

Critical Barriers of Smart Home Technologies (SHTs) to the Elderly in Hong Kong

Abstract

Similar to other developed economies, Hong Kong also faces a severe ageing-related problems. Considering the ageing-in-place initiative to enhance the safe living of the elderly population in their familiar living environments, the use of SHTs has been proposed and employed. Meanwhile, there are challenges that may impede the purpose of developing SHTs by the elderly. Therefore, this paper investigated the barriers of SHTs to the elderly in Hong Kong, determined the critical ones and further categorized into manageable size. Based on the various analyses conducted, the characterization of the critical barriers of SHTs to the elderly in Hong Kong are cost and knowledge barrier, personal concern, and uncertainty barrier. The study provides recommendations to manufacturers of SHTs, the organisations where the senior adults worked before retirements, families of the elderly, the government and the seniors that could help to improve and enhance the ageing-in-place (AIP) in Hong Kong.

Keywords: Smart home technologies, ageing-in-place, elderly residents, Hong Kong

Introduction

During the past few decades, the life expectancy in most developed countries has increased dramatically (Majumder et al., 2017). This improvement was primarily attributed to significant advancement in medical sciences and diagnostic technology, the rising awareness about personal and environmental hygiene, health, nutrition, education, and better social care services (Kalache and Gatti, 2003; Kulik et al., 2014; Thomas et al., 2001; World Health Organisation, 2012). In recent years, ageing-in-place (AIP) has also been denoted as contributing to improved quality of life, better health outcomes, etc., of the elderly (Morris et al., 2012; WHO, 2012). In fact, the gerontologists revealed that psychological trauma of the elderly can be reduced through AIP (Heumann and Boldy, 1993; WHO, 2012). AIP is a concept that allows the elderly to remain living in the locality they are familiar with to allow them to have a sense of belonging and optimum security (Bailey and Sheehan, 2009). It is worthy to note that the majority of the elderly in most countries embraced AIP concepts in the various surveys conducted (Basaraba, 2016; Judd et al., 2010). However, to ensure successful AIP policy implementation, addressing some vital issues that could guarantee the safety of the elderly is essential.

Considering the advocacy for AIP, which allows the elderly to live in their wished locality with certain level of independence (Rowles, 1993; Judd et al., 2010; WHO, 2011), some avoidable problems may persist. For instance, as seniors advance in age, their health deteriorates, and physical weakness sets in (Tieland et al., 2018; Shimada et al., 2018). The frailty in the physical structures of the elderly has led to several incidences with regrettable outcomes such as death (Mehmood et al., 2019; Stevens, 2005). Some lives of the seniors could have been salvaged if there had been timely medical interventions. Therefore, the use of smart home technologies (SHTs) has been reported as an assistive measure to aid AIP. In fact, there has been a barrage of scholarly articles that indicated a keen interest in SHTs to ensure the safety, and independently living of older adults at home. Some of the SHTs are specially designed to ensure that the healthy living of the elderly and the opportunity to receive quick medical attention in case of emergency (Yang et al., 2014; Pigini et al., 2017). On the

other hand, there are challenges that could make the essence of acquiring SHTs unachievable on the part of older adults, thereby putting them at risk (Guhr et al., 2020; Arthanat et al., 2020). Thus, understanding the perceived barriers of the elderly on the use of SHTs would help to achieve AIP and guarantee their safety and quick medical attention in case of emergency.

A comprehensive literature review on AIP and challenges in the use of SHTs was conducted. A questionnaire was designed to elicit the opinions of the elderly in HKSAR, China, on the barriers to the use of SHTs in a face-to-face structured survey. Afterwards, the data collected were analysed with descriptive and inferential statistics. Thereafter, the research findings and practical recommendations were discussed.

Ageing-in-Place (AIP) and Challenges of Using Smart Home Technologies (SHTs)

Although AIP enables seniors to maintain independence and autonomy while keeping connections with family and friends (Keeling, 1999; Lawler, 2015), the elderly can encounter certain challenges since they are getting physically weak. Their health and safety-related concerns are often at risk due to common and chronic diseases (e.g., cancer, heart disease, diabetes, and arthritis), sensory impairment, immobility, and chronic obstructive pulmonary disease (Lee et al., 2013; Garçon et al. 2016). Falls have been the main cause of death of the elderly living in their own homes (Demiris et al., 2004; Ng, 2017), and the physical, environmental, and behavioural factors largely contribute to this (Garçon et al., 2016).

As the concept of “AIP” is regarded as the best way to deal with ageing, there are some concerns over the safety of elderly people who live alone in their homes. For example, there have been a series of incidents reported over the past few years, including deaths of the elderly in Hong Kong, which could have been avoided if their homes had been equipped with certain assistive technologies. According to the Department of Health and the Census and Statistics Department, in 2015, there were a total of 255 deaths for those aged 65 or above due to injuries from falls, with 44% having occurred at home (Ng, 2017). On July 26, 2015, an 84-year-old disabled senior who was confined to a wheelchair was found dead with his 61-year-old son-in-law, who was the sole carer for the senior in their flat. Police believed that the sole carer may have died a few days earlier, and his father-in-law may have died about one or two days afterwards; since the father-in-law appeared gaunt and to have possibly starved to death (Chan and Siu, 2015). On February 27, 2017, an elderly Hong Kong woman suffered burn injuries in her Tung Chung flat, and a 69-year-old woman who rendered a helping hand was severely burnt as she attempted to quench the fire (Lo, 2017). On September 16, 2016, mid-Autumn lanterns sparked a fire in a flat, and this led to the hospitalization of two women aged 82 and 85 that lived in the flat (Lo, 2016). On December 28, 2015, an elderly woman fell and died in a public housing flat in Tin Shui Wai when hanging her laundry outside the window, in which the police opined that the incident was caused by a loss of balance (Ejnsight, 2015). On December 06, 2017, an 87-year-old man died, and 40 people were evacuated during a fire incident from an electric cooker (Lo, 2017).

With these incidents, the public has begun to question why elderly people in their homes are unsafe (Ngo, 2015). Meanwhile, other countries have also experienced similar incidents as Hong Kong. For instance, in Taiwan, on April 01, 2017, an elderly, who lived alone, fell and finally died after two days (Liberty Times Net, 2017). On June 01, 2017, an accident almost occurred when an elderly forgot to turn off the gasoline stove and went to bed; luckily, his neighbours had reported to the fire department before any fatal accident occurred (Lam, 2017). As the ageing population continuously grows, the relevant authorities should be prepared to

prevent these types of accidents if the government policy of AIP is to be implemented successfully. Especially, issues related to acceptance and usage of SHTs that can facilitate AIP by the elderly are of prior importance.

In past studies, Demiriz and Hensel (2008) explored the ethical considerations associated with smart home applications for patients at the end of life. The studies revealed privacy and confidentiality, informed consent, autonomy, etc., are the key issues with using SHTs. Earlier studies have identified different social, economic, safety and privacy issues for using SHTs. For example, safety issues included system failure during emergencies (Judge et al., 2009), increased risk of tripping on the misaligned carpet (Davenport et al., 2007), the possibility of incorrect dosage taken by older adults but not recorded (Tang et al., 2011) and concerns regarding the functioning of SHTs during a power outage (van Hoof et al., 2011). Balta-Ozkan et al. (2013) highlighted social barriers such as control, security, and cost for installing SHTs. Privacy and security of the transmitted data were reported as main barriers for installing and using SHTs (Courtney, 2008; Courtney et al., 2008; Majumder et al., 2017).

According to the study of Arthanat et al. (2020), limited or lack of knowledge of the elderly is a fundamental barrier to the use of SHTs in most cases. This is due to the less ownership and exposure to electronic devices by the elderly compared to the younger and middle-aged counterparts (Pew Researcher Center, 2017; Arthanat et al., 2018). Thus, understanding the profile of end-users are fundamental in designing technological devices (Venkatesh et al., 2003; Macedo, 2017). The elderly are also confronted with challenges that surround the usability of the SHTs (Arthanat et al., 2020). This is a situation in which the family of the elderly could afford SHTs, or the senior could purchase the device, but the complexity of using it is an impediment. Thus, while the technical capabilities of SHTs are considered by the manufacturer, the affective benefits and values of the older adults must be put into consideration as well (Lee and Coughlin, 2015; Holzinger et al., 2007). In the study of Pal et al. (2019), the impediments to adopting SHTs by the elderly hovers around service-specific characteristics, end-users related barriers and environmental characteristics.

In various studies, the financial concern of acquiring SHTs by the elderly has been largely debated (Li et al., 2021), because of limited monetary capability. The use of SHTs is linked with different protocols and connection requirement (Gonçalves et al., 2021). In fact, the cost of maintaining the SHTs has been reported as another challenge that hinders the wide acceptance of SHTs by the elderly (Lê et al., 2012). It is important to note that it implies that the cost commitments of acquiring SHTs include the cost of purchasing, installation cost, maintenance cost and running cost (Lê et al., 2012; Pal et al., 2019; Nikou, 2019). Thus, making cost-related challenges vital. Some seniors are more concerned about the infringement that SHTs could cause to their private life above other impediments (Guhr et al., 2020; Balta-Ozkan et al., 2014). On the other hand, the lack of understanding of the elderly on the benefits of the SHTs is revealed in the perceived fears documented in the literature (Townsend et al., 2011; Wilson et al., 2017). It, therefore, implies that educative programmes, training, and public enlightenment campaign are essential drivers to ensuring wide acceptance of SHTs by the elderly.

Research Methodology

Selecting the appropriate research design for a study is vital (Kothari and Garg, 2014; Ketchen et al., 2018), as it helps to determine if single or multiple source respondents are suitable for the investigation (Flynn et al., 2018). This research, therefore, adopted a survey research design

to investigate the barriers of SHTs to the elderly in Hong Kong. The survey design approach also assists in obtaining a large response from the target respondents (Ojo et al., 2020). The elderly households living in public housing (e.g., Public Rental Housing - PRH, Home Ownership Scheme - HOS and Tenants Purchase Scheme - TPS) and private sector housing were the target group. Based on the stratified random sampling method, a total of 201 face-to-face structured questionnaires drafted in both Chinese and English language were conducted in both public and private sectors, with the aim of obtaining the elderly' perception on the application of SHTs in their dwellings and the perceived barriers to the usage. As the elderly are mentally and physically relatively weak with low literacy, a face-to-face structured questionnaire survey is considered appropriate compared to a survey distributed via online platforms or postal (Herzog and Rodgers 1988). The other advantage is that the content of the survey could be explained to the elderly in a face-to-face questionnaire survey, which often boosts the response rate, although this approach is time-consuming and hence relatively costly. An easy-to-understand questions (with larger font size) questionnaire were designed for the elderly for easy comprehension and response. Prior to the distribution of the questionnaire, a pilot test was conducted with three older adults with a sound understanding of Chinese and English language to ensure the accuracy and the reliability of questions and to ensure that the elderly respondents understood the survey questions explicitly. The suggestions from the pilot study respondents were used to improve the final questionnaire. The final questionnaire comprised of three sections: (a) Demographic information, (b) perception on SHTs, and (c) the barriers of SHTs sourced from extant literature.

Data Analysis and Results

Based on the 201 questionnaires retrieved from the elderly, 43.8 per cent were male, and 56.2 per cent were female. The majority of the respondents were over 60 years of age, only 10 per cent aged between 51 to 60 years. Most of the respondents (72.6 per cent) were married, 10 per cent were single, widowed (11.9 percent), divorced (3 per cent), and 2.5 per cent were separated. Over 50 per cent of the respondents lived in rented private housing, 32.3 per cent lived in owned private houses, while others lived in public housing. The educational level of the elderly was also obtained, the majority (72.1 per cent) had "below primary" education, 3.0 per cent had primary school education, 23.9 per cent had secondary school education, and only one respondent had diploma certificate. Most of the elderly had lived in their present apartment for over 10 years, only 36.8 per cent had lived below 10 years in their current apartment. In their current apartment, 12.4 per cent indicated that they lived alone, 36.8 per cent lived with 1 to 2 people in the same apartment, while others lived with 3 or more people.

The survey also investigated if any SHTs were installed in time past in their apartment; only 14.9 per cent indicated that SHTs were installed in their homes. To further investigate if the SHTs were functioning as at the time of conducting the survey, only 9 per cent revealed that the SHTs in their apartments are still working perfectly. The elderly was also asked if they had heard of SHTs in time past, 65.7 per cent indicated 'yes', while 34.3 per cent had not heard of SHTs before.

Factor Analysis

According to Hills (2011), conducting an adequacy test of a dataset is the first and crucial part of the consideration in factor analysis. In this study, the Kaiser-Mayer-Olkin (KMO) of 0.822 at a significant level of 0.000 was obtained, and this implies that the Bartlett's Test of Sphericity for correlation adequacy between the variables was significant. The KMO

explained that 82.2 per cent of the data gathered were adequate and further explained the suitability of the collected data and its factorability (Hadi et al., 2016). The p-value obtained was <0.5 at the degree of freedom (df) of 78 and chi-square value of 1079.920 implies that all the barriers will significantly be correlated at 5% confidence level, and therefore, exploratory factor analysis is appropriate (Table 1).

In the analysis, varimax rotation (eigenvalue – 1 cut off) was adopted. This is important to establish the principal components that constitute each generated factor (Field, 2005). To generate the critical factors, the barriers with a factor loading of 0.5 were only considered satisfactory. Three barriers ‘*I am concerned about infringing into my individual privacy (B9)*’, ‘*it is exclusive to tenants, elderly, computer illiterate and people living in older properties (B10)*’, and ‘*I feel it is not necessary (B8)*’ with a factor loading of 0.385, 0.465, and 0.468 respectively were considered unsatisfactory; therefore, they were deleted. This approach was adopted in several studies to determine the important items that constitute a factor (Ojo et al., 2021; Okoro et al., 2020). The reliability of the dataset was also checked to determine the internal consistency of the factors formed (Pallant, 2011). The three α values generated were 0.778, 0.791, and 0.797, respectively. These α values are well above 0.6, and thus, they were considered satisfactory (Hair et al., 2010).

Table 1: First Factor Analysis of Barriers of Smart Home Technologies to the Elderly

Barriers	Mean	SD	R	Components			Alpha
				1	2	3	
B1- High cost of repair and maintenance	3.94	0.70	1	0.833			0.784
B2- The installation cost is high	3.91	0.72	2	0.780			
B3- I have no or limited knowledge about the devices	3.86	0.80	3	0.665			
B12- Technology devices are not reliable	3.55	0.87	12	0.576			
<i>B9- I am concerned about infringing into my individual privacy</i>	<i>3.58</i>	<i>0.75</i>	<i>9</i>	<i>0.385</i>			
B14- Smart home will disrupt my desired daily routine	3.41	0.86	14		0.720		0.829
B16- Smart home will make me more lazy and inactive	3.27	0.85	16		0.705		
B15- I can loss control of my home	3.34	0.88	15		0.653		
B13- Smart home will make me to worry more	3.45	0.87	13		0.648		
B6- Smart home will increase dependence on outside experts	3.64	0.78	6		0.647		
<i>B10- It is exclusive to tenants, elderly, computer illiterate and people living in older properties</i>	<i>3.57</i>	<i>0.87</i>	<i>10</i>		<i>0.465</i>		
<i>B8- I feel it is not necessary</i>	<i>3.61</i>	<i>0.81</i>	<i>8</i>		<i>0.468</i>		
B7- Lack of contingency plan in the event of power failure	3.63	0.67	7			0.782	0.797
B5- The fear of systems being compromised	3.70	0.69	5			0.749	
B4- I do not fully understand the functions and consequences of smart home	3.74	0.74	4			0.685	
B11- Smart home will not fit to my current and changing lifestyle	3.55	0.74	11			0.636	

Note: SD = Standard deviation, R = Rank, Italics = items with factor loading less than 0.5

The remaining thirteen barriers after deleting the unsatisfactory ones, i.e., B8, B9, and B10 were re-analysed to determine if the items still maintain the same factors and to determine the new factor loading. The factor analysis shows that the factor loading of each barrier is above 0.5, the initial three factors could also be used to group the barriers of SHTs, and their corresponding α values are satisfactory as well (see Table 2).

Table 2: Final Factor Analysis of Barriers of Smart Home Technologies to the Elderly

Barriers	Component			Alpha
	1	2	3	
B1- High cost of repair and maintenance	0.848			0.778
B2- The installation cost is high	0.802			
B3- I have no or limited knowledge about the devices	0.639			
B12- Technology devices are not reliable	0.571			
B14- Smart home will make me more lazy and inactive		0.747		0.791
B16- Smart home will disrupt my desired daily routine		0.715		
B13- Smart home will make me to worry more		0.667		
B6- Smart home will increase dependence on outside experts		0.654		0.790
B15- I can loss control of my home		0.603		
B7- Lack of contingency plan in the event of power failure			0.790	0.797
B5- The fear of systems being compromised			0.749	
B4- I do not fully understand the functions and consequences of smart home			0.682	0.646
B11- Smart home will not fit to my current and changing lifestyle			0.646	

Discussion

Based on the analysis conducted, four barriers, namely ‘high cost of repair and maintenance (B1)’, ‘the installation cost is high (B2)’, ‘I have no or limited knowledge about the devices (B3)’ and ‘technology devices are not reliable (B12)’ were grouped together and therefore, referred to as “*Cost and knowledge barrier*”; ‘smart home will make me more lazy and inactive (B14)’, ‘smart home will disrupt my desired daily routine (B16)’, ‘smart home will make me to worry (B13)’, ‘smart home will increase dependence on outside experts (B6)’, and ‘I can loss control of my home (B15)’ were named “*Personal concern*”, while ‘lack of contingency plan in the event of power failure (B7)’, ‘the fear of system being compromised (B5)’, ‘I do not fully understand the functions and consequences of smart home (B4)’, and ‘smart home will not fit to my current and changing lifestyle (B11)’ were termed “*Uncertainty barrier*”. Since there is no established procedure with which factors are named in factor analysis (Henson and Roberts, 2006), the researchers’ judgement was deemed appropriate factor analysis was deemed acceptable. Besides, the given names largely represent the constituting items in each factor (Oladinrin and Ojo, 2021).

Cost and Knowledge barrier

The four barriers (i.e., B1, B2, B3, and B12) that describes ‘cost and knowledge barrier’ were associated together in the analysis and possessed considerable high factor loading. The analysis indicates that the high cost of procuring SHTs, repairing them when they get faulty, or to keep them in good working conditions has the highest factor loadings in this study. The reality is that technological devices are not one-off entities that could be purchased without future any future costs to be expended on it. On the other hand, SHTs are expensive and could require huge initial capital to possess. This study confirms the common submissions on the high cost of procuring SHTs (Lê et al., 2012; Pal et al., 2019;). Meanwhile, considering the income of the target users of the SHTs, i.e., the elderly, they may not be financially buoyant to afford the required technological device for themselves. It is also important to note that most elderly may not have family members who may be willing or ready to buy the SHTs for the elderly because of other financial obligations. On the other hand, some elderly may not have immediate family members, such as children who may be willing to bear the burden of procuring SHTs for the elderly. For situations where the SHTs are procured, the financial

expenses of engaging an expert for the installation and the future cost of maintaining the devices or fixing it in case of fault are other cost-related barriers that the elderly may consider. It thus poses a great challenge to majority of the elderly who does not have incomes that could afford them purchasing the SHTs.

The paucity of knowledge of the elderly on SHTs is also revealed in this study. Frankly, the elderly, especially the ones that do not have formal education, may not comprehend the need for SHTs. Even the educated ones among them may not be technologically inclined or possess a willingness to have comprehensive knowledge on SHTs. Due to their limited knowledge on how to use technological devices in time past, they might have considered a device to be unreliable in time past. It is also possible for the elderly to relate such experience with SHTs and thus consider it unreliable. In fact, the reminiscence of the unreliable performance of a technological device they are aware of could form their decision not to consider SHTs necessary. Therefore, the limited or lack of knowledge of the elderly on the benefits of SHTs to their quality of life is a major barrier to buying it. Thus, the training of the elderly is essential to reduce the knowledge problems (Wong et al., 2017; Morris et al., 2013). Based on the grouping of the items that depict the high cost of SHTs and the limited knowledge of the elderly. It can be inferred that the elderly opined that it is not reasonable to expend an initial high cost on buying a technological device that is considered unreliable.

Personal concern

The barriers that dovetailed into ‘personal concern’ in the analysis conducted are B14, B16, B13, B6, and B13. Most of the barriers grouped into this factor depict items for describing dodging tactics. For example, “smart home will make me more lazy and inactive (B14)” implies a perception of an entity that hinders the users from undertaking normal daily activities (B16). In other words, B14 and B16 are mutually related to one another. The elderly desires to undertake daily activities without fear of being disrupted or rendered aground (Zheng et al., 2018). The few activities such as walking around the parks and community for exercise are vital to the quality of their life. Meanwhile, they want to do these daily tasks without being monitored or checkmated. It is important to note that SHTs do not interfere in the daily activities of the users or makes them lazy. The SHTs are designed to complements and enhance daily activities, and to provide timely assistance to the users when the need arises (Gentry, 2009; Singh et al., 2018). In fact, the use of SHTs makes undertaking daily activities optimally. The SHTs keep information of the users and help to benchmark it with the established metrics or cut-off criteria recommended by the medical practitioners who oversee their health.

In addition, the analysis also revealed that “smart home will make me to worry more (B13), “smart home will increase dependence on outside experts (B6)”, and “I can loss control of my home (B15)” are personal concern. SHTs are devised to prevent its users from worry on some issues. For example, some SHTs automatically are designed to automatically send a message or alert to health practitioners in case of emergency (Koh, 2015; Yang et al., 2014). The assurance of having an emergency centre that responds to sudden incidence should alley any form of fear from the elderly. On the other hand, the dependency on outside experts, e.g., health practitioners, are an intervention strategy to ensure the safety of the elderly. Thus, assisting in AIP of the elderly without any anxiousness from their relatives that may be far away. The assurance that the daily activities and health condition of their elderly are being monitored gives peace of mind, and this may encourage other people to purchase SHTs for their old ones.

Uncertainty barrier

The analysis revealed that B7, B5, B4, and B11 could be characterized as ‘uncertainty barrier’. Uncertainty about the performance or the outcomes that may be obtained from procurement of an electronic or technical gadget has been discussed in previous studies. In fact, issues relating to uncertainty on the performance or the usefulness of a device often bears a high degree of concern compared to the cost-related factors (Stavrakas et al., 2019). In this study, the uncertainty on the functions and consequences of smart home (B4) implies that the elderly are unaware of the benefits of SHTs. The uncertainty on the functions and consequences of SHTs also depicts the level of knowledge of the elderly. Understanding the importance to the quality of life of the elderly could be a driver that could encourage the elderly to purchase technological devices for enhancing their safety. Besides, the elderly may deliberately save funds during their service years towards retirement to procure the SHTs. In fact, the unknown importance of SHTs reflects the uncertainty if smart home will fit into their current and changing lifestyle.

Interestingly, SHTs does not only consider the changing lifestyle of the elderly (B11) but enhance it to be lived to the fullest. The elderly are not as strong as they used to be some decades ago, so, the current state needs attention and care. Meanwhile, most of them prefer to undertake their daily activities without being monitored. In fact, some prefer to live alone as they used to do when they were younger. In contrast, their state of health and feebleness are such that they demand attention and monitoring, or preferably, pseudo-monitoring. Thus, the design of SHTs considered the changing physical, physiological, mental, etc., of the elderly. For example, the use of Fitbits helps to keep the records of physical activities, monitor the heartbeat, etc., of the users. This makes SHTs suitable for providing vital information for medical practitioners, caregivers, etc., prior to administering medications or prescriptions. Furthermore, people that are not elderly use some technological devices to track the state of their health appropriately. Therefore, the uncertainty if smart home would fit into the current and changing life of the elderly could also be attributed to the lack of knowledge of the seniors.

Finally, the elderly was concern about a contingency plan in the event of power failure (B7) in this study. In fact, this item ranked highest among the components in the analysis conducted. First, it does not imply that the area of the research is a developing country where there is a failure of electricity supply. However, the study gives rise to a concern that most elderly may be living in an old apartment in which there is need for maintenance of electricity in the building for some hours. The need for a contingency plan if any emergency arise during the temporal electric power supply shutdown is thus important. Secondly, it is important to note that SHTs needs a constant electricity supply to function. It is also unclear if there would not be an abridgement in the information flow because of the electric power shutdown. Thus, understanding contingency plans is essential to always guarantee the safety of the elderly. On the other hand, the fear of the system being compromised (B5) connotes the uncertainty of the security of the information of the elderly. Meanwhile, previous studies have also shown the concern of the elderly on privacy-related issues on their data (Smit et al., 2014; Zhai et al., 2014; Zheng et al., 2018). It thus infers that ensuring confidentiality in the data of the elderly obtained via SHTs should be used for the expected purpose strictly. Besides, the manufacturers and other stakeholders with access to the data must assure the elderly professionalism in handling the information.

Implications of the Study

This study investigated the barriers of SHTs to the elderly in Hong Kong through a survey of 201 seniors aged 65 years and above. Based on the statistical analyses conducted, the critical barriers of SHTs to the elderly were identified and further categorized into manageable sizes namely, *cost and knowledge barrier*, *personal concern*, and *uncertainty barrier*. The study shows the inadequate or lack of knowledge on the functions of SHTs among the elderly. Therefore, it is recommended that the training on the importance of SHTs should be conducted in the local language of the elderly to enhance their knowledge. This would not only improve their awareness of such SHTs but also encourage them to publicize the importance among elderly friends and colleagues. The training of SHTs should not only target the elderly alone that might have retired from their active service in different sectors of the country. Training of community members who are approaching retirements, or those who are in the ‘penultimate decade, i.e., 55 to 64 years of age, should be educated early on the essence of SHTs and the benefits to users’ safety and quality of life. Through quality educative programmes to the elderly, the personal concern and uncertainty barriers could be easily dissuaded. The caregivers in care and attention homes should also be trained and updated on every new SHTs for the elderly. Thus, there should be a liaison between the care and attention homes and manufacturer of SHTs to have mutual communication of the needs of the elderly and devices that could meet the needs. The SHTs instruction manuals and operations should also be provided in the local language of the users to aid the understanding of the elderly. Finally, public enlightenment campaigns and strategies should be adopted by the manufacturing companies in different countries to assist the elderly, and their family members possess rich knowledge of SHTs and the importance to the elderly safety and quality of life.

Based on the analyses conducted, the cost-related of acquiring SHTs by the elderly was also revealed. To encourage the elderly to own SHTs, it is advised that mutual fund patterns should be embraced to assist the elderly. In other words, the organisations in which the elderly worked during their active years should contribute to procuring SHTs for them. This could be through setting aside some fund monthly at 10 years to the retirement of the elderly towards purchasing SHTs that will help the retired employee enjoy the retirement with technological devices that enhances safety and AIP. On the other hand, a small percentage of the salary of an employee aged 50 years could also be deducted monthly by the company towards procuring SHTs after retirement. The family members of the elderly may also procure the most essential SHTs and hand it over to them on the day of celebrating retirement from active service. This would make the elderly happy and feel safe the technological devices that could help in having an enjoyable retirement life are possessed by them. The elderly would also have a family bond with the households that consider procuring safety facilities for them.

Finally, the elderly indicated their concern about having a contingency plan during electric power outages for maintenance purposes and fear of the systems being compromised. It is therefore important for relevant stakeholders of the elderly with buildings where electric maintenance works are to be carried out to get informed about the duration of maintenance exercise and make necessary contingency plans for the elderly. Besides, the SHTs should also be designed with energy storage capacity that could assist in performing some limited essential tasks on the devices for a considerable time. In addition, the manufacturers must ensure end-to-end encryption of the SHTs, and other stakeholders with access to the elderly

data must handle such information with high professional conduct. In situations where the data are required for research purposes, the ethical process of relevant institutions must be obtained by the researchers.

Limitations and Future Research

The critical barriers of SHTs to the elderly were identified and grouped into manageable size in this study. However, the generalizability of the findings of this study may be limited by certain factors. First, obtaining larger number of responses may produce other results different from this study. Secondly, getting the barriers of SHTs to the elderly qualitatively is also essential to identify other challenges that may be important to the body of knowledge. However, this study achieved its intended objectives through different statistical analyses conducted.

Conclusions

This study investigated the barriers of SHTs to the elderly in Hong Kong at the time when AIP was being advocated for. A questionnaire was designed and administered through research assistants that speak the local language of the elderly for necessary assistance. A total of 201 valid responses was received and subjected to various statistical analysis namely mean score, standard deviation, factor analysis and reliability analysis. The factor loading of 0.5 was considered significant in this study; therefore, unsatisfactory items were deleted, and the factor analysis was conducted the second time. Based on the results of the factor analysis, three major groupings of barriers of SHTs to the elderly, i.e., cost and knowledge barrier, personal concern, and uncertainty barrier, were identified. The reliability of each factor formed was also checked and considered satisfactory for interpretation and discussion. Conclusively, the critical barriers of SHTs to the elderly identified in this study hovers around inadequate knowledge and cost constraints.

In other to address the critical barriers of SHTs to the elderly, several recommendations were posited to the government, manufacturers of SHTs, companies that employed the elderly in their active years, family members of the elderly, and the seniors. For example, a mutual fund in which a certain percentage of the elderly salary are deducted by the employers are deducted, while the employers also add a certain amount to purchase SHTs for the employees on retirement. In situations where the fund is not sufficient to procure the SHTs, government assistance could be sourced to complement the efforts of the employees and employers. The family members of the elderly could unanimously contribute to purchasing the essential SHTs for their elderly on the day of retirement from active service. Finally, training and education programmes in the local language are also suggested to assist the elderly understand the importance of SHTs to their safety and quality of life. Collaborative relationships between manufacturers and care attention homes of the elderly are also advised to encourage two-way communication on the unique needs of the elderly and the solutions to the needs.

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