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Elderly Customers' Open Innovation on Smart Retirement Village: What They Want and What Drive Their Intention to Relocate?

Booi Chen Tan ^{1,*} , Teck Chai Lau ² , Nasreen Khan ¹ , Wooi Haw Tan ³ and Chee Pun Ooi ³

¹ Faculty of Management, Multimedia University, Persiaran Multimedia, Cyberjaya 63100, Malaysia; nasreen.khan@mmu.edu.my

² Business School, UCSI University, UCSI Heights, 1, Jalan Puncak Menara Gading, Taman Connaught, Kuala Lumpur 56000, Malaysia; LauTC@ucsiuniversity.edu.my

³ Faculty of Engineering, Multimedia University, Persiaran Multimedia, Cyberjaya 63100, Malaysia; twhaw@mmu.edu.my (W.H.T.); cpooi@mmu.edu.my (C.P.O.)

* Correspondence: bctan@mmu.edu.my

Abstract: The rapid growth of the ageing population has increased the attention paid towards the provision of retirement village (RV). RV is a new form of housing on the ageing landscape that provides a full range of care from independent to assisted living to meet the diverse needs of the elderly. Numerous studies conducted in the past examined factors that influence elderly intention to relocate to the RV and the intention to adopt the smart home technology. The current study focused on the intention of elderly to relocate to the smart retirement village (SRV) (i.e., RV with the smart home technology). A customer-driven open innovation survey was conducted to solicit opinions from the elderly. This paper applied the Theory of Planned Behavior to examine such intention among the elderly in Malaysia. The types of smart home technology preferred by the elderly at the SRV were determined. The results from the multiple regression analysis ($N = 305$) indicated that attitudes, social norm, and perceived behavioural control contributed significantly to the elderly intention to relocate to the SRV. Further investigation revealed that 83% of the elderly choose the smart emergency contact system as the most important smart home technology to be included.

Keywords: smart retirement village; intention to relocate; open innovation; theory of planned behaviour



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1. Introduction

In the recent United Nations [1] report, globally in 2020, there were 727 million people aged 65 years and above, and the number of elderly is projected to more than double, reaching over 1.5 billion by 2050. In Malaysia, it is expected that the nation is moving towards becoming an ageing society by the year 2030, as the older population will account for 15% of the overall population [2]. Ageing population is pervasive and has profound social, economic, and political implications. This phenomenon will bring attention towards the provision of more comprehensive long-term elderly care services that take into consideration the psychosocial well-being of the elderly as they age.

As a result, a whole new market from elderly healthcare; lifestyle services; and facilities such as retirement homes, villages, and aged care home, are blossoming in Malaysia. In recent years, retirement villages (RV), which aim to meet the diverse needs of the elderly, have emerged on the ageing landscape. RV offers residents with independent living, full-day emergency assistance, and an age-friendly environment [3]. Past studies related to RV include the areas on the relocation, living experience, and environment [4–7]. Following the technological advancement, the property developers have been aggressively moving in the direction of transforming the existing RV to a smart retirement village (SRV) with the inclusion of Internet of Things, which depicts a world of networked smart devices, to distinguish its offering as well as to enhance life quality, promote independence, and

encourage social interaction at the golden ages of the elderly. Nevertheless, the types of smart technology or devices to be built at a smart home in the future SRV from the perspectives of the elderly, which are the future homebuyers, is still under-explored.

This paper consists of two objectives. The first objective is to determine the types of smart home technology at the SRV that are preferred by the elderly. The second objective is to apply the Theory of Planned Behaviour (TPB) to look at the effects of the three TPB variables (i.e., attitude, subjective norm, and perceived behavioural control) on the elderly's intention to relocate to the SRV. SRV is an extension from the existing RV with the inclusion of smart home technology to assist and facilitate the daily life of the elderly. A senior friendly smart home will be rewarding, and the social living environment in the village will certainly help to alleviate social isolation and loneliness. The study outcome is expected to provide an insight to those engaged with commissioning and developing services for the elderly, both in the public and private sectors. Although SRVs are a relatively new form of housing in Malaysia, they have a high tendency to support policy objectives to promote independence, choice, and life quality of the elderly.

This study is warranted as the identification of factors influencing elderly in seeking an ideal SRV as well as their expectation will allow the property developers to better design the types of facilities and services to match to their needs. Besides, the inclusion of smart technology in the development of SRV helps to promote health and well-being and reduce social isolation, which can bring about a negative impact on health status of the elderly. Therefore, open innovation from the point of view of the elderly is needed to find out types of smart innovative technology that the elderly looks for in SRV. SRV design should be sustainable because the elderly are best placed to provide constructive inputs on what they need for an age-friendly living environment.

2. Literature Review

2.1. Open Innovation Dynamics, Open Innovation Culture, and Sustainability

The focus on open innovation within the organization innovation process has been increasing dramatically over the last few decades. Generally, firms use internal and external activities to accelerate the innovative process based on various open innovation approaches [8]. It is “a process of distributed innovation based on knowledge flows purposely managed by organizational boundaries” [9], (p. 17). It is also a critical strategic option for businesses to maintain their market positions through collaborations from the internal and external sources to find opportunities and develop new markets [10]. Vaisnore and Petraite [11] stated that there are two basic types of open innovation analysis. First, open innovation refers to the networking and collaboration between firms. Second, open innovation is the partnership and collaboration between firms and its customers.

According to Yun et al. [12], open innovation dynamics can be divided into two levels, they are, open innovation micro-dynamics and open innovation macro-dynamics. According to Yun et al. [12], (p. 9), “open innovation micro-dynamics, that is, open innovation–complex adaption–evolutionary change dynamics; and open innovation macro-dynamics, that is, market open innovation–closed open innovation–social open innovation dynamics”. From the aspect of social open innovation, it focuses on the integration between the technology and society in the new creative and innovative ways, and it can be used as a source of market open innovation [13]. Nevertheless, organizational culture contributes significantly to the success of innovation performance [14,15]. The role of innovations in achieving higher levels of sustainability is critical [16–18]. Therefore, to move to the direction of sustainability innovation, the integrations between the organisations and the external customers, suppliers, and research institutions, are the most crucial competencies [19–22].

2.2. Customer Involvement into Open Innovation Processes

A vast quantity of early studies on open innovation used case studies and qualitative methods in general [23,24]. Nevertheless, customer perspective is well-known as a key contributor in the open innovation approach [25]. Customer involvement, with a more

active role of customers in innovation, has been brought to the attention of researchers and practitioners [11]. Customers are co-creators and they are the common source of creativity in the innovation process [26], and the understanding of lead users and application of their information influence the success of innovation significantly [27,28]. Firms that are customer oriented will more likely be able to identify emerging market opportunities than their competitors [29]. In addition, more firms have adopted new technology and emphasized an open innovation approach that includes opinions of customers, which could help reshape the competitive landscape and lead them to have a dominant position in the market [8]. In the current research, elderly customer involvement in the innovation process is an important input source at the juncture of designing the smart home technology or services in the SRV.

2.3. Retirement Village (RV)

According to Hu et al. [30], a retirement village (RV) can be described as a community that provides places to stay together with different services and facilities matching the diverse conditions of the residents (i.e., elderly). The main characteristics of the RV include independent living, institutionalization, and an age-built environment. Ball and Nanda [31] supported that independent living is one of the characteristics of RV and it has been deemed as a very crucial aspect for the health and well-being of the elderly. Besides, Xia et al. [32] suggested that a RV should provide a sustainable living environment that emphasized on the environment, economic, and social sustainability. Nevertheless, the technology aspect in the RV was not covered in Xia et al.'s study. In the context of RV in Malaysia, RV consists of several housing options that range from multi-generational homes, high density residences, to retirement resorts [33]. The location, site layout, facilities and services, social life, and living costs of a village are significant characteristics that need to be incorporated in a sustainable RV, according to a case study conducted by Hu et al. [34] in Australia. Besides, the quality of life among the elderly who live in RV tends to be higher compared to others [35]. Via the focus group studies (i.e., qualitative method), Kennedy and Coates [35] determined various types of consumer satisfaction with retirement community living, which were aligned with the aspects investigated by Stimson et al. [36] about the unit size/design, management, and social atmosphere, as well as the companionship, privacy, and security emphasized by Graham and Tuffin [37]. In addition, to encourage the move of elderly to RVs, the offering of outdoor living spaces, services in enhancing independence, supported living, and medical facilities are highly required, as reported by Crisp et al. [38].

2.4. Smart Home Technology

Smart village networks and services are enhanced through smart digital technology, telecommunications, innovation, and knowledge use, for the advantage of rural communities [39]. A smart home is a home where the users at home can use the networks and sensors to monitor, access, and control the domestic appliances, and other electronic and electric devices remotely [40]. The goal of smart home technology is to keep the elderly company while decreasing pain, annoyance, and movement limits [41]. Pal et al. [42] highlighted that providing various smart-home technology or services is essential as it is a positive step towards improving the elderly's quality of life.

With regards to the types of smart home technology or services, there are a variety of options. Balta-Ozkan et al. [43] divided smart home services into three categories that are interconnected: energy consumption and management, safety, and lifestyle support. In Malaysia, Wan Mokhtar and Ismail [44] reported the opinions among the homeowners from various ages in Hulu Langat, Selangor, towards the degree of importance on the smart home technologies, which comprised of the smart aspects in security and safety control, health, appliances, entertainment, and energy and lighting. The researchers revealed that the majority of the respondents are more willing to spend more to set up the smart safety and security control at their homes. The SRV in this paper will focus on capturing the opinions

of the elderly through customer-driven open innovation, for better design of the smart and age-friendly living environment to assist them to live well, safely, and independently.

2.5. Theory of Planned Behaviour (TPB)

In addition to the initial two variables (attitude and subjective norm) found in the Theory of Reasoned Action, the Theory of Planned Behaviour (TPB) [45] added the variable of perceived behavioural control, which is an individual's perception of the difficulty of performing a specific behaviour based on previous experiences, resources, opportunities, and barriers to doing so. In the nutshell, TPB is a psychological theory with three core variables, which are, attitude, subjective norm, and perceived behavioural control, which can affect the behavioural intention of an individual. The next section will describe the concept of each of the variables in TPB as well as the relevant studies in the context of behavioural intention of the elderly.

Attitude, Subjective Norm, and Perceived Behavioural Control

Attitude can be defined as “a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object” [46], (p. 211). It refers to the psychological predisposition to judge whether an individual likes or dislikes a particular object [47]. Subjective norm, on the other hand, relates to the perception that an important person will approve and support a specific behaviour, as well as the additional variable of perceived behavioural control, which refers to a person's perceived difficulty in carrying out a given behaviour [45]. These variables together affect an individual intention. Table 1 presents the empirical evidence about the relationship of each of these three variables on the behavioural intention of the elderly as reported from previous research. The studies reported in Table 1 can be divided into three categories: (1) elderly intention towards the general behaviour [48–53]; (2) elderly intention to move to the RV or nursing homes [4–7,54,55]; and (3) elderly intention to use the smart home services or products [42,56–58]. Studies that focused on the RV combined with smart home technology are still very much under-explored.

Table 1. Empirical evidence on the relationship between various variables.

No.	Authors	INT	ATT	SN	PBC	Sample	Country
1.	Lu [53]	Intention to continue working	ATT→INT *	SN→INT *	Not included	Elderly	Taiwan
2.	Ahmad et al. [52]	Intention to exercise	ATT→INT * (among men)	SN→INT * (among women)	PBC→INT * (among men)	Elderly	Malaysia
3.	Gazali et al. [51]	Intention to save for retirement	ATT→INT *	SN→INT *	Not included	Non-elderly	Malaysia
4.	Valois et al. [50]	Intention to adapt heat	ATT→INT *	SN→INT *	PBC→INT *	Elderly	Canada
5.	Duarte et al. [49]	Intention to perform physical activity	ATT→INT *	SN→INT (NOT *)	PBC→INT *	Elderly	Portugal
6.	Callow et al. [48]	intention to practice social distancing in the near future	ATT→INT *	SN→INT *	PBC→INT (NOT *)	Elderly	Maryland, US State
7.	Luo et al. [55]	Intention to enrol in nursing homes	ATT→INT *	SN→INT *	Not included	Elderly	China
8.	Ng, K.T. [5]	Intention to move to the RV	ATT→INT (NOT *)	SN→INT *	PBC→INT *	Elderly	Malaysia

Table 1. Cont.

No.	Authors	INT	ATT	SN	PBC	Sample	Country
9.	Ng, S.I. [6]	Intention to move to the RV	ATT→INT *	SN→INT *	PBC→INT *	Elderly	Malaysia
10.	Sritharan et al. [7]	Intention to move to the RV	ATT→INT *	SN→INT *	PBC→INT (NOT *)	Elderly	Malaysia
11.	Judge et al. [54]	Intention to purchase sustainable housing	ATT→INT *	SN→INT *	PBC→INT *	Non-elderly	Australia
12.	Lim et al. [4]	Intention to move to the sustainable RV	ATT→INT *	Not included	Not included	Elderly	Malaysia
13.	Park et al. [56]	Intention to use the smart home services	ATT→INT *	Not included	Not included	Non-elderly	Korea
14.	Pal et al. [42]	Intention to adopt smart home services	ATT→INT *	Not included	Not included	Elderly	Thailand
15.	Ferdhany and Aldianto [57]	Intention to use the smart home products	ATT→INT *	Not included	Not included	Non-elderly	Indonesia
16.	Tsai [58]	Intention to use smart clothing	ATT→INT * (elderly without cardiovascular disease) ATT→INT (NOT * for elderly with cardiovascular disease)	Not included	Not included	Elderly	Taiwan

Note: INT: Intention; ATT: Attitude; SN: Subjective Norm; PBC: Perceived Behavioural Control; * significant.

2.6. Proposed Framework

Based on the TPB model, this study proposed a research framework as shown in Figure 1 to investigate the elderly's intention to relocate to the SRV. From the research framework, attitude, subjective norm, and perceived behavioural control were the independent variables, and intention to relocate to the SRV was modelled as the dependent variable. Hence, three hypotheses were developed:

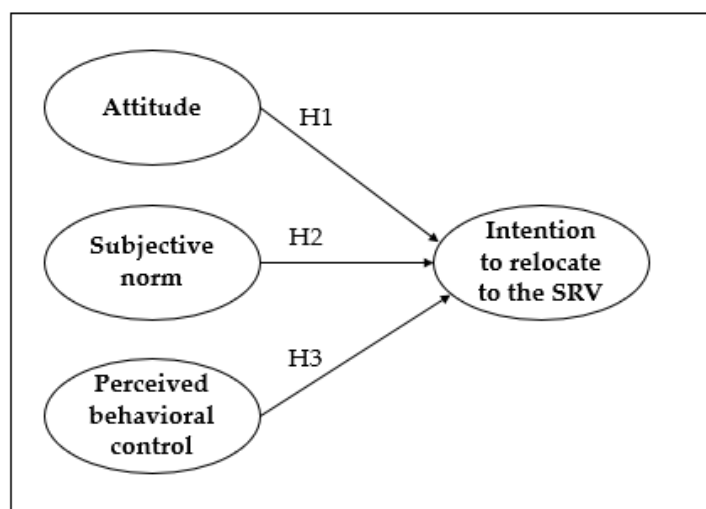


Figure 1. A proposed research framework.

Hypothesis 1 (H1). *Attitude has a positive and significant relationship on the intention of the elderly to relocate to the SRV.*

Hypothesis 2 (H2). *Subjective norm has a positive and significant relationship on intention of the elderly to relocate to the SRV.*

Hypothesis 3 (H3). *Perceived behavioural control has a positive and significant relationship on the intention of the elderly to relocate to the SRV.*

3. Method

The unit of analysis in this research was elderly aged 55 and above, who lived in Klang Valley, Malaysia. As data ($N = 305$) were collected during Covid-19 outbreak in 2021, face-to-face survey method was omitted for the safety of the elderly. This was replaced by the online method by sending the questionnaire link to the Facebook community groups and WhatsApp messaging. Respondents that were 55 years old and above, and were aware about the smart home and retirement village, were invited to join the survey. The questionnaire consisted of two sections. Respondents were asked to fill up the information about their demographic profile and choose the types of smart home technology that they would prefer to be included in the SRV in the first section. Following the studies by Wan Mokhtar and Ismail [44] and Balta-Ozkan et al. [43], together with feedback obtained from the preliminary interviews with five elderly, 10 types of smart home technologies were included in this study and well-structured in Appendix A. The second section of the questionnaire comprised of the measurement scales for each of the variables (i.e., four variables). The five-item scale of attitude (ATT) was adapted from Ajzen and Fishbein [59], three items of subjective norms (SN) and five items of perceived behavioural control (PBC) from Cheng and Tung [60]. The five-item scale of intention (INT) to relocate to the smart retirement village was adapted from Ha and Janda [61] as presented in Appendix B.

4. Results

4.1. Demographic Profile of the Respondents

The respondents of this study consisted of 58% male and 42% female ($N = 305$). Most of them were from the age group of 55–60, representing 44.9% of the respondents. This is followed by 26.2% (61–65), 22.3% (66–70), and 6.6% respondents above 71 years old. The breakdown of ethnicity of the respondents were Malay (40.3%), Chinese (39.7%), Indian (18%), and others (2%), which closely represented the multi-racial society in Malaysia. For marital status, 60.3% of respondents were married, with 43% of them living with their spouses, and 32.1% living with their children. The majority had secondary education (43.3%) followed by tertiary education (42.6%). Lastly, 36.4% of the respondents were retired, and 63.6% of them were still working either full or part time.

4.2. Descriptive Analysis of the Types of Smart Home Technology Preferred by the Elderly

The first objective of this study was to identify the types of smart home technology at the SRV that were preferred by the elderly. Lifestyle support, healthcare, and safety were the three main inter-connected categories of smart home technology surveyed. The types of smart technology at home preferred by the elderly were presented in Table 2 based on the frequency and percentage responded. As indicated in Table 2, a total of 83% of the elderly wanted the smart emergency contact system to be included in the SRV. This is followed by the inclusion of safety and home security devices (78.4%). The least preferred types of smart home technology chosen by the elderly were smart alarm (24.9%) and smart window blinds (22.3%). The results also showed that the majority of the elderly preferred the inclusion of smart home technology from the categories of healthcare (65.25%) and safety (61.65%), rather than lifestyle support (40.35%). Nevertheless, smart display from the category of lifestyle support was highly preferred by the elderly (60.3%). Smart displays such as smart TV and smart screen that connect to the WIFI, applications, and phones that

allows video calls serve as the greatest preferred entertainment choice as compared to other types of lifestyle support at the smart home for the elderly.

Table 2. Types of smart home technology preferred by the elderly ($N = 305$).

Categories	Types of Smart Home Technology	Frequency	Percentage
Lifestyle support	Smart lighting <ul style="list-style-type: none"> Automated lighting devices that connect to phone and voice automation to control lighting brightness and lighting schedules 	129	42.3%
	Smart displays <ul style="list-style-type: none"> Smart TV and smart screens that connect to WIFI, applications, and phones to allow video calls and entertainment 	183	60.3%
	Smart alarms <ul style="list-style-type: none"> Different wake up sounds for different days 	76	24.9%
	Smart kitchen appliances <ul style="list-style-type: none"> Microwaves, ovens, and refrigerators that can be connected to phones with LED touchscreen displays and sensors 	161	52.8%
	Smart audio devices <ul style="list-style-type: none"> Smart speakers to control and play songs through phones 	121	39.7%
	Smart window blinds <ul style="list-style-type: none"> Automatically open and close window blinds with phones or buttons 	68	22.3%
Healthcare	Smart emergency contact systems <ul style="list-style-type: none"> Wearable electronic devices that include fall alerts and basic medical information (ECG stats, heart rates, blood type etc.) 	253	83%
	Smart medication assistance <ul style="list-style-type: none"> Automatic pill dispensers, sensor pads located underneath medication bottles to monitor when and if medications are taken 	145	47.5%
Safety	Safety and home security devices <ul style="list-style-type: none"> Home security camera, CCTVs, smart fingerprint door locks 	239	78.4%
	Smart gas detector <ul style="list-style-type: none"> Detect smoke and carbon monoxide 	137	44.9%

4.3. Factor Analysis

Factor analysis was used in this work to minimise a huge number of overlapping measurable variables to a considerably smaller set of components [62]. According to Hair et al. [63], 60% of the total variance is deemed satisfactory in the social science studies. Factor loadings at ± 0.50 or higher are deemed significant, whereas communality measures greater than 0.50 indicates a strong relationship between the items, thus meeting acceptable levels of explanation. Based on the factor analysis result, PBC 3 from the variable perceived behavioural control was removed because of the low values of communalities (<0.50). The percentage of the total variance explained increased from 68.327% to 71.373% ($>60\%$) after PBC 3 was removed. In terms of the sampling adequacy, the sample size of 305 was

adequate and satisfactory because the KMO was 0.853 (>0.7). In Table 3, the factor analysis and reliability results for all variables were provided. Factor loadings of 0.60 (>0.50) and higher for all variable items reported were considered significant for interpretative purposes. Besides, high internal consistency of items for all research variables was found because the Cronbach's alpha values reported for all variables were greater than 0.80 (>0.60) [52].

Table 3. Results of the factor analysis and reliability for all the variables.

Items	ATT	SN	PBC	INT	Cronbach Alpha
ATT1	0.762				0.852
ATT2	0.764				
ATT3	0.714				
ATT4	0.773				
ATT5	0.658				
SN1		0.892			0.856
SN2		0.849			
SN3		0.755			
PBC1			0.896		0.913
PBC2			0.890		
INT1				0.751	0.802
INT2				0.768	
INT3				0.656	
INT4				0.665	

4.4. Multiple Regression Analysis

Multiple regression analysis was used to examine Hypothesis 1, 2, and 3. In Table 4, the result for the regression model was significant at the significance level equal to 0.000, which indicated that all the constructs were simultaneously significant to the dependent variable. Besides, the three constructs surveyed in this study contributed 45.5% to intention to relocate (adjusted R square= 0.455). According to the findings, attitude (H1), subjective norm (H2), and perceived behavioural control (3) all influenced intention to relocate favourably and considerably, with significance values of $p0.000$, $p0.000$, and $p0.016$, respectively. Hence, all three proposed hypotheses were supported. The standardised coefficient beta reported that attitude was the most vital variable that impacted on the intention to relocate to the SRV (beta= 0.487), followed by subjective norm (beta= 0.216) and perceived behavioural control (beta= 0.120). Tolerance rate > 0.1 and VIF < 10 reported in Table 4 indicated that multi-collinearity was not presented in this study.

Table 4. Results of multiple regression analysis.

Dependent Variable: Intention to Relocate to the SRV					
	Standardized Coefficient (beta)	t-Value	Significance	Tolerance	VIF
Constant		3.463	0.001		
ATT	0.487	9.834	0.000	0.731	1.369
SN	0.216	4.476	0.000	0.768	1.303
PBC	0.120	2.419	0.016	0.726	1.377
	R ² = 0.460 Adjusted R ² = 0.455	F value = 85.586	Significance = 0.000		

5. Discussion

5.1. The Intention and Relocation of Smart Retirement Village

The first objective of the study is to determine the types of smart home technology at the SRV that are favoured by the elderly. From the perspective of the elderly open innovation input, the top three smart home technology preferred (in terms of priority) are smart emergency contact system, safety and home security devices, and smart displays. The three least preferred smart home technology (in terms of priority) are smart window blinds, smart alarms, and smart audio devices. The results are somewhat expected. As a person ages, health, safety, and mobility become issues of concern. The elderly are looking at SRV that could provide an assurance of emergency system and home security devices in the event of untoward incidences that affect their health and lifestyle. Elderlies are more prone to health scares due to their current health conditions. Therefore, providing these essential technologies is not only expected but has become part and parcel of what is to be expected in a good SRV. Developers of SRV will need to be extra vigilant and sensitive to these needs to provide these technologies as essential features in the SRV. In the context of the least preferred options, these technologies (smart window blinds, smart alarms, smart audio devices) are nice-to-have features but not considered essential. SRV developers need to be open to innovation and could also consider including these technologies in the SRV as an added features that could bring convenience to the elderly. By including these as added smart home technologies, this will add value to the homes and further differentiate one SRV from another.

The study's second objective is to apply the Theory of Planned Behavior (TPB) to investigate the effects of the three TPB factors (attitude, subjective norm, and perceived behavioural control) on the elderly's intention to relocate to the SRV. The results indicated that H1, H2, and H3 are supported as all three variables are significant contributors towards intention to relocate (with the most important contributing factor of attitude, followed by subjective norm, and lastly perceived behavioural control). The result is consistent with past research [4–6]. This provides SRV developers, planners and designers with information about the important features that are sought after by the elderly. This can move the current phenomenon by increasing elderly positive attitudes and its benefits towards the SRV. Besides, SRV town planners should be more open and innovative in their strategies to attract the market to consider this possible way of living. In Malaysia, the elderlies are driven to consider relocating to SRV due to their attitude; secondly by subjective norm factors they receive from peers, friends, and family; and thirdly their perceived behavioural control. In other words, the potential customers of SRV will be more willing to relocate to this village when they favour the concept of SRV. Moreover, elderlies will be motivated to comply with their family members, relatives and friends' views in making decisions to relocate to the SRV. Therefore, marketers through open innovation could also use the findings of the study to plan on how to promote SRV in Malaysia. SRV developers can have supporting mechanisms including public relation campaigns to enhance elderly's awareness on the safe and convenient lifestyle and benefits associated with SRV living. Information such as what is a smart retirement village, why it is important to consider this as an option, in which circumstances to consider SRV, and how SRV benefits their future retirement plan are required to be included in the future advertisement and promotional campaigns.

5.2. Customer Open Innovation Contribution towards Smart Retirement Village

According to Fagerberg [64], innovation is an important factor that explain differences in performance and long-term growth among firms, regions, and countries. Open innovation with the involvement of customer is not a new business phenomenon in the competitive environment [11]. In Malaysia, competitions among property developers are intense, which signal a good sign for the market, as such competition pushes these developers to remain innovative and enable them to adapt to the discerning homebuyers' ever-changing wants and needs, especially during their golden age. The advent of new

technologies is changing the dynamics of every industry including the property industry. Assistive technology plays a crucial role in the lives of elderly by allowing them to lead a more independent lifestyle. This leads to an urgency of involving the active players and co-creators of knowledge, who are using or consuming the product or services, as participants of innovation process [65]. In terms of customer-driven open innovation, the outside-in open innovation approach, which involves the integration between the firm with its customers as well as the external knowledge sources, helps to increase firm's innovativeness [66]. Customer involvement especially concerning information about their needs and solutions serves as a main contribution in enriching the information bases that could be utilized in the innovation process [67]. To decide on the types of new products or services, which include technology in the smart home as one of the selling points for the future SRV, elderly customer involvement and participation in open innovation process is essential to make this successful.

From the perspectives of the elderly in Malaysia, lifestyle support, healthcare, and safety were the three main inter-connected categories of smart home technology surveyed in this study. Based on these three categories, the elderly were asked to indicate their preferences on the different types of smart home technology, which consisted of smart lighting, smart displays, smart alarm, smart kitchen appliances, smart audio devices, smart window blinds (lifestyle support), smart emergency contact systems and smart medication assistance (healthcare), safety and home security devices, and smart gas detector (safety). As a person ages, healthcare will be their primary concern especially if they are not staying with their children (i.e., care taker), followed by their safety and lifestyle support. As a result, through the involvement of elderly customers, who act as co-designers of smart home technology, they could assist SRV developers to effectively focus on changes that are needed, thus enhancing the success rate of innovation [68]. The top 3 smart home technologies that the elderly preferred are smart emergency contact system, safety, and home security devices and smart displays that need to be integrated in the smart homes when they relocate to the SRV. Nevertheless, open innovation and dynamic capabilities reinforce one another [69]. Firms that emphasize customer involvement in the open innovation processes in developing new products and services, such as human capital and financial capital [70], as well as the system capital and open capital [71], will be well connected to enrich the innovation activities, leading to successful innovativeness [72]. With this, besides working closely with customers, property developers will be better placed to understand their strength before embarking on SRV development.

6. Conclusions

There were two main objectives of the present study. The first objective was to determine the types of smart home technology to be included in developing the SRV from the perspective of the Malaysian elderly; and the second objective was to examine the influence of attitude, subjective norm, and perceived behavioural control on the relocation intention of the elderly based on the TPB model. The results from customer open innovation survey indicated that the majority of the elderly desired the smart emergency contact system, such as wearable electronic devices that include fall alerts and basic medical information (ECG stats, heart rates, blood type etc) to be provided when they are to stay at the SRV. The least preferred smart home technology was the smart window blinds that can automatically open and close the window blinds via smart phones or buttons. The results also supported the applicability and useability of TPB model in predicting elderly intention in the context of SRV, as all three variables (attitude, subjective norm, and perceived behavioural control) serve as significant contributing factors that affect the decision towards the places to stay. The outcome of this study provides insights to relevant parties, both in the public and private sectors, to better develop and market housing options for the elderly. It also serves as a platform to understand the plan for future housing development and growth from the elderly's perspective in Malaysia. The types of smart home technology based on the elderly's needs or types of technical application to be

built in the SRV could certainly help to promote independence, choice, and quality of life for the elderly.

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Appendix A

Table A1. Types of Smart Home Technology.

Categories	Types of Smart Home Technology
Lifestyle support	Smart lighting: Automated lighting devices which connect to phone and voice automation to control lighting brightness and lighting schedules
	Smart displays: Smart TV and smart screens which connect to WIFI, applications and phones to allow video calls and entertainment
	Smart alarms: Different wake up sounds for different days
	Smart kitchen appliances: Microwaves, ovens and refrigerators that can be connected to phones with LED touchscreen displays and sensors
	Smart audio devices: Smart speakers to control and play songs through phones
Healthcare	Smart window blinds: Automatically open and close window blinds with phones or buttons
	Smart emergency contact systems: Wearable electronic devices that include fall alerts and basic medical information (ECG stats, heart rates, blood type etc)
	Smart medication assistance: Automatic pill dispensers, sensor pads located underneath medication bottles to monitor when and if medications are taken
Safety	Safety and home security devices: Home security camera, CCTVs, smart fingerprint door locks
	Smart gas detector: Detect smoke and carbon monoxide

Appendix B

Table A2. Survey Instrument on the Variables of Attitude (ATT), Subjective Norm (SN), Perceived Behavioral Control (PBC), and Intention (INT).

Items	Items
ATT1	Smart Retirement Village is a good idea
ATT2	Smart Retirement Village is a wise idea
ATT3	I like the idea of Smart Retirement Village
ATT4	Smart Retirement Village would be pleasant
ATT5	Smart Retirement Village is appealing
SN1	Most people who are important to me think I should relocate to the Smart Retirement Village
SN2	Most people who are important to me would want me to relocate to the Smart Retirement Village
SN3	People whose opinions I value would prefer that I relocate to the Smart Retirement Village
PBC1	Whether or not I relocate to the Smart Retirement Village is completely up to me
PBC2	I am confident that if I want, I can relocate to a Smart Retirement Village
INT1	The probability that I will relocate into Smart Retirement Village is very high
INT2	I am willing to move into the Smart Retirement Village in the near future
INT3	I will consider to move in the Smart Retirement Village
INT4	I would like to recommend others to move into Smart Retirement Village

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