The ageing of the population is a worldwide phenomenon and is increasing in developed and developing countries. According to Östlund, the proportion of older adults in the world over 60 years of age is projected to double from 11% to 22% between 2000 and 2050. It has also been reported that 80% of the world’s ageing population will live in developing countries by 2050.

This ageing phenomenon is placing increasing pressures on families, governments, institutions and organizations. Increasingly, urban and international migration has resulted in more people leaving the rural areas for better job opportunities in the more developed countries and in cities. This leaves a large number of older adults living independently in rural areas. In addition, family structure is changing and shifting from the traditional extended family structure to a situation where older adults have to live alone. As a result of this drastic change in social structure many older adults suffer or are in danger of suffering as a consequence of age-related incapacity.

There is increasing evidence indicating that technology holds great potential for supporting older adults in maintaining their vitality and independence at home. Gerontechnology is a technology domain that links existing and developing technologies to the aspirations and needs of ageing and aged adults, with the goal of increasing the quality of life for older adults.

Although gerontechnology and assistive technology have great potential to be useful to the ageing population, successful adoption of a technology is dependent on the technology acceptance behavior of older adults. In many instances, older adults appear to be resistant to the adoption of technology. This idea of resistance is supported by the work of Marschollek et al. which suggests that the reluctance (behavior) of older adults is the major barrier to technology adoption. A number of factors such as age, computer-related self-efficacy, anxiety, inadequate technical experience and perceived technological complexity have been identified as reasons for the resistance shown by older adults to new technology. Problems faced by older adults in using new technologies have also been shown to be related to cognitive factors. All these potential factors need to be further consid-
gerontology, the scientific study of ageing, and technology, the development and distribution of technologically based products, environments and services"15). Within gerontechnology literature, many studies on the adoption of technology by older people have been conducted using a quantitative approach involving, for example, surveys and structural equation models15. Over the last decade there have been a large and increasing number of scholarly publications concerning technology adoption by older adults6,17-21, however these studies have not generally provided insights into the elderly-specific factors that influence the decisions of older adults to adopt technology. Therefore, the aim of this study was, through a qualitative approach, to examine the elderly-specific factors influencing the adoption of, or resistance to, technology by older adults. The factors considered in this study were categorized as product, personal or economic. This study aims to explore the factors underlying technology adoption (or resistance) of older adults through a qualitative exploratory method: GUAM (Gerontechnology Usage and Acceptance Model).

**RESEARCH METHODOLOGY**

This research was approved by the Monash University Human Research Ethics Committee.

**Near Field Communication (NFC) home system**

In this study, we applied the Near Field Communication (NFC)-enabled technology and Bluetooth-Low-Energy (BLE)-enabled Raspberry-PI to design and develop the NFC home system. The NFC home system was designed using a set-top-box as a convergence platform to integrate different home appliances for home automation. In this system, home appliances are operated using a tap-to-connect mechanism where users tap an NFC card on the set-top-box to activate a specified digital appliance. An illustration of this can be seen in Figure 1, in which user can switch on/off the lamp by tapping the NFC card with a set-top-box.

The tap-to-connect interaction triggers signals to be transmitted in the virtual world and operates the lamp in the real world. The set-top-box can read multiple NFC cards for different home devices. Internet connection is not required for the entire operations. Given that this NFC home system is portable and easy-to-use, it can be regarded as an assistive technology because it provides a convenient way for older adults to improve their independence at home.

It has been reported that many products have not been tested using older people before being classified as technologies for older adults1. This is not a very satisfactory situation because it is likely that the direct experience that older adults have with a technology will influence their evaluation of, and decisions, regarding the technology. In this study, an experiment was conducted, allowing participants to have a direct experience with the NFC home system. Interviews were then conducted to understand the perceptions of the participants and their experience with the technology. This information is important to understand the key factors influencing the decisions by older adults to adopt or not to adopt a technology.

**Study setup**

The target sample for this study was older adults living in Malaysia. According to the latest Malaysia’s decennial census22, the total population of Malaysian citizens are 28.3 million of which 67.4% are Bumiputra (i.e., indigenous people, mainly Malays), 24.6% are Chinese, 7.3% are Indian and 0.7% are from other ethnic groups. Back in the 19th century, many Chinese from south China (e.g., Fujian and Guangdong provinces), Shanghai and northern China came to Malaysia22. The Chinese immigrants and their local-born children are granted citizenship under...
the Malaya’s constitution (Malaysia was formerly known as Malaya). Therefore, the descendants of Chinese immigrants are Malaysian citizens. Malaysia is a multiethnic society and the Chinese in Malaysia identified themselves as a Chinese ethnic group. They are multilingual and generally speak Mandarin and their mother tongues (e.g., Cantonese, Hokkiens, Hakka, Teochews etc). They celebrate a number of festivals such as the Chinese New Year, Mid-Autumn festival (zhongqiu jie), Winter festival (dongzhi) etc based on the Chinese calendar.

A total of 118 Chinese older adults (49 males and 69 females) participated in the experiment involving survey questionnaires and interviews. The breakdown of age group is as follows: 40 participants between 55-64 years old, 48 participants between 65-74 years old, 25 participants between 75-84 years old, and 5 participants above 85 years old (Table 1).

Before the experimental session, the participants were briefed on the objective of the research, the experimental tasks and precautions. Participation was voluntary and prior consent was obtained. All participants were assured of anonymity. During the experimental session, the participants were required to provide their demographic information before they were introduced to the NFC home system. All participants were given a set-top-box and an NFC card to operate the home appliance; in this experiment, it was a lamp. After completing the experiment, each participant was asked to answer a questionnaire. Face-to-face interviews were then conducted. During the interview, semi-structured and open ended questions were asked, allowing the older adults to articulate their experiences and needs regarding the NFC home system. The open ended questions asked about the participants’ feelings and experience when using the home system, difficulties in using the home system, their attitude towards the home systems, the role of new technology in their lives, and their attitudes towards new technology. The questions were pre-tested with ten older adults (n=10) to check if respondents could understand the questions as intended.

**Interview questions**

The first interview question was “Please describe your experience of using the NFC home system,” which was followed by discussion prompts tailored to individual hands-on experience of using the NFC home system. The second question, “How do you feel when using the NFC home system?” encouraged participants to discuss their feelings toward the NFC home system. The third question, “What were the difficulties/barriers in using the NFC home system?” was asked so participants could describe the difficulties they encountered while using the system. The next questions, “What did you like and dislike about the NFC home system?” and “Do you think new technology such as this NFC home system will help you live a better life?” were asked to encourage participants to describe their attitudes toward the NFC home system. The interview ended with discussion questions on what and how new technology could impact the respondents’ daily life.

The interview was audio-taped and then transcribed. Common insights were identified and coded in a code book. Themes and subthemes were identified from the coded data.

**Results**

The qualitative evidence was categorized into four meta-themes for factors, namely, product, personal, economic and desired outcome/benefit.

**Product factors**

**Ease-of-use**

When discussing what respondents liked about the NFC home system product, 118 participants mentioned the ‘ease-of-use’ feature. The most frequently reported ease-of-use descriptions were ‘simple’ and ‘practical’.

Most respondents found the NFC home system easy to operate using the tapping mechanism tap to turn on/off. The steps in the process of using the NFC home system were easy to remember and the process was manageable given the age, frailty or other age related health conditions, e.g., stroke, which may affect the abilities and mobility of older adults. Several of the adults over 60 years of age indicated that

### Table 1. Participant demographics (n=118)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency</th>
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<tr>
<td>Gender</td>
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<td>3</td>
<td>2.5</td>
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very little effort was needed to switch on/off the home appliances. Below are some selected quotes:

“It’s very easy to memorize and easy to operate” (RC2011, female, age 61).

“Easy to turn on/off the light which means that walking around is not required” (RC1021, female, age 65).

“Meaning just tap. I don’t have to… err… you know. Very little effort needed” (RC2007, male, age 60).

“It is easy to operate, because is just, is just putting down the card only” (R1047, male, age 72).

“What should I say? Ah…(Paused for 2 seconds) Like in the hotel they use cards to open the door, easy, you don’t have to search for the keys. For example, you don’t have to search for which switch to put on the light you want. Here you have the card ready, when you tap it on, it’s on” (RC1014, female, age 69).

Simple
A total of 118 participants indicated that the NFC home system was convenient and simple to operate. The NFC home system was simple to operate because no complicated steps were required, and not much effort was needed to access the system. A 91-year-old female participant indicated that anyone who is an older adult or for that matter any other family member will be able to operate it without difficulty. A 70-year-old male respondent said that the home system was simple because it was just a matter of lifting an arm and using fingers without having to leave the bed. This notion was supported by a 61-year-old female participant who mentioned that the lamp can be switched on while one is still in bed. Another 78-year-old male respondent said that it was easy to teach others to use the home system as well. It will also be simple to operate for home users with disabilities. The following are the sample quotes:

“Yes, I think anyone can use it because it is simple. Every family member can easily operate it and very convenient” (RC1001, female, age 91).

“There is no difficulty… it’s… yea, there is no obstruction, nothing… simple to operate, there is nothing… Well, it is just a matter of lifting the finger up and put the finger there ma… the hand there ma… nothing else” (RC2034, male, age 70).

“For instance, when I am on the bed, I can just switch on or off the light without getting up” (RC1015, female, age 61).

“It’s pretty simple. All you have to do is take the card and tap it on the box and it’s done” (RC1029, female, age 62).

“It wouldn’t be confusing, very simple. Ah, for me, for us, switching on lights, these things are very simple only. Touch and go, just like us going out, like that. It’s very simple” (RC1011, female, age 65).

“Because some people, their legs have no strength, or that they cannot walk, this sensor, put it beside their bed, once they cover (tap), once it covers, cover, then it can switch on or off” (RC1040, male, age 64).

“Adults, children all might know how to use. Like this take away, stick it back and then take away, then it turns off, a lot of people also know, should be, easy to teach” (RC3041, male, age 78).

Practical
A total of 107 participants reported that the NFC home system was practical in terms of their needs. A 76-year-old male respondent mentioned that it was not necessary to look for the wall switch or walk towards the switch in the dark. The peripheral device and the card can be placed by the bedside and can be operated while the user is still in bed. This is practical for the older adults as it avoids accidents like falls in the dark at night. A 67-year-old female mentioned that the NFC home system was practical for older adults who felt tired when they woke up and were unable to walk to the wall switch. Another female participant found it practical for those with incontinence in that they did not have to grope in the dark to reach the wall switch. Older adults can use the card placed by the bedside to switch on/off the lights when in need of an immediate restroom visit. In this instance, older adults do not have to worry about leaving the lights on all night in case they have to go to the toilet. Also, a lit room will often result in difficulty in falling asleep, resulting in sleep deprivation due exposure to light all night.

The operation of the home system does not require any physical strength which makes it practical for the user. One respondent indicated that the operation of the device is straightforward and no instructions are needed. In fact, the steps to operate the system are easy to remember and this makes it practical for older adults who have memory problems. A 76-year-old male respondent indicated that the NFC home system is similar to the remote control used for an automatic gate because it can be operated from a distance. A 60-year-old female participant compared the peripheral device (card) to the Hong Kong Mass Transit Railway (MRT) card where users just tap
Usage and acceptance model

their wallet containing the card on a reader to pass through the gate. Likewise, another participant associated the home system (which is simple and practical) with the ‘Touch n Go’ smart card, an electronic toll payment system used by Malaysian highway operators. A 55-year-old male respondent suggested that this home system is useful and practical for a large gathering of people in a big hall. In such a situation one can just tap to switch on/off the lights instead of having to communicate with those nearer to the switches. Overall, the home system also comes across as an easy-to-manage and a handy device for the elderly.

“It is not necessary to walk towards the switch to put it on and it is easy to put it off as well. Overall, it is a very good appliance” (RC2003, male, age 76).

“When you know how to operate the light system it will be very easy. Even for the normal light system, you need to walk and you can fall over suddenly? So, this is the first benefit” (RC1016, female, age 67).

“You don’t need any physical strength or anything like that lah” (RC2006, male, age 68).

“It’s very easy to memorize and easy to operate” (RC2011, female, age 61).

“This box works like a remote control. You can operate it even from a distance. Just like our gate, which you can open with a remote control when your car reaches the gate” (RC2003, male, age 76).


“I would suggest ideally this apparatus is good for a (3 second pause) church hall where we have community gatherings or in other places. 40-50 people attending such a meeting so, we can get these things to put the lights on. You can signal that fella to on this light and that light ah. So, this apparatus will be easy. The one operating ah can easily tap only then the lights come on. You don’t have to signal to somebody” (RC2005, male, age 55).

“It’s something new lah. It’s a new technology as far as I see, you know? And then for senior citizen ah, it is easy to manage, to handle lah. It’s like a toy, you know? You can play around” (laughs) (RC2005, male, age 55).

“If the card is like the Hong Kong MRT then you put in your wallet and you tap it, the machine can also sense it, and then it will be even better. So, you don’t have to hold the card everywhere you go. If you could make it like that it would be even more convenient. The elderly or anyone could use it better” (RC2009, female, age 60).

Security

A possible misplacement of the peripheral device (card) is seen as a security issue. The interview also captured the product features of the NFC home system that older adults disliked.

Generally, the respondents liked the NFC home system as they did not have to walk towards a wall switch and grope around in the dark in order to turn on a light. Although the NFC home system can be very convenient for older adults, they were anxious that the card may be misplaced. In this study, 18 participants expressed their concerns about losing the card. Participants said that carrying the card was fine but misplacing the card disturbed them. This is not surprising because decline in memory is often associated with normal aging. Therefore, older adults need to worry about losing things or misplaced their possessions. Misplacing the card and trying to remember where it is, will be a cause for concern for older adults.

Also, there were concerns that the card might be moved or taken away by other people. Some of the participants indicated that if the card is removed from the set-top-box, they fear that it will be misplaced when they need it. In this context, some participants suggested a better space or system to store the card together with the set-top-box. Below are examples of quotes:

“Difficulty to me as an aged person is maybe the loss of the card. I may misplace the card. I don’t know how many cards we need or just one card. Sometimes, we tend to forget where we put the card. That’s our challenge” (RC2007, male, age 60).

“I’m actually worried the card can be lost easily. You cannot use it anymore if it is lost” (laughed) (RC1019, female, age 64).

“Yes, I am afraid that it will be lost. My grandchildren will lose it” (laughed) (RC1030, male, age 77).

“Actually… if… sometimes it would, ahh, sometimes it would. Sometimes you put it on the table, then you might forget”. “Make some spaces to put the cards. Oh (yes), it is best if it can store the card too” (RC1031, female, age 62).

“It is very convenient but provided the card handling uh should be together with the, with the unit” (RC2001, male, age 67).

“Some people itchy-handed (手多多) take it away then no more already” (RC2042, female, age 63).
Usage and acceptance model

Personal factors
Fear-of-use
Participants expressed both positive and negative attitudes about their fear-of-use towards the NFC home system. A total of 103 participants indicated a positive attitude towards the NFC home system.

Positive attitude
Among the respondents, 103 older adults were not fearful about the use of the home system as they found no apparent danger when they used it. Some were a little fearful but still willing to use the home system. For example, an 84-year-old female participant had a certain degree of fear in using the home system, but she was willing to learn to use any device if training or guidance is provided. Other participants indicated that there was an initial fear towards the home system but this was overcome after the initial process of handling the system.

A 60-year-old male participant indicated that the NFC home system was just an ordinary appliance. Another 66-year-old female respondent expressed her opinion that the NFC home system can be used during a thunderstorm, and there was no fear of being electrocuted. Overall, the NFC home system came across as a safe device to many of the participants. A 65-year-old participant also said that this new product encourages users to keep up with technology.

"Of course I want such a device, but I am scared because I don't know how to use it and need someone to teach me" (RC1034, female, age 84).

"I am not scared, what is there to be scared about? (chuckles) There isn't any danger..." (RC1004, male, age 78).

"It's ordinary, nothing much. I don't have many opinions about it; it is just an ordinary appliance" (RC1005, male, age 60).

"It's not scary because it is not dangerous. Why would I be scared? It's just a card and it's convenient. Even though it's raining heavily with thunder you won't be afraid to get electrocuted with the card" (RC1012, female, age 66).

"Yes, initially quite apprehensive and afraid of using it. But once you get used to it..." (RC1009, female, age 57).

"I will use what is invented by the inventors. We need to keep ourselves updated with new technologies" (RC1021, female, age 65).

Negative attitude
Some participants expressed negative attitudes towards the NFC home system. A 77-year-old male respondent indicated that the home system seemed confusing sometimes. Other participants raised concerns that the home system did not light up or switch off when the card touched the box. They said they would get anxious and upset when the home system did not function according to their expectation. A 70-year-old male participant said that locating the card (in the dark) was a problem.

A few of the participants were concerned about the side effects of the NFC home system to their health. They did not understand what was embedded in the card. This created concerns that there might be side effects, e.g., cancer, with long term use when the card touched one's body.

One participant preferred the wall switch as opposed to the home system. Another participant did not like using products like the NFC home system as he becomes weaker with age he will not be able to cope with changing technology in the future. A few participants had a negative view of learning and using new technology. These older adults can be described as ‘technophobes’ who fear, dislike or avoid new technology. Below are some sample quotes:

"I think possibly confuse, sometimes" (RC1030, male, age 77).

"Yes, I'm afraid I did not touch the point (on the box) properly and light cannot be turned on/off. Just have a thought about it and worry at the same time" (RC1019, female, age 64).

"Because as I said just now, you got to locate a card, you got to locate a controller, and you want to do it at night, when there is no light, it is very difficult" (RC1027, male, age 70).

"If the card touches this, we don't know the side-effects/ repercussions. The card inside got something right? So, you cannot put it near the body always" (RC1028, female, age 67).

"What I scared the most is side effect. When you used it for a long period there might be side effect that will affect your health. Maybe it will trigger cancer when you use it frequently. This is my concern" (RC1012, female, age 66).

"I don't know how to use technologies since I last time" (RC1030, male, age 77).

"But you have to have an electric source. You need to plug it in an electric source. (pause) In short it is not more convenient than a remote control" (RC1040, male, age 64).
Usage and acceptance model

“When our age goes up is very hard for us to follow nowadays, the technology that we see, we can’t follow” (RC1041, male, age 75).

[Question: Would you want to use it?] “No lah, never thought of it” (RC1042, male, age 76).

“But I can learn, but I don’t want to be bothered about it. I don’t want to learn. Don’t want to be troubled” (RC1043, male, age 71).

“I am not so good at it” (RC2003, male, age 76).

“For example, the alarm system, I don’t use it. I’m scared I forget the code” (RC2014, female, age 74).

“When I first started using technology ah, I didn’t know how to type so that was the one put me off. Then I have to search the size of the letters and whatever it is lah. Then you have to search for it and you know the new one not so bad you can have the big alphabet. Last time you have 123 all in the same button. Then you tap tap tap. Waste so much time” (RC2014, female, age 74).

Personality

The interview also noted older adults’ ‘active’ (or a ‘passive’) attitudes towards the NFC home system, because these attitudes can provide insight into individual personality with regard to the adoption of technology.

Active

Among the participants, there were active technology users. These active users were keen to improve themselves and to keep up with up-to-date technology. They want to keep up with their friends and society at large and have been exposed to modes of communication like Skype and WhatsApp. For other participant, technology is seen as part of life. Some of the older adult participants showed willingness to try any form of new technology.

One of the participants was not fearful of using computers because her grandchildren used such technology without any adverse effects that she could detect on them. A 69-year-old female participant could not afford to buy technological items but was willing to recommend new technology like the NFC home system to her friends. Other participants such as a 63-year-old female wanted to keep up-to-date with technology. For one interviewee, the computer sort of filled the void in his life and he was able to immerse himself in various activities using the Internet. Some other participants tried to keep up with new technology. A few of the participants were keen to use other technologies such as solar, sound technology and cloud computing. Others suggested substituting the card with a phone for the NFC home system. Some sample quotes are as follows:

“Because we need to improve ourselves in this new era. I need to learn new things that I don’t know. Many things nowadays are uploaded online and we might not aware of them which slow us down” (RC1015, female, age 61).

“If everyone is using it you must adapt to the current flow of society. Whichever is more convenient and most suitable then I would use” (RC1029, female, age 62).

“Now, in fact I’m thinking of putting in a solar system if I were to build a new house” (RC2019, male, age 69).

“I am very happy with it, part of it it’s my life, you now? I can be alone… Yea I can be alone and immerse myself in these kind of things, the whole day. All these Skype, and what’s app, all these things. So, here is no more tension la, I can see my children even where they are, so pick up the phone and click here and click there I know where they are” (RC2034, male, age 70).

“I used to watch my grandchildren use computers, I think it’s very convenient and simple. No much difficulty. I will not be scared that it will be dangerous, where to plug it in and how to use it. If my grandchild teach me, I also will know how to use it” (RC1012, female, age 66).

“It’s nice of you to tell me these things, new, new technology, new things coming in the market. If I cannot afford to buy, I can recommend to other friends to buy” (RC1014, female, age 69).

“I want to learn how to use a computer and upgrade myself” (RC1017, female, age 63).

“Keep upgrading myself and learn many different things. I have a lot of dreams that have not been achieved” (RC1017, female, age 63).

“Now, in this current world, we must always upgrade ourselves” (RC2012, male, age 64).

“I am learning how to use Samsung phone and surf the internet” (RC1017, female, age 63).

“We just follow the flow. They produce it then if we feel that it is suitable then we will use it” (RC1045, male, age 56).

“The Cloud computing is a one area that I’m proposing. Because recently we have a problem ah on the Prime Minister Hibiscus Award assessment ah
we are talking about environmental friendly. Last time, we don’t ask people to send in papers submission now we ask people to send in CD. Now, instead of sending CD, we still consuming materials. So, we said why not send all your documents in the Cloud then we access it in the Cloud. That’s a very good technology. Of course, the solar technology is a very good technology to be installed at home. ‘Cos Malaysia we are not reach that stage where we can install enough solar, we can sell back the power to the power generator. My brother in Australia is doing that. Japan is doing that over many many years ago already. Malaysia I think we should think of that. Recently, I went to Kota Kinabalu, I met a contractor who actually volunteered a solar project ah, where he built a taxi stand solely plant by solar technology. It is a unique project lah. It’s good thing that we have this solar. The other thing is that our light. Sound technology that can be used for people who are blind. I think Malaysia we are very backward in some technology. You see the Singapore; they have already, even at the traffic light got the ta ta ta ta ta then the blind fella will know,’ Ok, red light.’ But, Malaysia ah. KL. I haven’t seen ah. One or two places they have. But, actually poor lah our technology I think sound technology will have for the what you called the house ah. There are emerging technology that ah can be... let’s say when you stay then you know this is your home, your door. Then you are clear to enter” (RC2007, male, age 60).

“I prefer the phone so everything is there. Everything put there so light system just tap light” (RC2007, male, age 60).

Passive Some older adults were relatively passive towards the NFC home system. In some instances, there had been a lack of facilitative support to assist older adults in using technology. Some participants said that they were willing to use technology if someone would teach them how to use technology. However, they were not willing to reach out to acquire the skill if no one offers to teach them. A 66-year-old male participant said that he will not seek out new technology. A 65-year-old female respondent indicated that she will not learn how to use a computer because it might make her sedentary in the long run.

“If you teach me something and I understand it, then I will use it. If you don’t teach me then I can’t use it” (RC1004, male, age 78).

“My son won’t teach me, and I don’t have the time to learn things like this. Because if I learn how to use the computer, I wouldn’t move away from the computer and I’ll be living a sedentary lifestyle” (RC1021, female, age 65).

“I am not highly educated, I have no opinion. The most important thing is that the inventors invent products that are convenient for the elderly” (RC1016, female, age 67).

“I wouldn’t want to go out and seek new technologies” (R1025, male, age 66).

“We are so old. We will never learn it. We only know how to turn on the television, air conditioner, and kettle…” (RC1033, female, age 79).

“If you teach me something and I understand it, then I will use it. If you don’t teach me then I can’t use it” (RC1004, male, age 78).

“Price is always a factor” (RC2013, male, age 76).

“Hmm unless very reasonable price, then it’s okay” (RC2013, male, age 76).

“All these... you listen carefully to this sentence, young people thinking and old people thinking is absolutely two different matter. For you all, the more trendy the more advanced the better it is. But us we are going backwards. Don’t say that people become older, 70 80 years old still can do what young people do, which is impossible” (RC2040, male, age 68).

Economic factors Cost Cost was a frequently reported economic factor affecting technology acceptance and adoption. The older adults were concerned about the price of the NFC home system. The technology may be useful to older adults but high cost may deter them from buying the set compared to keeping their existing system or getting an available less technical alternative. Another deterrent was power consumption. A 67-year-old female mentioned that she limits the usage of everyday household technology due to electric power consumption. Electricity consumption is a big concern for older adults as many of them have to be cautious with their expenses because they no longer have much income. A female participant indicated that if she had to change her home system, she would require 10 different cards for 10 switches, resulting in additional costs. According to a 76-year-old male participant, replacing a lost or damaged card would also incur additional cost. New technology may be practical and may enhance the quality of their lives but technology usage can be expensive.

“Price is always a factor” (RC2019, male, age 69).

“Hmm unless very reasonable price, then it’s okay” (RC2013, male, age 76).

“The only thing you worry is for senior citizen that it’s very costly. The cost to acquire one - that is the big question mark” (RC2006, male, age 68).
“Hmm, what I think ah… this technology since is out, honestly lah, feel that it is very suitable and very satisfied to use it. But have to see if we know how to use or not. See the price of the thing. For example, compare to those normal ones then if too much difference then people can’t afford to buy it. If can then honestly it is very convenient, very simple lah (laugh) that’s all I can say.” (RC2017, male, age 59).

“Oh (understood), high power consumption, later… he/she will also consider, because later when they’re paying the electrical bill… (chuckles) then they’ll complain” (RC2033, female, age 69).

“Does it use up a lot of electrical power? (chuckles) Sometimes if it uses up a lot of electrical power then they will complain” (RC2033, female, age 69).

“Rice cooker ah. Now everything is simpler because most of it run using electricity. But, I rarely use electrical items because electricity became more expensive. Last time, all my items run on electricity, now very much less” (RC1028, female, age 67).

“Cost say, there will be more than 10 switches in an average family. So if you want to change to card system then they will more than 10 cards” (RC2001, female, age 67).

“If grandchildren take it away, you will have to buy a card, every now and then you will have to buy. One year, you may have to buy at least 4 or 5” (RC2013, male, age 76).

Desired outcome or benefit
Enhanced quality of life
A total of 118 participants indicated that new technology such as the NFC home system could enhance the quality of their lives. Technological items like the home system can give them a better life as in the future. This is because an older adult will not have to walk to the wall switch to put lights on and off, but is able to use the card which can be placed on a bedside table as pointed out by a 69-year-old female participant. Technologies like the home system make their twilight years more enjoyable. A 67-year-old participant cited the convenience of the home system for reading a book and enjoying it. It can be particularly useful for those with vision problems because the home system just requires a tap with the card. A 65-year-old female participant indicated that the home system would be useful for those with disabilities. Such devices may mean that disabled individuals would not have to depend on carers quite so much. Some participants were happy with household type technologies that serve to help with daily activities and enhance the quality of their lives. Their experience with everyday technology that has been incorporated into their lives has been found to enhance the quality of their lives.

“Oh… it will help most of the people to live a better life… Like older people, they don’t like walking distance to put on the switch. They want a device to be near them, so that when they touch it the light is on. They don’t have to walk a distance to put on the light” (RC1014, female, age 69).

“Well it’s improvement in lives” (RC3017, male, age 64).

“If I need it then it would give a better life, but if I don’t need it, it wouldn’t affect much” (RC1023, female, age 73).

“Of course, I hope I have time to enjoy all the benefits, even at my twilight, you know? twilight years… I am very grateful that I can enjoy the Internet, because this came along the in last 6 or 7 years. I am able to enjoy it, I am very thankful to god and everybody, that I am still alive to enjoy all the benefits. Technologies, my tension is less, because those days you know, when you coming back late, you can’t even contact them, you don’t know where they are… Now, you when you click your phone you know where they are already. You don’t have to worry ma… Even they are at Penang, or where you know, even at 3 o’ clock” (RC2034, male, age 70).

“Especially for people that are reading or studying, they can switch on the light easily to check the time only with a tap and because of the fast speed” (RC1016, female, age 67).

“Oh, I will like it if there is any because my eyes sight is really bad now” (RC1016, female, age 67).

Happiness
Happiness is translated from the word ‘Eudaimonia’ from Aristotle’s ‘Nicomachean Ethics’. According to Kraut, “happiness is a psychological state and nothing more; it involves, among other things, the belief that one is getting the important things one wants, as well as certain pleasant affects that normally go along with this belief”. The NFC home system made some of the older adults happy and was thought to improve their lives and. This is because it is easy to use, simple and practical. An active user of technology would get pleasure as well as practical benefits out of using the home system.

Innovative technologies like the home system are helpful for leisure activities like reading. A fe-
male participant aged 84 mentioned that she had the habit of reading before falling asleep. With the home system, she does not have to get out of bed to go and switch off the lights. She added that in case of her having to leave her bed she might not be able to fall asleep again. A male participant aged 72 indicated that the home system will add to his comfort as he could easily control the light. If he heard a sound of someone entering the room, he could switch the light on. Another participant found the home system magical and fun to use. Use of technology in general can be a pleasant experience for older adults, some saying that it is enjoyable and makes them happier. A female participant found life easier with technology, even her grocery shopping. A 70-year-old male participant found technology useful. He hoped to enjoy life beyond 70 years and live comfortably with advances in technology such as the NFC home system. The following are sample quotes:

“Sure, it can help me to become happier” (RC1001, female, age 91).

“Huh? Is very good life, very enjoyable” (RC3035, female, age 82).

[Question: “Do you think it is good to have new technologies?”] “Of course, especially for lazy people like me, I will 100% agree” (RC1020, female, age 61).

“I like it. It can control everything” (RC1033, female, age 79).

“I am lazy, and I read books every night before I sleep. Sometimes I fell asleep and did not switch off the light. Right now, with this light system, it will turn off immediately without having me to walk towards the switch. Because after you get out of the bed it’s very hard to sleep. When I feeling sleepy I can tap the box. I am lazy” (RC1036, female, age 84).

[Question: “Do you think new technology such as this home system will help you live a better life?”] “This one will be better la… Live better la. Easy, not dangerous la. Because no need to get up la, just by your bedside, very safe la” (RC1038, female, age 71).

“If I can use the computer, then I can use less time, there’s those eyesight courses, 10 small course also OK, then I don’t need to waste my time at home and at the shop, gossiping” (RC1040, male, age 64).

“Yes, definitely, because you don’t have to move around. You could just lie down on the bed and tap and the light would turn on. Then, it becomes very convenient. Normally, when we want to go to bed and I want to read something, I would have to get up to walk and turn on the light so it’s a little troublesome. But if I want to check what time is it, all I have to do is tap and I would know the time” (RC2010, male, age 69).

“Do wonders with these things, the thing that will affect your this thing, that thing you have to be careful la, but it helps a lot, but I don’t have these, I think I don’t know where I will be, I am very dependent on technology, thank you for… thanks to the advancement of science, we are able to enjoy healthy life at my age, that’s my… thank you” (RC2034, male, age 70).

Independence
The home system should help to give older adults independence especially when they are unable to move around upon waking up or when they have to go to the toilet. This is helpful to those with eyesight issues and for those who are immobile, affected by strokes and individuals who, for any reason, may find it hard to dress and get

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know because in the dark people will be scared brightness bring people confidence we can see around the surrounding. No intruder or anything” (RC1047, male, age 72).

“If it’s multipurpose use, you can turn on the air-conditioner; or the TV, you know, as you said before, you have a picture of an air-cond, TV and all that. You tap on that and it get. Life is very simple lah. It makes it easier, you know” (RC2006, male, age 68).

“Makes your life easier. Whenever you need to search for anything that you would normally not find anywhere, all you have to do is Google. For example, even if you want to do grocery shopping, you could also do it online” (RC2009, female, age 60).

“I am already 70 years old; the lifespan of the people in our country as far as I know is 70 on only… I hope to extend and look forward to more… see more new inventions la… to help people who are this age la… to enjoy whatever number of years they have left… to enjoy comfortable life la… not extend… no superman la… to enjoy la, I am enjoying… all these things I am enjoying…” (RC2034, male, age 70).
around. By using the home system, older adults will not have to walk some distance to a wall switch - a point made by a 60-year-old participant. The home system can be very useful in that it can play some part in reducing dependence on carers. A 71-year-old female participant felt that technology like the home system was useful for those who were using walking aids like the wheeled walker but added that this did not apply to her. Another respondent mentioned that this home system was useful for those with disabilities or motor symptoms like tremors while another person mentioned it as being useful for those afflicted with Alzheimer’s disease. For both these situations technology provides some degree of independence for the older adult. A 68-year-old male respondent mentioned that the technology used in the home system could be useful for other household items for the aging population e.g. a medication management system to remind the older adults to take their medication or voice activated technology to read books to them. However, he was pleased with the home system. By using technology the individual does not have to be so dependent on care givers.

“Ah… it will help most of the people to live a better life… Like older people, they don’t like walking a distance to put on the switch. They want the device to be near them, so that when they touch it the light is put on. They don’t have to have to walk a distance to put on the light” (RC1014, female, age 69).

“Very advanced, not much to dislike about it. It also saves a lot of space and is good for elderly that are immobile. Nowadays, many elderly are unable to walk and have some problem with their sight, this light system will be helpful for them” (RC1017, female, age 63).

“No need to ask other people for help” (RC2029, female, age 72).

“At least they are helping me in err. and helping in life as well as err helping in enjoyment, helping in every sense. Helping to ease one’s life. One’s work. Making things…fantastic” (RC3012, male, age 56).

“Er… (pause) This would be useful actually in the… (pause) old folks’ home or in areas where… where very… old people who are somewhat immobile and er… they need to have light before they move out of their bed, to move, to go to the bathroom and that” (RC3019, male, age 72).

“It is really helpful for those that are completely immobile” (RC1018, male, age 62).

“It’s for those lazy people. It has the same concept with the remote controls, then you wouldn’t have to move about” (RC1029, female, age 62).

“For those older people la, who, are using a walker, this one will be useful” (RC1038, female, age 71).

“Should be fine. Because, I’ve seen a person with his/her hands and legs shaking badly, but still able to live his/her solitary life. Independent life, not solitary, independent life” (RC1040, male, age 64).

“One way they can actually use is, you know, elder people they usually need to go to the washroom in the middle of the night. They usually need to get up and switch on the lamp first. So, what this device can help is to just place next to them and then you just tap and wait the light on first then only can get out. So, it kind of helps the process for some people but of course, some people say I have my own lamp which is next to me as well, but erm maybe, you know, not everyone will have a lamp next to them. So, the device can actually control the light system. Not just lamp so just it’s your room light system as well. So, in a way it helps also, you know right?” (RC2006, male, age 68).

“Because when… you see ah, if you save man-power, the card you can keep yourself, you can whatever you want to off, on or on, do it yourself” (RC3044, female, age 80).

“Hmm.. Let me see. (5 seconds pause) Like the old people medication is very important and medication you always have some health issues. So, the time – when no one is around, the time to take the medicine, there must be some kind of technology that help the man to remember that this is the time to take the medication all that, you know? Maybe, tap on something and the medicine will pop out. You don’t have to go look for the medicine” (RC2006 male, age 68).

Convenience
When discussing what respondents liked about the NFC home system, respondents frequently mentioned its convenience aspect for older adults. It is convenient for an older adult with mobility issues or perhaps vision problems at night when it is dark. The older adults do not need to get up and walk in the dark to look for the wall switch. Instead he or she could just tap the card and the light comes on. The tap of the card and the speed at which the light comes on is particularly convenient. It is of great convenience when one has to go to the toilet especially the elderly who frequently visit the toilet at night. One of the participants described the experience
as similar to the use of cards in hotels to open the doors of the room. The card is simple like a credit card and convenient to carry around. It can be placed in a bag for safe keeping. It is also convenient to use and also operate. The speed at which the home system lights up is faster than a fluorescent lamp. This is particularly convenient for the weak, those who are immobile etc.

The use of the card was particularly convenient for a 66-year-old female participant as she pointed out that if she walked away from the wall lamp switch, she could still easily switch the light on or off using the device and save electricity. Without the device, one has to walk back to the switch, to switch it off. To another person the card was light and easy to tap, to switch on the light. This respondent found the device very convenient.

A male respondent found the design of the lamp appealing and trendier than fluorescent lights. He also preferred the card to wall plugged lights and switches that have to be removed when the light/lamp is not required anymore in comparison to a card. This home system can function without being plugged into the wall and is useful when there is no power or when there is a power failure due to power surge. Below are some sample quotes:

“Convenient and easy la...What should I say? Ah... (Paused for 2 seconds) Like in the hotel they use cards to open the door, easy, you don’t have to search for the keys. For example, you don’t have to search for which switch to put on the light you want. Here you have the card ready, when you tap it on, it’s on” (RC1014, female, age 69).

“The device is convenient. It seem that convenient in this case is refer to a person that may have mobility problems or eyesight problem or being able to switch on electrical appliances... Er... Either in the dark or perhaps from a distance where mobility is an issue...” (RC2008, male, age 60).

“This light is very convenient for elderly people, because they don’t need to get up, once you press it will turn on, press again and it will turn off. This technology is very advanced” (RC3035, female, age 82).

“Convenient, can use it anywhere. You can place it in a bag, pocket or anywhere in the house” (RC1001, female, age 91).

“Convenient lah and fast lah... Not to say is very difficult (mumbles)... Once you see then you know, 3 things 4 things then you know lor” (RC1002, male, age 74).

“It is very fast, if we want to use it, it is very convenient. We just need to tap it then it works, very fast. Turning on fluorescent lights still need to wait quite long. This one is very convenient, very good” (RC1004, male, age 78).

“I think it is very convenient. Also, it is nice for decoration. People nowadays will prefer this design for house decoration especially the trendy ones. It is very beautiful; better than the fluorescent light; very good-looking. Using card to control is very convenient, and good to use” (RC1012, female, age 66).

“It’s quite convenient. I can walk away anytime and switch off the lamp. When I return, I can put it on, then it will save electricity, very convenient. You don’t have to walk towards the switch every time to switch the light on or off. You can just sit at certain position and tap, so convenient” (RC1012, female, age 66).

“Bring convenience to the people even during blackout. During blackout you take the light around the house” (RC1047, Male, age 72).

“Convenient, meaning let’s say that my problem now is that I always go to the toilet at midnight for urine. So once I wake up, got glow in the dark ah to look for the switch. So, with this, I just take the card so that is convenient” (RC2007, Male, age 60).

**Discussion and conclusion**

The primary goal of this study was, using a qualitative exploratory approach, to explore the factors underlying the decisions of older adults in adopting or resisting technology. The qualitative evidence underscored four meta-themes namely; product, personal, economic and desired outcome/benefit. A model called, the Gerontechnology Usage and Acceptance Model (GUAM), is formulated, with these meta-themes (Figure 2). As shown, the product factors such as easy-to-use (simple and practical) and security (misplacement of peripheral devices) were the main predictors of desired outcomes for older adults (enhance quality of life, happiness, independence and convenience). These relationships were jointly influenced by personal factors (fear of use and personality) and economic factors (cost).

In this study, participants expressed the views that the NFC home system was easy-to-use, will particularly be convenient for those who are immobile, and will reduce dependence on carers or other family members. Older adults have been shown to have the capacity to learn to use new technology. In most instances, older people will use technology if it is beneficial to them.
One of the main concerns of the participants here was the misplacement of a peripheral device, in this case a card. This was a concern as increasing aging often brings with it an onset of declining memory. To most of the older adults interviewed, once the card is misplaced, it would be difficult to operate the NFC home system. Therefore, technology developers and researchers should look into an integrated product design for gerontechnology through an interdisciplinary dialogue between older adults, caregivers, family, healthcare professionals and designers in order to address the distinctive product handling features required by older adults.

Cost was the key economic factor raised by the participants. As cited by Carpenter and Buday, barriers to frequent use of technology include financial issues. However, in the gerontechnology literature, Mitzner et al. suggest that the benefits of technology often outweigh the cost. In other words, if the technology is not too expensive, older adults are more willing to use these products. One possible way to ease the financial burden of the older adults is the provision of grants, small loans or financial care systems by the government or local authorities. Examples include the social benefits managed by the Elderly Care in England.

In this qualitative study, participants expressed both positive and negative attitudes about their fear-of-use towards the NFC home system. This is not surprising as some older adults misappropriate and abandon technology while others appropriate and adopt new technology in their daily lives. Those with positive attitudes generally focused on the future and were active and ready for continuous change. Those with negative attitudes were more passive and not interested in learning and using new technology now or later. Therefore, it is important to explore ways of how to encourage the passive older adults to learn and use new technology to improve their quality of life. Hernández-Encuente et al. suggest that the way to change the attitudes of older people is through information and training, especially if the information and training comes from their age peers who are “one or a half step ahead.” This point has been well made recently in gerontechnology research, and it could be appropriate for governments, educators, and aged care practitioners to engage older adults as trainers in various collaborative training programs.

The use of NFC home system was found to enhance the quality of the life of older adults in terms of happiness, independence and convenience. A great deal of psychology literature has been published on the relationship between health and happiness. Studies on the Technology Acceptance Model (TAM) have largely focused on additional variables such as perceived enjoyment and perceived playfulness. However, surprisingly little research has focused on the question of how technology can increase individual happiness. In particular, little is known about older adults’ perception of technology and how it impacts their happiness. The pursuit of happiness is certainly important for older adults. From a theoretical aspect, this study provides a fresh insight for scholars and others in order to understand the influence of technology on older adults’ happiness while extending the scope of TAM study beyond perceived enjoyment and playfulness.

This exploratory study had four research limitations. First, the findings were based on data collected in Malaysia. Future studies should undertake more in-depth investigations on larger group of older adults from various countries. Second, this research was a qualitative exploratory study to investigate the older adults’ percep-
tion of technology adoption. Future research should include a more detailed survey questionnaire to validate variables that can provide a more generalized understanding of usage of or resistance to technology by older adult. Furthermore, future studies can analyze the effect of moderating variables such as gender, age and education that may affect the relationships between the variables.

Third, this study only examined one type of NFC home system (i.e., operating a lamp). This may limit the generalizability of our findings. Therefore, further research may examine other gerontechnology such as assistive technologies with various home-based applications to further validate our findings.

Finally, the data was collected from Chinese in Malaysia and therefore is constrained to Malaysia’s cultural and sociopolitical context. Future research can consider examining the investigated relationships with larger samples that are representative of the Chinese general population.

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