*(4), 73-92. doi:10.1300/J031v10n04_05

Liu, G., Yap, P., Wong, G. H., Wei, H. X., & Hua, E. C. (2015). Day care centers for seniors in Singapore: looking back and looking ahead. *Journal of the American Medical Directors Association, 16*(7), 630. e637-630. e611.

MOH. (2016). *I feel young in my Singapore: Action plan for successful aging*. Retrieved from Singapore: https://sustainabledevelopment.un.org/content/documents/16269Action_Plan_for_Successful_Aging.pdf

Ramesh, M. (1992). Social security in Singapore: Redrawing the public-private boundary. *Asian Survey, 32*(12), 1093-1108.

Rich, A., & McGee, M. (2004). *Expected usability magnitude estimation.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.

Teo, P. (1997). Space to grow old in: The availability of public spaces for elderly persons in Singapore. *Urban Studies, 34*(3), 419-439.

Weintraub, A. P. C., & Killian, T. S. (2007). Intergenerational Programming: Older Persons' Perceptions of Its Impact. *Journal of Applied Gerontology, 26*(4), 370-384. doi:10.1177/0733464807302671

APPENDIX A
BRIEF SURVEY AT FOCUS GROUPS

"FALL SAFETY AND NEW BATHING EXPERIENCES"
(Brief survey to be filled out before Focus Group session)

Your Age: _____   **Gender:**   M   /   F

Have you had a fall before? *(Circle your response)*

Yes *(Location):* _____   No

How much do you worry about falling?

Very Much _____   Somewhat _____   Not Much _____   Not at All _____

How helpful are the following in preventing falls at home? *(Use a check ✓)*

	Very Helpful	Somewhat Helpful	Not at all Helpful
Home safety features (E.g. grab bars, pullcords etc.)			
Live-in caregiver			
Fall prevention program for home safety			
Home visit from trained therapist			

EXAMPLE BATHROOM WITH FALLING HAZARDS

Check any of the items that apply to your home.

☐ 1. Presence of unsafe bath rugs   ☐ 6. Slippery tub (lack of bath mat, etc.)
☐ 2. Lack of grab bars in the shower area   ☐ 7. Raised edge at shower area
☐ 3. Clutter   ☐ 8. Lack of bath chair in the shower area
☐ 4. Lack of grab bars near the toilet   ☐ 9. Wet floor
☐ 5. Toilet is too high or low   ☐ 10. Dim lighting

Other _____
Adapted from Home Safety Self Assessment Tool

Would you like to try a new type of bathing experience that combines: *(Check any or all ✓)*

Spa _____   Water Aerobics _____   Massage _____   Jacuzzi _____

Aromatherapy _____   Physiotherapy _____   Sauna _____

Would you be comfortable bathing at a spa with people of the same gender?

Very comfortable _____   Somewhat comfortable _____   Not at all comfortable _____

Do you ALREADY use any of the following to prevent falls at home? *(Circle your response)*

Joined a fall prevention program for home safety	Have home safety features (E.g. grab bars, pullcords etc.)	Have a live-in housemaid for full time personal care
Have home visits from trained therapist	None of these	Others: (please specify)

Do you get help for the following activities? *(Circle the best answer)*

ACTIVITIES	I CAN DO IT ON MY OWN (**WITHOUT** supervision, direction or personal assistance.)	I DO THIS WITH HELP (**WITH** supervision, direction, personal assistance or total care.)
BATHING	I bathe on my own or I may get some help in reaching my back or legs.	Someone helps me with bathing most of my body, getting in or out of the tub/shower.
DRESSING	I can get my clothes from my closet and drawers. I can dress myself.	Someone helps me with dressing.
TOILETING	I can use the toilet without help.	Someone helps me with going to the toilet and cleaning myself.
GETTING OUT OF BED OR FROM SEATING	I can move in and out of bed or chair without help. I may use a walker or grab bar to get up.	Someone helps me with moving in and out of bed or chair.
CONTINENCE	I have control of my bladder and bowel.	I have partial control with my bladder or bowel.
EATING	I can feed myself without help.	Someone helps me with eating.

Adapted from the Katz Index of Independence in Activities of Daily Living

Who do you live with? *(Check all that apply ✓)*

By myself _____ With my spouse _____ With my children _____ With siblings _____
With relatives _____ Others (please specify) _____

What type of housing are you living in? *(Circle the best answer)*

1. Studio apartment   2. HDB Flat (1-2 room)   3. HDB Flat (3-4 room)
4. HDB Flat (5 rooms and above/HUDC/Executive)   5. Others (please specify) _____

Who helps you in taking care of your medical conditions or personal care? (Check all that apply ✓)

Spouse _____ Children/in-laws _____ Helper_____ Others (please specify) _____

Which ethnic group do you belong to? (Check one ✓)
Chinese _____ Malay _____ Indian _____ Others (please specify) _____

APPENDIX B

VISUAL CUES OF ENVIRONMENTAL HAZARDS AT HOME

VISUAL CUES OF HEALTH SPRINGS IDEA BOARD

Health Springs Wellness Center Ideas Board

1) Outdoor
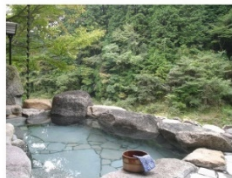
2) Outdoor

3) Family Space

4) Group Space

5) Indoor

6) Indoor

7) Water Aerobics

8) Physiotherapy

9) Bath Bench

10) Bath Beds

11) Massage

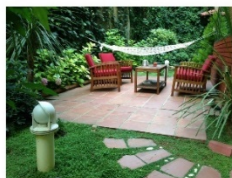12) Foot Massage

13) Seated Shower

14) Private Shower

15) Sauna

16) Aromatherapy

17) Care Station

18) Garden

19) Grooming

?

PHASE TWO VISUAL SURVEY WITH HEALTHCARE PROFESSIONALS

H E A L T H   S P R I N G S

Promoting Health through a New Community Spa Experience

This research project is exploring the possibility of new type of amenity for residential estates.

The purpose of the Health Springs Community Spa is to reduce falls and promote a **"healthy aging" lifestyle - where seniors stay physically and mentally healthy and are actively engaged longer.**

Health Springs centers are places for personal care, safe recreational bathing, physical activity, and social interaction under one roof.

These new amenities will be located at existing HDB buildings at the void deck and adjacent outdoor areas.

We'd like to know your ideas about this!

Thanks!
Jinting

PS – This should take only 10-15 minutes. Please use the "previous" and "next" buttons to navigate – if you accidentally use your browser's "back" button, you can re-enter by clicking the original link, and your answers will reappear when you return.

V I S U A L   S U R V E Y

Geriatric Education & Research Institute

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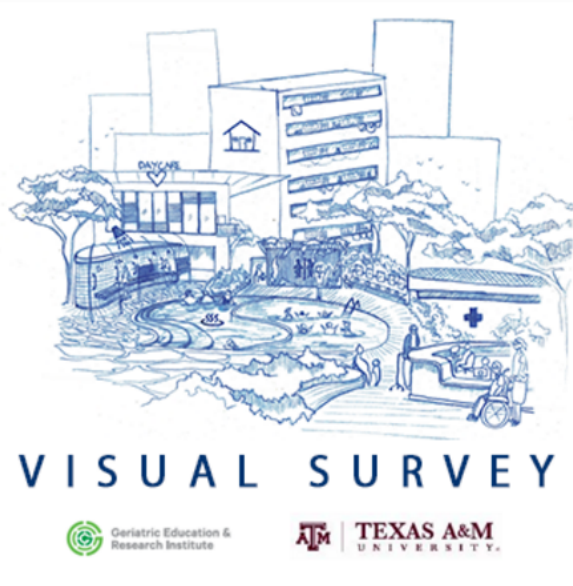
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Consent to Participate

-**You are invited because** you are a healthcare staff, caregiver, or volunteer who helps older adults in bathing functions and/or are familiar with elderly spatial usage in the bathroom at home or in a healthcare setting.

-**This study aims to recruit** 30-50 participants from March to April 2017.

-**This study will ask** your opinion on fall safety and new approaches to bathing experiences for seniors.

-**If you take part in this study, you will be asked to fill out a short survey**. The survey will ask for your demographic information and a few questions related to the proposed Health Springs Community Spa. If you choose not to answer any question, you may skip the question. If at any point you choose to quit the survey, you may simply close the browser.

-**No identifiable information will be obtained** in connection with the survey. Your answers will not be traced back to you. The results of the survey will be published in student projects or discussed in conference, but no information will reveal your identity

AUTHORIZATION:
I voluntarily consent to take part in this research study. I have fully discussed and understood the purpose and procedures of this study. This study has been explained to me in a language that I understand. I have been given enough time to ask any questions that I have about the study, and all my questions have been answered to my satisfaction.

If "No" is selected, participant will be directed to end of

Yes   ○

No   ○

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Tell us more about yourself!

○ Male

○ Female

Age:

○ 18 - 24   ○ 45 - 54

○ 25 - 34   ○ 55 - 64

○ 35 - 44   ○ 65 or older

Have you participated in the previous focus group sessions regarding Health Springs project?

○ Yes

○ No

Are you involved in providing care/looking after an older adult? *(Older adult refers to person aged over 65years old)*

○ Yes

○ No

If you look after an older adult, what is your relation to them? *(Check all that apply)*

☐ Spouse   ☐ Parent-in-laws

☐ Parents   ☐ Others/Not applicable [   ]

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Could you tell us about your living arrangements? *(Check all that apply)*

☐ By myself

☐ With my spouse

☐ With my children

☐ With my parents *(Please indicate age)*
[_____]

☐ Others/Not applicable [_____]

How much do YOU worry about older adults falling at home?

Very much	Quite a bit	A little	None at all	Not applicable
○	○	○	○	○

For this survey, which type of experience will you mainly base your answers on? *(Check all that apply):*

☐ Direct personal experience

☐ Professional experience

☐ Others
[_____]

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SITE CONTEXT: Possible location of Health Springs next to HDB void deck.

LOCATION

The proposed Health Springs would be located at the void deck of HDB estates, near existing garden and fitness corners.

How convenient do you think this location would be for older adults?

○ Very much

○ Quite a bit

○ A little

○ None at all

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ACTIVITY SPACES

Based on earlier focus groups and design workshops with older adults and healthcare workers, the following spaces* and programs are proposed:

1. Garden Café
2. Activity/ Learning Room
3. Exercise Pool
4. Therapy Pools
5. Community Kitchen
6. Personal Care Room
7. Bathing/ Changing Room

*Additional spaces would include restrooms, staff/ volunteer kiosk, etc.

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GARDEN CAFE

The Garden Café is a partly shaded outdoor area for sitting, eating, socializing, and other activities, such as gardening.

How useful would the Garden Cafe be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Garden Cafe support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Garden Cafe?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

ACTIVITY/LEARNING ROOM

The Activity/ Learning room is a multi-purpose area for activities such as classes, yoga,
tai chi, childcare, exercise, etc., led by residents or volunteers.

How useful would the Activity/Learning room be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Activity/Learning room support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Activity/Learning room?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

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EXERCISE POOL

The Exercise Pool can be used for individual exercise, or low-impact physical classes for about 20-25 people.

How useful would the Exercise Pool be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Exercise Pool support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

Do you think plants and greenery would encourage people to use the Exercise Pool?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Exercise Pool?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

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THERAPY POOLS

Therapy Pools can be used by individuals or small groups, for fun or rehabilitation, with jacuzzi, hot/cold water, etc.

How useful would the Therapy Pools be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Therapy Pools support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

Do you think plants and greenery would encourage people to use the Therapy Pools?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Therapy Pools?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

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COMMUNITY KITCHEN

The Community Kitchen allows residents to cook together, share food and socialize.

How useful would the Community Kitchen be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Community Kitchen support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Community Kitchen?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

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PERSONAL CARE

The Personal Care room can be used for massages, pedicures, acupuncture, hair styling, physiotherapy, etc., by residents, volunteers, or professionals.

How useful would the Personal Care room be for older adults?

Very much	Quite a bit	A little	Not at all
○	○	○	○

How well would the Personal Care room support healthy aging?

Very much	Quite a bit	A little	Not at all
○	○	○	○

In your opinion, how likely do you think the following groups would use the Personal Care room?

	Very Much	Quite a bit	A little	Not at all
Older adults (65 years and older)	○	○	○	○
Children (18 years and younger)	○	○	○	○
Myself/Adults (Between ages 19-64)	○	○	○	○

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Fully lit ceiling for adequate lighting

Movable ceiling mounted shower head to reduce wall clutter

Windows for additional daylighting

Flip up handrails to allow for more space for personal assistants

Screened windows for ventilation

Flip up shower seat to accommodate older adults' different physical needs

Special floor material for anti slip and fast drying properties

Swing-out sink to assist older adult independece

The Bathing/ Changing room would have specially-designed features to help caregivers and maximize independence and safety, while helping to prevent falls in older adults.

How well would the Bathing/Changing room support healthy aging?

Very much	Quite a bit	A little	None at all
○	○	○	○

Could seeing and/or using new bathing equipment and layouts help raise awareness on how to reduce the risk of falling at home?

Very much	Quite a bit	A little	None at all
○	○	○	○

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SAFETY AND ACCESSIBILITY

The Health Springs would have healthcare workers and volunteers to monitor the safety of therapy and exercise pools. **Do you think having a community watch would increase older adults' usage of the pools facilities?**

Very much	Quite a bit	A little	None at all
○	○	○	○

Handrails, ramps and staircrawls will allow older adults of different functional ability to use the therapy and exercise pools. **Do you think the provision of safety aids would increase older adults' usage of the pools facilities?**

Very much	Quite a bit	A little	None at all
○	○	○	○

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Overall, do you think these spaces/programs support the Health Springs' purpose to encourage and raise awareness for healthy aging in the community?

	Very much	Quite a bit	A little	Not at all
Garden Cafe	○	○	○	○
Activity/Learning Room	○	○	○	○
Exercise Pool	○	○	○	○
Therapy Pools	○	○	○	○
Community Kitchen	○	○	○	○
Personal Care Room	○	○	○	○
Bathing & Changing Room	○	○	○	○

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Thank you for your feedback! ☺
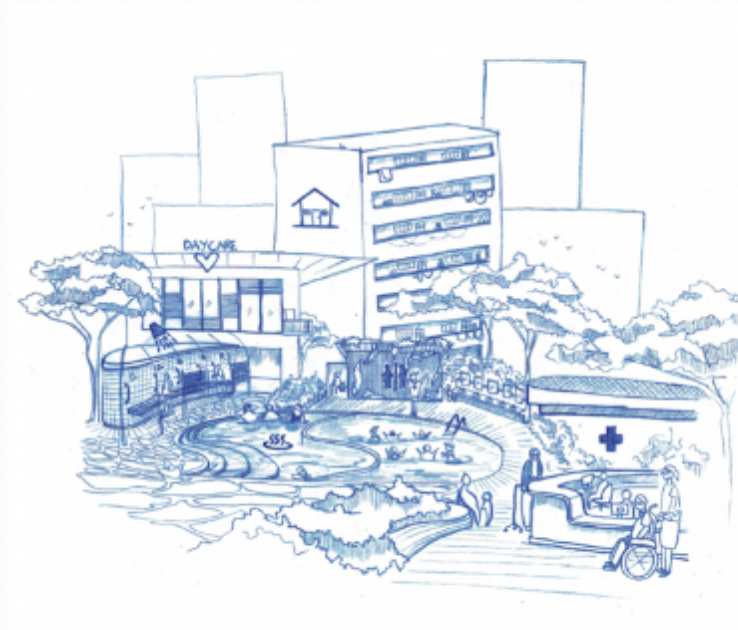
If you have any questions or additional input, please contact me!

Jinting Lee
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Texas A&M University
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Email: leejinting@tamu.edu

Please Click "NEXT" to submit your feedback and exit.

Please click "PREVIOUS" if you need to review your answers.

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APPENDIX E

SURVEY FOR HOUSING RESIDENTS, OLDER ADULTS, AND

DESIGNERS/PLANNERS
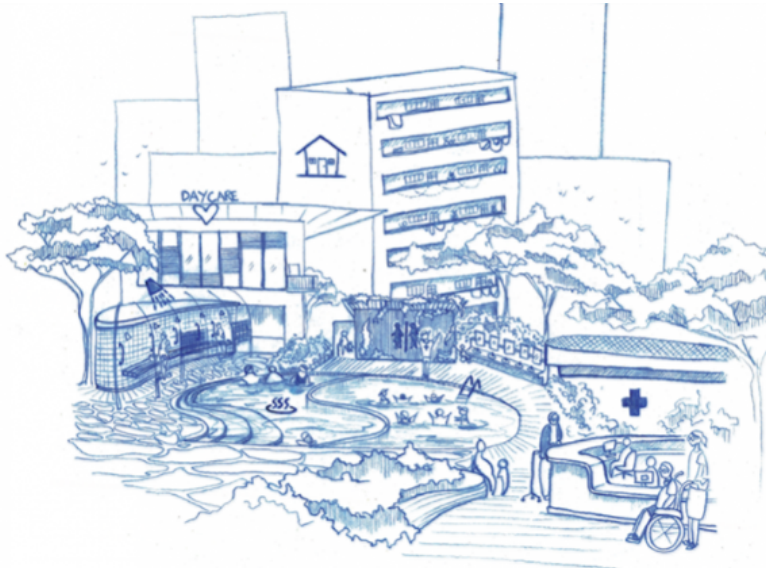
You Are Invited
to an Optional
V I S U A L   S U R V E Y
"New Approaches to Aging in Your Neighbourhood"

Hello! My name is Jinting Lee, and I am doing a study with Texas A&M University. The purpose is to learn about your **opinions on new approaches to healthy aging, wellness and social support in your community.** This research project is exploring the possibility of new type of amenity for residential estates.

You were selected to get viewpoints from different people. Everything you say is confidential. **Results will help design future communities; not change the place you live now.**

Could you give us a few minutes of time, to improve our study? You do not need any special knowledge or information. We'd like to know your ideas about this!

Thanks!
Jinting Lee   Chek Hooi Wong,
Principal Researcher   Principal Investigator
Texas A&M University   Geriatric Education and Research Institute
College of Architecture   Singapore

PS – This should take only 15-20 minutes. Please use the "previous" and "next" buttons to navigate – if you accidentally use your browser's "back" button, you can re-enter by clicking the original link, and your answers will reappear when you return.

Consent to Participate

-**You are invited because:**

             1) You are a resident in Singapore.

             2) You are a resident of a HDB community

             3) You are aged 21 or more

-**This study aims to recruit** 300-380 participants from April 2018 to June 2018.

-**This study will ask** your opinion on how you perceive yourself or a loved one aging in your current community and new ways to **encourage healthy aging, mobility, safety and social support** for future seniors. You can base your answers on your personal concerns or your concerns for a loved one.

-**If you take part in this study, you will be asked to fill out a short survey**. The survey will ask for your demographic information and a few questions related to the idea of a Health Springs Community Spa. If you choose not to answer any question, you may skip the question. If at any point you choose to quit the survey, you may simply close the browser.

-**No identifiable information will be obtained** in connection with the survey. Your answers will not be traced back to you. The overall results of the survey will be used in student projects or discussed in conference, but no information will reveal your identity

AUTHORIZATION:
I voluntarily consent to take part in this research study. I have fully discussed and understood the purpose and procedures of this study. This study has been explained to me in a language that I understand. I have been given enough time to ask any questions that I have about the study, and all my questions have been answered to my satisfaction.

                  Yes   No

                  ◯   ◯

Please let us know **which year** you were born

(Enter a 4 digit number)

[   ]

In general, would you say your health is...

Excellent	Very good	Good	Fair	Poor
○	○	○	○	○

The following items are about activities you might do during a typical day. **Does your health now limit you in these activities? If so, how much?**

	Yes, limited a lot	Yes, limited a little	No, not limited at all
Moderate activities (e.g moving a table, pushing a vacuum cleaner or bowling)	○	○	○
Climbing several flights of stairs	○	○	○

During the past 4 weeks, have you had any of the following problems with your work or other regular activities **as a result of your physical health?**

	Yes	No
Accomplished less than you would like	○	○
Were limited in the kind of work or other activities	○	○

During the past 4 weeks, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

Not at all	A little bit	Moderately	Quite a bit	Extremely
○	○	○	○	○

These questions are adapted from the SF-12 Health Survey

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Expectations Regarding Aging

Please check ONE box that best matches how you feel about EACH statement.
If you are not sure, check the box that you think BEST match your feelings.

	Definitely true	Somewhat true	Somewhat false	Definitely false
1. When people get older, they need to **lower their expectations** of how healthy they can be.	O	O	O	O
2. The human body is like a car: **when it gets old, it gets worn out.**	O	O	O	O
3. Having more aches and pains is an **accepted part of aging.**	O	O	O	O
4. Every year that people live, their **energy levels** go down a little more.	O	O	O	O

	Definitely true	Somewhat true	Somewhat false	Definitely false
5. I expect that as I get older **I will spend less time** with friends and family.	O	O	O	O
6. **Being lonely** is just something that happens when people get old.	O	O	O	O
7. As people get older, they **worry more.**	O	O	O	O
8. It is **normal to be depressed** when people get old.	O	O	O	O

	Definitely true	Somewhat true	Somewhat false	Definitely false
9. I expect that as I get older I will become **more forgetful.**	O	O	O	O
10. It's an expected part of aging to have **trouble remembering names.**	O	O	O	O
12. It is impossible to escape the **mental slowness** that happens with aging.	O	O	O	O

Expectations Regarding Aging Survey (ERA-12) (Sarkisian, 2005)

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Let's talk about your living arrangements!

Which of the following are reasons for you to **age in place**? *(Check all that apply)*

☐ You want to be able to live independently

☐ Your home is located in a good neighbourhood

☐ You've invested financially in your home

☐ Your home meets all your needs

☐ You cannot afford to move

☐ Other

[   ]

☐ You want to stay close to friends or family

What do you think are some **challenges** you might face in your home as you get older. *(Check all that apply)*

☐ Risk of falling

☐ Lack of adequate home safety (e.g. emergency pullcords, grab bars)

☐ Inability to perform daily activities by yourself (e.g shopping, driving, bathing, eating)

☐ Being far from necessary services

☐ Loss of mobility and moving around

☐ Other

[   ]

☐ Social isolation

What do you think are the biggest **challenges** your neighbourhood will face in dealing with an aging population in the next five years? *(Check all that apply)*

☐ Lack of sufficient health care access

☐ Lack of conveniently located gathering spaces

☐ Lack of convenient public transportation

☐ Lack of social organizations that supports older adults' needs

☐ Lack of emergency services

☐ Other

[   ]

To help you maintain the way you live as you get older, how important are the following items? *(Check all that apply)*

	Very important	Somewhat important	A little important	Not important at all
Physical activities	O	O	O	O
Social activities	O	O	O	O
Part-time/Volunteer work	O	O	O	O
Family or spouse support	O	O	O	O
Home modifications (e.g emergency pullcords, grab bars)	O	O	O	O
Neighbourhood development (e.g lift upgrades, covered walkways, ramps)	O	O	O	O
Community resources (e.g daycenters, community centers)	O	O	O	O

How important is **access** to each of the following items as you get older?

	Very important	Somewhat important	A little important	Not important at all
Physical activities	O	O	O	O
Social activities	O	O	O	O
Part-time/Volunteer work	O	O	O	O
Family or spouse support	O	O	O	O
Home modifications (e.g emergency pullcords, grab bars)	O	O	O	O
Neighbourhood development (e.g lift upgrades, covered walkways, ramps)	O	O	O	O
Community resources (e.g daycenters, community centers)	O	O	O	O

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Now let's look at a NEW concept!

The **Health Springs Community Spa is an open-air center** that allows residents to bond in different activity areas, promoting health and wellness programs in a natural, kampung-like setting.

The Health Spring Community Spa could be **located at the HDB void deck.**

SITE CONTEXT: Possible location of Health Springs next to HDB void deck.

Activities in the Health Springs Center

Based on earlier focus groups and design workshops with older adults and healthcare workers, the following spaces* and programs are proposed:
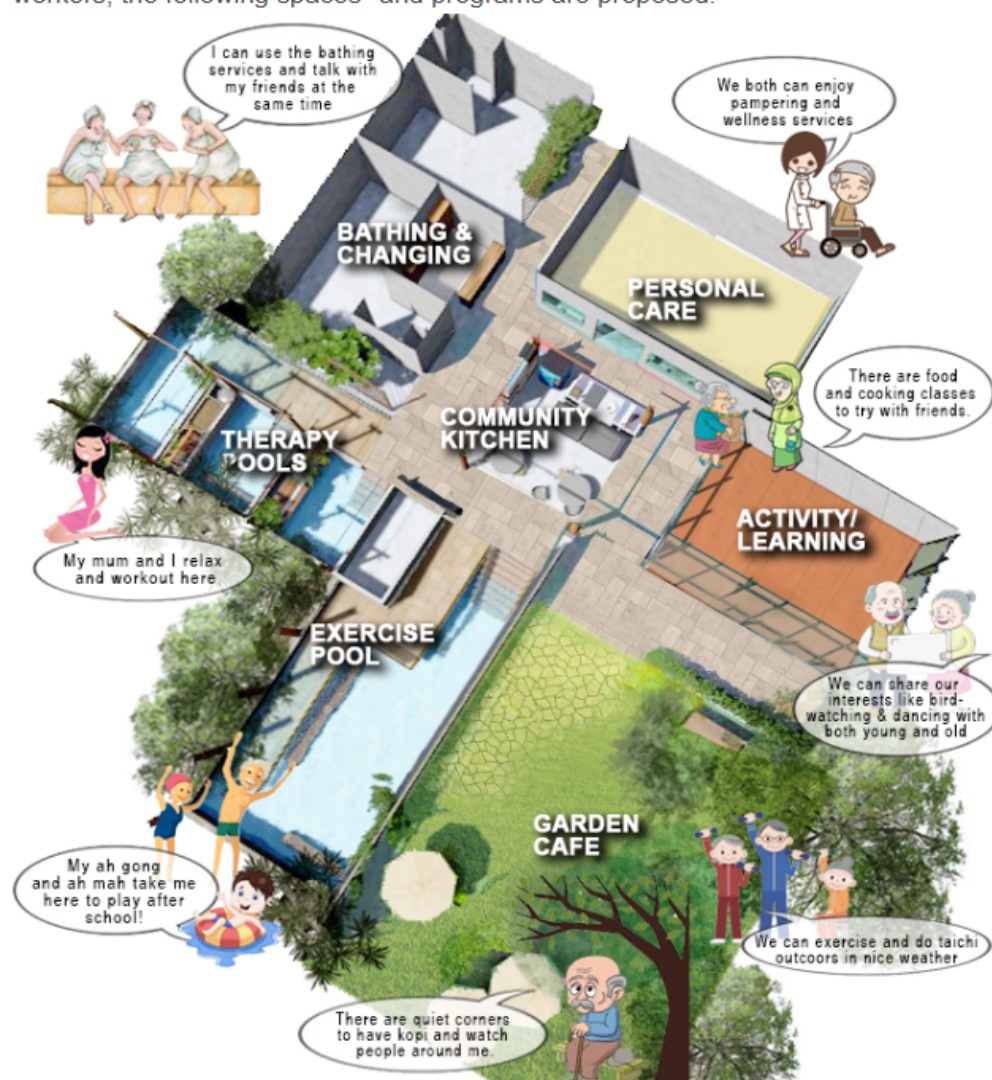
1. **Garden Café** a partly shaded outdoor area for eating and other activities like gardening

2. **Activity/ Learning Room** a multi-purpose area for classes, tai chi, childcare etc., led by residents or volunteers

3. **Exercise Pool** used for low-impact physical classes or children swimming, monitored by trained safety volunteers

4. **Therapy Pools** used for fun or rehabilitation, with jacuzzi, hot/cold water, etc., monitored by trained safety volunteers

5. **Community Kitchen** allows residents to cook together and share food

6. **Personal Care Room** used for massages, acupuncture, physiotherapy by older adults, residents, volunteers, and caregivers

7. **Bathing/ Changing Room** with specially-designed features to maximize independence and safety

Usability of the Health Springs

Please check ONE box that best matches how you feel about EACH statement.
If you are not sure, check the box that you think BEST match your feelings.
Adapted from System Usability Scale (Brooke, 1986)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. I think that I would like to use the Health Springs **frequently**	O	O	O	O	O
2. I find the Health Springs **unnecessarily complex**	O	O	O	O	O
3. I think the Health Springs would be **easy to use**	O	O	O	O	O
4. I think that I would **need the support of a caregiver** to be able to use the Health Springs	O	O	O	O	O
5. I find the various facilities in the Health Springs are **well integrated**	O	O	O	O	O

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6. I think there is **too much conflicting features** in the Health Springs	O	O	O	O	O
7. I imagine that **most people will learn** to use the Health Springs very quickly	O	O	O	O	O
8. I find the Health Springs will **not be compatible** to use	O	O	O	O	O
9. I would feel very **confident** to use the Health Springs	O	O	O	O	O
10. I need to learn a lot of things **before** I can going with the Health Springs	O	O	O	O	O

Overall, how likely would **you use the Health Springs** as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
O	O	O	O

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Expected Health Outcomes

Adapted from the Credibility/Expectancy Questionnaire (Devilly, 2000)

With the Health Springs Center in your neighbourhood, how much **improvement** to **YOUR** overall health do your feel will occur?

Not at all				Somewhat				Very much	
1	2	3	4	5	6	7	8	9	10

Your physical activity

Your social interactions

Your mental wellbeing

With the Health Springs Center in your neighbourhood, how much **improvement** do you think will occur in the **elderly's** overall health?

Not at all				Somewhat				Very much	
1	2	3	4	5	6	7	8	9	10

Physical activity

Social interactions

Mental wellbeing

GARDEN CAFE

The Garden Café is a partly shaded outdoor area for sitting, eating, socializing, and other activities, such as gardening.

How likely would you **take part** in activities at the Garden Cafe as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
O	O	O	O

As you get older, how likely would you **use** the Garden Cafe if...

	Extremely likely	Moderately likely	A little likely	Unlikely/ Not at all
It is **located at the ground floor** of your building	O	O	O	O
It is **near other services**	O	O	O	O
There are **plants and greenery**	O	O	O	O
There is volunteer program to **support safety**	O	O	O	O

How likely do you think the following **groups** would use the Garden Cafe?

	Extremely likely	Moderately likely	A little likely	Unlikely/ Not at all
Older adults (65 years and older)	O	O	O	O
Adults (Between ages 19-64)	O	O	O	O
Children (18 years and younger)	O	O	O	O

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ACTIVITY/LEARNING ROOM

The Activity/ Learning room is a multi-purpose area for activities such as classes, yoga, tai chi, childcare, exercise, etc., led by residents or volunteers.

How likely would you **take part** in activities at the Activity/Learning room as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
○	○	○	○

As you get older, how likely would you **use** the Activity/Learning room if...

	Extremely likely	Moderately likely	A little likely	Unlikely/ Not at all
It is **located at the ground floor** of your building	○	○	○	○
It is **near other services**	○	○	○	○
There are **plants and greenery**	○	○	○	○
There is volunteer program to **support safety**	○	○	○	○

How likely do you think the following **groups** would use the Activity/Learning room?

	Extremely likely	Moderately likely	A little likely	Unlikely/ Not at all
Older adults (65 years and older)	○	○	○	○
Adults (Between ages 19-64)	○	○	○	○
Children (18 years and younger)	○	○	○	○

EXERCISE POOL

The Exercise Pool can be used for individual exercise, guided low-impact physical classes or children swimming lessons for about 20-25 people. The Exercise Pool is monitored by trained safety volunteers.

How likely would you **take part** in activities at the Exercise Pool as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
O	O	O	O

As you get older, how likely would you **use** the Exercise Pool if...

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
It is **located at the ground floor** of your building	O	O	O	O
It is **near other services**	O	O	O	O
There are **plants and greenery**	O	O	O	O
There is volunteer program to **support safety**	O	O	O	O

How likely do you think the following **groups** would use the Exercise Pool?

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
Older adults (65 years and older)	O	O	O	O
Adults (Between ages 19-64)	O	O	O	O
Children (18 years and younger)	O	O	O	O

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THERAPY POOLS

Therapy Pools can be used by individuals or small groups, for fun or rehabilitation, with jacuzzi, hot/cold water, etc. The Therapy Pools are monitored by trained safety volunteers.

How likely would you **take part** in activities at the Therapy Pools as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
O	O	O	O

As you get older, how likely would you **use** the Therapy Pools if...

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
It is **located at the ground floor** of your building	O	O	O	O
It is **near other services**	O	O	O	O
There are **plants and greenery**	O	O	O	O
There is volunteer program to **support safety**	O	O	O	O

How likely do you think the following **groups** would use the Therapy Pools?

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
Older adults (65 years and older)	O	O	O	O
Adults (Between ages 19-64)	O	O	O	O
Children (18 years and younger)	O	O	O	O

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COMMUNITY KITCHEN

The Community Kitchen allows residents to cook together, share food and socialize.

How likely would you **take part** in activities at the Community Kitchen as you get older?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
O	O	O	O

As you get older, how likely would you **use** the Community Kitchen if...

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
It is **located at the ground floor** of your building	O	O	O	O
It is **near other services**	O	O	O	O
There are **plants and greenery**	O	O	O	O
There is volunteer program to **support safety**	O	O	O	O

How likely do you think the following **groups** would use the Community Kitchen?

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
Older adults (65 years and older)	O	O	O	O
Adults (Between ages 19-64)	O	O	O	O
Children (18 years and younger)	O	O	O	O

PERSONAL CARE

The Personal Care room can be used for massages, pedicures, acupuncture, hair styling, physiotherapy, etc., by residents, volunteers, caregivers or professionals while other activities are ongoing.

How likely would you **take part** in activities at the Personal Care room as you get older?
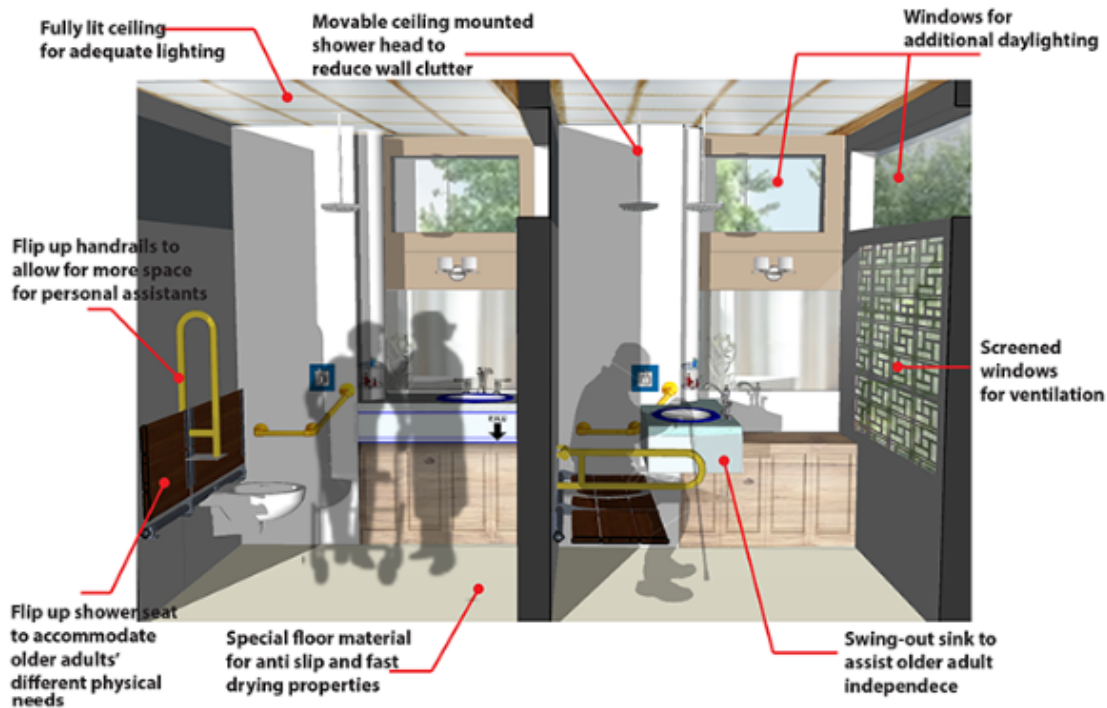
Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
○	○	○	○

As you get older, how likely would you **use** the Personal Care room if...

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
It is **located at the ground floor** of your building	○	○	○	○
It is **near other services**	○	○	○	○
There are **plants and greenery**	○	○	○	○
There is volunteer program to **support safety**	○	○	○	○

How likely do you think the following **groups** would use the Personal Care room?

	Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
Older adults (65 years and older)	○	○	○	○
Adults (Between ages 19-64)	○	○	○	○
Children (18 years and younger)	○	○	○	○

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Fully lit ceiling for adequate lighting

Movable ceiling mounted shower head to reduce wall clutter

Windows for additional daylighting

Flip up handrails to allow for more space for personal assistants

Screened windows for ventilation

Flip up shower seat to accommodate older adults' different physical needs

Special floor material for anti slip and fast drying properties

Swing-out sink to assist older adult independece

The Bathing/ Changing room would have specially-designed features to help caregivers and maximize independence and safety, while helping to prevent falls in older adults.

The semi-open design will allow for health volunteers and other users to look out for each other.

Could seeing and/or using new bathing equipment and layouts help raise awareness on how to **reduce the risk of falling at home**?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
○	○	○	○

Would you consider **modifying** your home bathroom based on the design of the Bathing/Changing room to reduce the risk of falls?

Extremely likely	Moderately likely	A little likely	Unlikely/Not at all
○	○	○	○

Tell us more about yourself!

	Male	Female
	○	○

What is your **ethnic group?**

- ○ Chinese
- ○ Malay
- ○ Indian
- ○ Others [_____]

What is your highest level of **education**?

- ○ Primary education
- ○ Secondary education
- ○ Polytechnic education
- ○ Tertiary education
- ○ Others [_____]

Tell us which **housing estate** do you live in *(Please select from the options below)*

[_____ ▼]

Thank you for your feedback! ☺
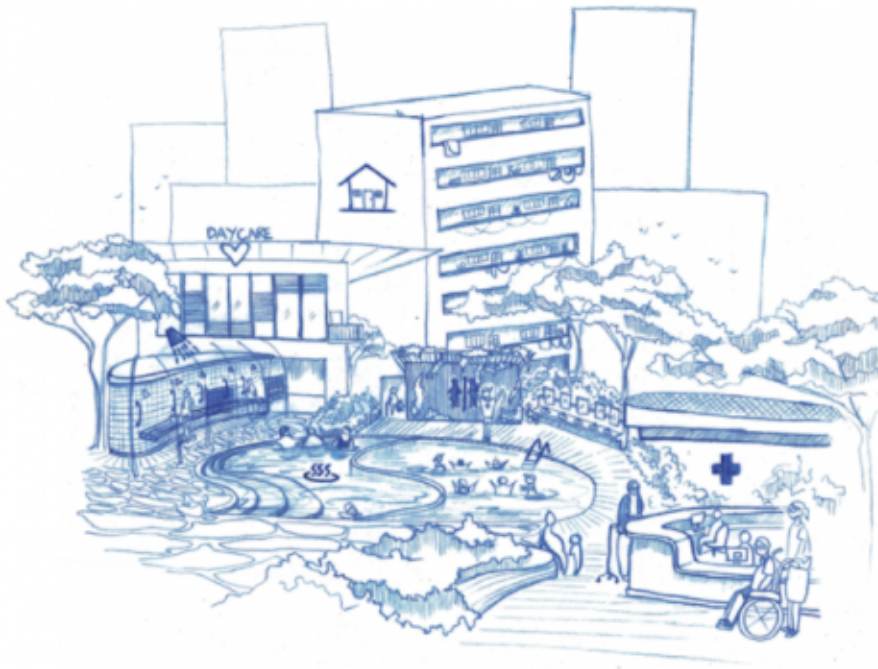
If you have any questions or additional input, please contact me!

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