Impact of the psychological resistance and the trust-building factors
on elders' technology adoption decisions

by

Parth Vijaybhai Shah

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Supervisor Prof. Uma Kumar
Co-Supervisor Prof. Vinod Kumar
Carleton University
Ottawa, Ontario

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ABSTRACT

The increasing elderly population in western countries has created a shortage of personal support workers (PSW), and the current healthcare systems are struggling to keep up with the rising demand for PSWs. The coronavirus outbreak worsened the situation because PSWs were becoming a medium for the coronavirus to spread. However, the recent technological advancement in elderly personal care (e.g., Care robots, Ambient intelligence devices/sensors) provides a promising solution to these problems. This research studies how the psychological resistance and trust-generating factors affect the technology adoption decisions of elderly personal care devices. The moderating effects of age, gender, income, past profession, and lifestyle on the relationship between the independent variables (the psychological resistance and trust generating factors) with the dependent variable (technology adoption decision) were studied in this research. The study provides interesting results and proposes a new framework to understand the technology adoption of elders.

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CHAPTER 1 INTRODUCTION

In most developed countries, the population of elders has been increasing at a faster pace than the younger population can support them. Most western countries are struggling to provide adequate support to their elders. The increasing elderly population is also putting more pressure on the public healthcare systems. The COVID-19 pandemic crumpled the healthcare systems around the world, and the elders were at the highest risk. At the beginning of the COVID-19 pandemic, many countries were struggling to provide enough care/support workers to their elders in retirement/long-term care homes. For example, Ontario Health Coalition reported that on average long-term care homes were short five to ten personal support workers every day in 2019 (*Caring in Crisis: Ontario's Long-Term Care PSW Shortage Report & Recommendations from the Front Lines across Ontario*, 2019). The situation only got worst during the early pandemic outbreak in 2020.

Many researchers and companies have already started working towards finding a solution to these problems. Golant (2017) and Orlov (2011) sees the inclusion of automation, ambient intelligence, and smart home technology in older people's lifestyle as a solution to many of problems mentioned above. Automation and ambient intelligence can enable older adults to live healthier, safely, comfortably, independently regardless of whether they are living in an old age home or with their family (Orlov, 2011). The author considers that technology products can be a partial solution to many problems which were mentioned above. Technological advancements in the last decade have made many products accessible to the middle class and poor people. In this study, the technological products that can help elderly people as "Smart Home Technology Products (STP)" are presented. These smart technology products will include smart speakers, smart security

solutions, Robo-animals, various sensors, android/humanoid robots, etc. These products are explained comprehensively in the following chapter 2.

The study has focused on older people's behavior towards the adoption of the above-mentioned products. There are many different technology adoption methods and models that are popular for studying and understanding people's and organizations' behavior towards technology. Technology Adoption Model (TAM), updated version of TAM (TAM2), and Unified Technology Acceptance and Use of Technology model (UTAUT) are widely used models. However, with TAM, UTAUT, and their modified forms, there is an inherent problem when used for other than work settings. Various factors that significantly affect older people's decisions in accepting new technology were not accounted for in previous TAM, TAM2, and UTAUT models. Khalilzadeh et al. (2017) found that these models do not include the user's attitude, anxiety, and self-efficacy towards new technology. Min et al. (2008) found that the previous model does not include privacy and trust in technology into consideration for user acceptance, which has become a massive part of accepting technology in the internet age. In a study on mobile shopping behavior, Aldas-Manzano et al. (2010) argue that most technology acceptance models, including UTAUT, are developed for organizational contexts, which results in the neglect of consumer-related variables. In a study of the effect of social influence on other UTAUT constructs, É et al. (2015) failed to find support for the claim that social influence directly impacts the effort expectancy of technology.

In this study, older people's behavior is studied towards accepting new technology. Several factors were found which might affect elderly consumers' behavior towards technologically advanced products, which were not covered in previous models. This study

is proposing a new model that can be used for measuring and explaining older adults' technology acceptance behaviors by measuring their psychological resistance. The study has tried to find support for psychological resistance and trust-generating factors and their connection with each other to validate the proposed model. TAM, TAM2, and UTAUT were highly focused on the principle that technology is a new thing and how helpful someone perceived it vs. how useful they find technology when they use it. Many researchers have criticized TAM for its oversimplification of situations and how it cannot be generalized (Ajibade, 2018). Other problems that the author found with these models is that they were never developed with the focus on a person's ability to learn something new, what kind of psychological resistance a person has while accepting new technology. The proposed model tries to cover these problems that were not included in previous models.

In sum, the study has tried to understand the effects of various psychological resistance factors and trust generating factors found in the literature on the elders' technology adoption decisions with age, gender, income, past profession, and lifestyle as moderating variables.

The study is divided into the following chapters: Comprehensive overview of the STPs and robotic assistive devices, literature review, research questions and hypotheses, proposed research model, research methodology, data collection and analysis, results, and conclusion.

It may be noted that this exploratory study is part of a more extensive study undertaken by co-supervisors Dr. Uma Kumar and Dr. Vinod Kumar, for which funding has been awarded to them under Carleton University research grant number CU-COVID-19 RRRG-112984. The more extensive study has a broader mandate in terms of

variables/constructs, a much larger number of participants, and the use of advanced data analysis statistical techniques.

CHAPTER 2 OVERVIEW OF SMART HOME TECHNOLOGY AND ROBOTIC ASSISTIVE DEVICES

Since most western countries have a high cost of living and high labor costs, it created an incentive for many companies to develop robotic devices that can assist elders and disabled people who cannot afford the high cost of keeping a personal care worker with them all the time. It is a prevalent scholarly topic as well, due to that many academic researchers are also working to understand elders' behaviors and psychology to provide insights to entrepreneurs and designers for better and quickly acceptable/learnable devices.

These devices come in various sizes and forms, such as the following:

1. Robotic companion pets,
2. Care Robots,
3. Smart robotic companions for emotional support,
4. Wearable devices,
5. Smart home devices or Ambient intelligent devices,
6. Bathing and feeding assistive devices.

The main objective of these devices is as listed below:

1. To keep elders safe,
2. To keep elders connected with their family members,
3. To alert family/nurse/public authorities in case of emergencies,
4. To make elders more independent in doing their daily activities.

Besides these use-case scenarios, most of these devices can also be programmed to help a particular situation. In this chapter, an example of each of these devices has been given with an explanation of their best use case scenarios in the following subsections. For

ease of readability, the pictures of these devices are given in Appendix A. There are other even more sophisticated devices available to help elders, but the author has focused on devices that are affordable to average consumers.

2.1 ROBOTIC COMPANION PETS

The concept behind robotic companion pets is, elders with Dementia or Alzheimer's can have a company of a life-like pet that responds to their voice, touch, and motion just like a real pet, and it provides elders with emotional support or companionship in their golden years. These pets would not need their owner to feed them, wash them, train them, or clean after them. They run on batteries, and they are equipped with many sensors. Companion Pet Pup showed in appendix A is one of the many pet products offered by Ageless Innovation LLC to provide companionship to elders with Dementia/Alzheimer's. There are many other companies around the world making similar companion pets to help elders with emotional support and companionship. These robotic pets are available on several online websites starting at 150 dollars (for Canadians). (*Amazon.ca : JOY FOR ALL*).

2.2 CARE ROBOTS

Care robots are robots designed to help elders and people with disabilities to lead a more independent life than constantly relying on having a care worker or a family member help them. The currently available robots can perform a wide range of tasks such as bringing food, feeding, checking vitals (heart rate, blood pressure) at regular intervals; reminding about medication, exercising, staying hydrated and necessary appointments; connecting with doctors/loved ones through video conferencing. The robot allows family members to check on elders when they are outside; it can provide companionship and

entertain elders through music, cinema, and robot dance performances; it can alert family members/nurses for emergencies and call local emergency authorities by itself if needed. Many companies are developing modular robots nowadays, which allows them to put a replaceable arm on the robot, which allows one of its arms to be replaceable with a tray or small storage compartment for medicines/food. These robots are also becoming more and more interactive, easy to use/operate, so people with no experience with similar technology can also adapt to them easily.

Many companies also offer specially programmed robots for use in care homes that can take care of more than one person simultaneously. The care robot “Ruby” developed by INF robotics in the United States and the multi-purpose care robot “Care-O-Bot 4” produced by Fraunhofer Institute for Manufacturing Engineering and Automation from Germany are shown in appendix A. Both robots can perform most of the above-mentioned tasks with ease and can be programmed to do more things.

2.3 SMART ROBOTIC COMPANIONS FOR EMOTIONAL SUPPORT

The concept behind these robots is to provide elders with a companion who can understand them, talk to them, advise them and surprise them with some tips and tricks the same as a human being. Unlike robotic pet companions, these robots are very advanced and equipped with many extra sensors. They can sense a person’s presence in the room and initiate a conversation with the person, and they are programmed to understand the context of the talk or chat, and they will respond with appropriate emotions. Some of these robots can be programmed to become your friends as well. An example of such a robot is provided in appendix A.

The robot shown in appendix A is ElliQ designed by Intuition Robotics. It is designed to empower older adults' independence, and support them in leading happier, healthier lives at home. Over the years, ElliQ is supposed to become a true source of companionship, comfort, and fun for her older adult users through learning more about the users and using artificial intelligence to respond more and more like a human being. Here is a quote from Intuition Robotics about how ElliQ can change and fit into elder's life: "Unlike anything they have experienced before, ElliQ® is a friendly, intelligent, inquisitive presence in older adults' daily lives – there for them, in their corner, offering tips and advice, responding to questions, surprising them with suggestions – a dedicated sidekick on their journey through this remarkable part of life." – Intuition Robotics. Besides the above-mentioned use cases, ElliQ can also help them with medical check-ins, health records tracking, exercise, meditation, entertainment, and playing cognitive games to help keep up their mental health.

Just like ElliQ, there are other robots also available in different markets. Some examples are *BUDDY The Emotional Robot* by Blue Frog Robotics in France, *Ipalrobot* by Nanjing AvatarMind Robot Technology in China, etc. Unlike ElliQ, these robots are a little costly, but they come with wheels and move around in the house and help you bring or carry stuff as well, on top of the emotional companionship.

2.4 WEARABLE DEVICES

A wearable medical device can be described as an autonomous, non-invasive system that performs a specific medical function such as monitoring or support (Glaros & I. Fotiadis, 2005b). The term "wearable" implies that the device is either supported directly on the human body or a piece of clothing and has an appropriate design enabling its

prolonged use as a wearable accessory (Glaros & I. Fotiadis, 2005a). In the last few years, many companies have introduced various wearable devices that can track and log user's health information on the device or connected applications on their smartphone or personal computer. These wearable devices include Smartwatches, Blood Pressure & Blood glucose trackers, SOS devices & Location trackers, Activity trackers, etc.

2.4.1 SMARTWATCHES

A smartwatch is “a wrist-worn device with computational power, that can connect to other devices via short-range wireless connectivity; provides alert notifications; collects personal data through a range of sensors and stores them; and has an integrated clock (Cecchinato, 2015).” Smartwatches are wrist-mounted, and therefore possess substantial advantages over other devices: their mount location and the continual connection to the skin make them a great health tracker (Rawassizadeh, 2015). Currently, Apple Watch Series 6 and Samsung Galaxy Watch 3 are the most popular and most advanced smartwatches available to regular consumers (*The Best Smartwatches In 2021*, Forbes). Apple Watch Series 6 can measure your blood oxygen level with a sensor and app, and it can take an ECG (Electro Cardiogram) anytime, anywhere. It lets you see your fitness metrics (calories burnt, steps, distance ran/walked, sleep patterns, and many more) at a glance (*Apple Watch Series 6 - Apple*). “With Apple Watch Series 6 on your wrist, a healthier, more active, more connected life is within reach.” – Apple Inc. Apple Watch, Samsung watch, and most other smartwatches are equipped with sensors that enable them to track various vital signs. The author has only discussed a single product as a demonstration and an example of available smartwatch technology. Apple Watch Series 6

and various features available on it (*Apple Watch Series 6 - Apple*) are shown in appendix A.

2.4.2 BLOOD PRESSURE AND BLOOD GLUCOSE TRACKERS

Wearable blood pressure and blood glucose trackers are available in various shapes and sizes nowadays. In this section, the author has shown the best consumer blood pressure and blood glucose tracker as an example of each.

HeartGuide™ wearable blood pressure monitor by Omron Healthcare, Inc is a watch-like blood pressure monitoring device. It can be worn on the wrist just like a watch, and it will periodically measure the user's blood pressure during the day and send updates to their phone. Besides the blood pressure sensor, it is also equipped with an accelerometer and gyro-sensor, which can track the user's steps, exercises, and sleep patterns. The product is shown in appendix A.

The FreeStyle Libre 2 system by Abbott Inc. is one of the many continuous glucose monitoring devices available in the market. This system includes a wearable sensor that connects with the user's phone. It will measure the user's glucose levels every 20 minutes and send updates to the phone (users can choose to record blood glucose levels less frequently if they desire). It is shown in appendix A. It is a very convenient and easy way to keep track of glucose levels. It also has the feature to alert family members, caregivers, nurses if the glucose readings are too high or too low.

2.4.3 SOS DEVICES

There are various SOS devices available for many different situations elders can find themselves stuck in. There are SOS neck wearable pendants, wrist wearable watches, car adapters, keychains, etc., available for elders. These SOS devices can be divided into

active SOS devices and passive SOS devices. Active SOS devices are equipped with sensors that can detect emergency situations like fall, car accident, stillness or inactivity for an unusual period of time, and these SOS devices will alert the responsible person for immediate action. Passive SOS devices usually require users to press a button to ask for help, and they are generally only equipped with GPS trackers. Few examples of SOS devices have been shown in Appendix A.

2.5 SMART HOME DEVICES OR AMBIENT INTELLIGENCE DEVICES

The informal definition and idea behind smart home devices are to create an ecosystem of products/appliances connected through the Internet and make them interact with each other in order to give owner/user more control over the home at the same time providing more independence. An appliance or product that has the above-mentioned functionality added on top of its core functions can be called a Smart home appliance/device (*The Best Smart Home Devices for 2021 | PCMag*). Yoon & Jang (2012) defined Smart home appliances as home appliances that can provide customized content and smart-home service functions with network connectivity and various service control functions. Kim & Baek (2019) found the attributes mentioned in table 1 for smart home appliances.

Smart home appliances are the key component for home automation which will allow any home member of the house to control items around the home. It includes activities like controlling window shades, dispensing food in pet feeders, turning on and off lights, air conditioning, etc. It also makes home surveillance easy and better. In this subsection, the author has provided examples of various smart home devices available in the consumer market and how they can be a help to elders to lead a more independent life

at the same time providing good connectivity and surveillance features to their family members.

Table 1 Attributes of smart home appliances (Kim & Baek, 2019)

Attributes	Description
Context-awareness	To perceive the situation, environment, and condition in which a device works
Knowledge accumulation	To accumulate the data related to environmental changes and users' life patterns
Inference	To extract meaningful information from data analysis
Proactivity	To perform required actions without the intervention of users or a central controller
Machine to machine (M2M) cooperation	To share capabilities and functions with other devices to achieve a common goal
M2M communication	To share required information with other devices to achieve a common goal
Personalization	To tailor the function of the device toward the users' purposes and preferences
User-friendly interaction	To communicate and interact with users in a natural and humanlike way
Multifunctionality	To perform multiple functions
Business-awareness	To consider the business (business rules, business models, transaction models) and legal constraints
Semantic self-description	To perceive the goals, plans, designs, and semantic dependencies of both the overall system and each function, method, or module

2.5.1 SMART SPEAKERS AND DISPLAYS

A smart speaker is a speaker with a Virtual AI (Artificial Intelligence) assistant built into it which can listen to the user's commands, answer questions, control other connected devices and perform various actions – a loose definition of Smart speaker by Amazon (*Amazon Alexa Voice AI | Alexa Developer Official Site*). Currently, various companies are making smart speakers and displays in different shapes and sizes, but devices with Amazon Alexa and Google Assistant are predominant in the Smart home appliance market. Both of these virtual assistants provide compatibility with a large number of third-party product manufacturers.

These smart speakers or displays with virtual assistants can provide elders control over things like their home security, home temperature, home lightings, cooking appliances (giving commands to start boiling water, brew coffee), entertainment, providing information (weather, local business locations, and hours, reminders). The important thing about these smart speakers and displays is that the more user interacts with them, the more virtual assistant will learn about the user and customize itself to the user's behaviors, daily routine, and needs. Appendix A shows google home mini smart speaker & Google nest hub display (*Nest Audio, Amazing Sound at Your Command – Google Store*) and Amazon Echo devices, respectively.

2.5.2 SMART PLUGS

A smart plug is a small adapter that can be plugged into a regular electric wall outlet. It can be connected to the Wi-Fi network of the home. Once connected, smart plugs can be controlled remotely through the smartphone, the smart home hub, Smart speakers or displays, and other compatible input devices. It can be useful to elders for operating certain electric devices like outdoor motors, pumps, garage doors without going out of the house. Getting a smart plug is usually more affordable than getting automated or very sophisticated products that have non-frequent usage or has a high probability of failure. An example of a generic brand smart plug is shown in appendix A

2.5.3 SMART HOME SECURITY SYSTEMS

The smart home security system includes smart locks, smart doorbells, smart cameras, motion detection sensors. Smart home cameras allow their users to surveillance their property for any unknown or unwanted person without making contact with them. These systems can be attached to windows and front & back doors to detect any break-ins.

It can become very useful to especially elders living alone or only living with their spouses. An example of a smart home security system that allows users to watch the feed on their smartphones or their smart displays is (*SimpliSafe Home Security Systems | Wireless Home Security | Burglar Alarms*). With more technological advances and their usefulness, this feature is becoming more and more common in smart home security systems. Besides, current smart home security systems can differentiate between animals, pets, and humans; so, it does not go off when the user's pet is going in and out of the house, or some other small animals enter your property. An example of a smart home security system is given in Appendix A. It includes burglar alarm, motion sensors, glass break-in sensor, siren, security cameras, smart door locks and bells, SOS button.

2.5.4 SMART THERMOSTAT

“A smart thermostat, also known as a connected or communicating thermostat, allows you to create automatic and programmable temperature settings based on daily schedules, weather conditions, and heating and cooling needs” -Efficiency Vermont (*Efficiency Vermont*). Smart thermostats are always connected to the internet, and they can check the local weather conditions then learns and understands user's behaviors using artificial intelligence during the various weather conditions. With more data about the user, it can keep the home cozy for the user without the user needing to change or update temperature, ventilation settings manually. They can also be programmed to adapt to individuals in the households and keep comfortable temperatures for each user in their rooms. It can be very handy for the elders with problems of Alzheimer's or Dementia, and it has the added benefit of helping elders or users save money by not wasting unnecessary

electricity or natural gas. Examples of a low-cost smart thermostat and an advanced smart thermostat are given in appendix A.

2.5.5 SMART LIGHTING

A Smart light system is a lighting technology for smart homes that are connected to the internet. These smart lights can make decisions, follow schedules, and they can be controlled remotely using a mobile app, voice-activated personal assistants, or condition-based IFTTT (if this, then that) technology. They can be paired with the Smart hub, and it can allow elders to control the entire house's lighting without forgetting to turn on-off any lights. There can be motion-activated lighting for several parts of the house, such as the staircase, basement, hallways; this will ensure that even if an elder cannot find the light switch, they will still be able to see and keep safe. An example of a smart bulb is given in appendix A.

2.5.6 SMART HOME APPLIANCES

LG defines smart home appliances as “More convenient, more seamless, more integrated, more organized, more fun, and more connected devices that use artificial intelligence” -LG (*LG Connected Home | LG Canada*). Most Appliances manufacturers suggest a similar definition for Smart Home Appliances; it can be streamlined and presented as a device that is connected to the home network and can communicate with other devices in the same home, make certain decisions and perform the certain task autonomously using artificial intelligence to make its users' life easier and safer. Smart kitchen appliances can be a great help to elders living on their own. Some examples are given below, how smart home appliances can help elders live a safer and more independent life.

- Smart refrigerators can detect what kind of food is put inside when it was put inside and the expected expiration date; they can detect foods that are running low and make suggestions to users to add them to their shopping list. Some more advanced refrigerators can find out what user is missing in the refrigerator for a given recipe, and they are equipped with cameras that allow users to see what is inside from any place (*Home Appliances | Samsung Canada*). These appliances have many more unique features, but ones important to elders have been stated here.
- Smart Laundry machines can detect what type of clothes are put inside and wash/dry them accordingly, taking out the guesswork and ruining the clothes by mistake (*LG Connected Home | LG Canada*).
- Smart ranges, stoves, and hoods can communicate with each other and turn on ventilation automatically when something is being cooked. They can also be programmed to start air circulation if they detect bad air quality in the kitchen, which can include something burning on the stove or inside the oven (*Home Appliances | Samsung Canada*). That can act as an extra safety feature to fire hazards on top of fire alarms.

Many Smart home appliances are very promising, and they would be able to provide a lot of help to seniors who live alone by simplifying their daily chores.

2.5.7 ROBOT VACUUMS AND MOPS

Robotic vacuums can be very handy to elders who have physical problems. Cleaning a big house every day while living alone can be a huge task. The current generation of robotic vacuums offers hassle-free cleaning, vacuuming, and mopping. Ecovacs Deebot Ozmo T8 AIVI (*DEEBOT OZMO T8 AIVI - ECOVACS*) is used as an

example of a Robotic vacuum; it can vacuum the home as well as mop it. Ecovacs Deebot Ozmo T8 AIVI is an intelligent vacuum cleaner that connects with your phone through an application, and then it will measure your rooms. Once it is finished mapping your home, it can be programmed to clean and mop different rooms at different times. Appendix A shows Ecovacs Deebot Ozmo T8 AIVI.

2.6 BATHING AND FEEDING ASSISTIVE DEVICES

A crucial factor for living independently is the ability to maintain personal hygiene. Personal hygiene is one of the intimate and sensitive subjects in western cultures. It is usually carried out in privacy. Relying on support from someone (usually relatives or home care services) is often accompanied by feelings of shame and helplessness (Aronson, 2002; Franklin, 2006). Robotic bathing assistive devices can help elders maintain their dignity in their golden years. Currently, the most advanced bathing assistive devices include I-SUPPORT: a Robotic Platform of an Assistive Bathing Robot for the Elderly Population, Portable Wheelchair Safe Shower Stall by Agingcare. I-SUPPORT offers a very advanced bathing solution that includes motion sensors, a Kinect sensor as a 3D imaging sensor, and robotic arm hoses. Motion sensors and Kinect create a 3D image of the person, and robotic arms use that image to go around the person and bath/wash them (Zlatintsi, 2020). I-SUPPORT would require remodeling the entire bathroom and installing costly robotic arms. It is possible for hospitals and care homes while average elders trying to live by themselves might find it unaffordable.

Portable Wheelchair Safe Shower Stall by Agingcare is an example of affordable bathing assistive device. It is a portable stall that can be placed anywhere in the house with a water connection. It has a portable shower head, 4-side curtains, and a water collection

pan. It provides a full sense of privacy to elders, and at the same time, if needed, a caregiver or family member can come and help the elder while staying outside of the shower (*Portable Wheelchair Safe Shower Stall - AgingCare.Com*). Appendix A shows I-SUPPORT: a Robotic Platform of an Assistive Bathing Robot for the Elderly Population and Portable Wheelchair Safe Shower Stall by Agingcare.

Assistive feeding devices are available in various forms, and the author has used the example of Obi by Desin LLC (*Obi – The First Dining Robot of Its Kind*) in this chapter. Obi is a dining device for individuals who lack upper extremity function. It increases independence, social interaction, and effective food capture. It has four compartments to fill them with four different foods. Assistive feeding devices like Obi can keep elders living with their spouses or family members independent. Obi (*Obi – The First Dining Robot of Its Kind*) is shown in appendix A.

CHAPTER 3 LITERATURE REVIEW

In this chapter, the author has presented literature on problems of increasing elderly population, the novel coronavirus pandemic, and technology acceptance models. The chapter has been divided into three subsections. A detailed literature review on how the elderly population is increasing and how governments, public health systems around the world are struggling to provide enough care and support has been presented in subsection 3.1. Subsection 3.2 provides a detailed literature review on the current COVID-19 pandemic, its effect on the elderly population, and lessons learned from it. Subsection 3.3 is divided into two further subsections; subsection 3.3.1 discusses the literature on the chronological development of TAM, and subsection 3.3.2 discusses the problems with existing technology acceptance and adoption models.

3.1 INCREASING ELDERLY POPULATION AND ITS PROBLEMS

All of us are growing and aging every day. We, humans, have a finite life cycle, and we are in a race to expand our finite lives as much as possible. With more and more scientific findings and medicines to fight various diseases, we have expanded the longevity of our life cycle by huge margins. To put that in perspective, Researchers from Oxford University did a study on human life expectancy. Max, Esteban, and Hannah (2019) found that in the 1800s, the average life expectancy in the Americas and Europe was 35 years and 34 years, respectively, and the average human life expectancy for the world was 29 years. In the 1950s, the average life expectancy of North Americans and Europeans was 68 years and 62 years, respectively. The average life expectancy in Asia and Africa was only 41 years and 36 years which was very less compared to western countries. The average life expectancy was 46 years globally. Fast forward to today, the average life expectancy of

North Americans and Europeans in 2015 was 80 years and 78 years, respectively (Max, Roser; Ritchie, Hannah; Ortiz-Ospina, 2013). Scientific and Medical breakthroughs have helped humans expand our life cycle, but we are currently living in a world where the aging population is becoming a problem. The aging population is growing faster than the young population that can support them. Adding more to that, researchers forecast that the average life expectancy of North Americans will reach between 86.2 years to 89.6 years in 2050 (Olshansky, 2009). The increased life expectancy can be seen in the Demographics of the country's population. Globally, a rise in older retired people is being observed in many countries. On 1st January 2017, the European Union had a population of 511.8 million people out of 7.55 billion of the total world population. The young population (0-14 years old) constituted only 15.6% in Europe while it was 25.92% for the world and the working population in the European Union is 65.00% which is the same as the 65.38% for the world. That means the EU has a 19.4% population age 65 and over compared to only 8.70% for the world (*Eurostat*). According to the United Nations data (United Nations, 2019), there is one older adult (age 65 and above) in every eleven persons. This demographic is supposed to change to one older adult in every six persons by 2050. It is predicted that one in every four persons will be over the age of 65 by 2050 in Europe and North America (United Nations, 2019). If we talk about Canada, the country is currently predicting it will have more than 9.5 million Canadians above the age of 65 by the year 2030. That represents 23% of Canada's current population. The reason these numbers are concerning because the aging population poses various threats to the country's social, economic, and health systems. According to various national institutes in the USA, as the life expectancy of people increases, they will have more and more age-related disabilities, chronic non-

communicable diseases (i.e., Cancer, Diabetes), cardiovascular disease. It will require governments to spend more on health care to accommodate the rising aging population (Dobriansky, 2007). The family structure of developed countries has changed. People are living longer and have fewer children, which means they have fewer options for care when they grow older. Grant (2004) found that developed countries have more educated people; they live a planned lifestyle, which includes wealth accumulation plans, child plans based on their education. This lifestyle mostly favors late marriage, a single child, which is why the low birth rates in developed countries (Grant, 2004). (Jowit, 2013; Pettinger, 2019; Serban, 2012) have worked extensively to study the effects of the aging population on the economy and labor market. The increase in older populations requires more healthcare spending by governments and impacts greatly the public finance system. While there will be an increase in public healthcare to support older people, the working population or workforce of countries is shrinking. It creates two big problems; 1. An increased strain of the current workforce to support the cost of healthcare for the old population, 2. Requires more healthcare professionals to take care of elderly people (Jowit, 2013; Pettinger, 2019; Serban, 2012). As the retired population is growing, the ratio of working population to retired people is shrinking, and it will put a huge strain on countries' pension systems (Dobriansky, 2007).

3.2 THE NOVEL CORONAVIRUS PANDEMIC

The outbreak of Novel coronavirus disease (COVID-19) at the end of 2019 was later declared a pandemic by World Health Organization (WHO), which spread across the countries around the world and affected many people and industries (*WHO Director-General's Opening Remarks at the Media Briefing on COVID-19 - 11th March 2020*). In 2020, the world experienced how much human resources and money will be needed to manage the rising old age population. We are currently experiencing a pandemic (COVID-19) where older adults are most vulnerable. The research conducted by the Centers for Disease Control and Prevention, USA shows that people age between 65-74 years has five times more risk of hospitalization and 90 times higher chances of death than people between the age of 18-29 years. While people between the age of 75-84 years have 220 times more chances of dying and people above the age of 85 years have 630 times more chances of dying than people age 18-29 years due to COVID-19 (*Risk for COVID-19 Infection, Hospitalization, and Death By Age Group | CDC*). In Canada, as of 18th October 2020, people above the age of 60 years represent 96.757% of deaths due to COVID-19. (Government of Canada, Epidemiology update 18th October 2020). A Bar chart from the Epidemiology department of Canada about Age and Sex distribution of COVID-19 deceased people is shown in figure 1 to illustrate the seriousness of the situation for elderly people. Canada has seen COVID-19 outbreaks in old age care homes, which have resulted in huge death numbers. Old age homes were blamed for being understaffed and personal support workers working in more than one care home (The Globe and Mail, 11th August 2020). Taking care of older people suffering from various mental and physical health diseases is already very difficult for provinces, and COVID-19 acted as fuel in the fire. It

exposed many problems being faced by governments and private organizations taking care of elderly people. These problems include a shortage of support workers, expenses of taking care of older people, support workers unknowingly acting as disease carriers, etc. (CBC news, 21st September 2020). The situation in other developed countries is similar with a few exceptions. The main cause of the high death toll of older people is their underlying chronic health conditions, and most older people's immune systems and organs are weaker than healthy adults (WHO Newsroom). New ways for care and support are needed to avoid human transmissions (They will be discussed in the following chapters).

Figure 4. Age and sex ³ distribution of COVID-19 cases in Canada as of October 18, 2020, 7 pm EDT (n=9,654 ¹)

Figure 1 Age and Sex distribution of COVID-19 cases from Epidemiology Department Canada

To summarize this section, there is enough concrete evidence that the elderly population is more vulnerable to diseases and has a weaker immune system compared to healthy adults (Faraji & Metz, 2021). Many technological advances present themselves as an economic solution to support older people live an independent life (Chapter 3 talks about technological products that can help older people lead more independent life). The issue,

however, remains if such technological products will be successfully adopted by the elderly population to support them in their daily personal health care routines. Technology adoption is the main issue dealt in this thesis. The next subsection sheds light on the literature relating to various technology adoption models.

3.3 TECHNOLOGY ACCEPTANCE MODEL (TAM) AND ITS VARIANTS

As discussed in the last section, research needed to understand elders' technology acceptance is needed to make better and user-friendly products. In this section, the literature related to the technology acceptance model and reasons why it is not properly equipped to address the research question in this study is presented in subsections 3.3.1 and 3.3.2, respectively.

3.3.1 CHRONOLOGICAL DEVELOPMENT OF TAM

In 1989, Fred Davis introduced the technology acceptance model (TAM) derived from the theory of planned behavior (TPB) and the psychology-based theory of reasonable action (TRA) (Davis, 1989). Later, it became a dominant model in investigating factors affecting users' acceptance of the technology and users' behavior towards the technology. The TAM presumes a mediating role of two variables: 1. perceived ease of use and 2. perceived usefulness in the relationship between system characteristics and potential system usage (Marangunić & Granić, 2015). The perceived ease of use and the perceived usefulness would help predict behavioral intention and further imply their actual system usage (Davis, 1989). Figure 2 illustrates the original TAM model published by Davis in 1989.

Later Davis and Venkatesh refined the model by characterizing the external variables as user training, user participation design, system characteristics, and the nature of the implementation process (Venkatesh & Davis, 1996). Similarly, other researchers also proposed several new modifications to TAM. In doing so, it evolved as the leading model in predicting and explaining user behavior and system use. Later in the early 2000s, Venkatesh and Davis further refined the TAM and proposed an extended version of TAM,

which became TAM2 (Venkatesh & Davis, 2000). It identified the variables which heavily influenced the perceived usefulness. These variables include 1. Subjective Norms: The influence of others on the user's decision to use or not to use the technology; 2. Image: The desire of the user to maintain favorable standing among others; 3. Job relevance: The degree to which the technology is applicable; 4. Output quality: The extent to which the technology adequately performed the desired tasks; 5. Results demonstrability: the production of tangible results (Venkatesh & Davis, 2000). Later, voluntariness and experience were added as moderating variables of the subjective norm. TAM2 Model is shown in figure 3 (Venkatesh & Davis, 2000).

Note-X1, X2, and X3 represent external variables.

Figure 2 Technology Acceptance Model (Davis, 1989)

Figure 3 Technology Acceptance Model 2 (Venkatesh & Davis, 2000)

Later, Venkatesh et al. (2003) proposed a new model called Unified Theory of Acceptance and Use of Technology (UTAUT) to replace TAM models and better predict a person's technology adoption behavior. UTAUT model proposed four factors that influence the intention and usage of technology. The four factors those Venkatesh (2003) added are as follows:

1. Performance Expectancy: It is the degree to which an individual believes that using the system will help him or her to attain gain in job performance (Venkatesh, 2003).
2. Effort Expectancy: It is the degree of ease associated with the use of the system (Venkatesh, 2003).

3. Facilitating Conditions: It is the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system (Venkatesh, 2003).
4. Social Influence: It is the degree to which an individual perceives those others believe that he or she should use the new system (Venkatesh, 2003).

Figure 4 Unified Theory of Acceptance and Use of Technology (Venkatesh, 2003)

This new UTAUT model used Gender, Age, Experience, and Voluntariness of use as moderating variables. Venkatesh's UTAUT model is shown in figure 4. Despite wide acceptance of the model, Venkatesh continued to work on UTAUT. He added three more constructs into the model, and it is now known as the UTAUT2 model (Venkatesh, 2012). The UTAUT2 model is shown in figure 5, and the new constructs were as follows:

1. Hedonic motivation: It is defined as the fun or pleasure derived from using technology, and it has been shown to play an important role in determining technology acceptance and use (Venkatesh, 2012).
2. Price value: This is an important difference between a consumer use setting and the organization use setting. Consumers usually bear the monetary cost of such use whereas employees do not. The cost and pricing structure may have a significant impact on consumers' technology use (Venkatesh, 2012).
3. Habit: It is measured as the extent to which an individual believes the behavior to be automatic (Venkatesh, 2012).

Figure 5 Unified Theory of Acceptance and Use of Technology 2 (Venkatesh, 2012)

(Note: Performance expectancy is moderated by age and gender. The effort expectancy is moderated by age, gender, and experience. The social influence is moderated by age, gender, and experience. The effect of facilitating conditions on user behavior is moderated by age and experience)

3.3.2 PROBLEMS WITH EXISTING TECHNOLOGY ACCEPTANCE/ADOPTION MODELS

The current widely accepted models like TAM, TAM2, UTAUT were developed for the organizational settings to understand employees' technology adoption behaviors better. Khalilzadeh et al. (2017) found that these models do not include the user's attitude, anxiety, and self-efficacy towards new technology. Min et al., (2008) found that the previous model does not include privacy and trust in technology into consideration for user acceptance, which has become a huge part of accepting technology in the internet age. In a study on mobile shopping behavior, Aldás-Manzano et al., (2009) argued that most technology acceptance models, including UTAUT, are developed for organizational contexts, which results in the neglect of consumer-related variables. Venkatesh agrees that his previous models did not consider the regular consumers. To address that issue, he added new variables price value, hedonic motivation, and habit, into the UTAUT model developing a new UTAUT2 model (Venkatesh, 2012). During the literature search for this study and type of products this study targets, the author found several factors such as fear of human connection loss, lack of confidence in adapting/learning new technology, fear of technology failure, or loss of privacy very prominent factors for elders while deciding to buy and use any new technology products. TAM, TAM2, and UTAUT models do not consider fun associated with learning and playing with new technology products (Chtourou

& Souiden, 2010). Privacy concerns for personal data and financial information are also a real concern for the people who might have experienced misuse of technology, but the current UTAUT models do not consider them (Morosan & DeFranco, 2016). Regarding health care technology products such as wearables, elders pay more attention to perceived expectancy, self-efficacy, effort expectancy, and perceived severity, but none of the prominent models take self-efficacy and perceived severity into account without major changes (Gao, 2015).

Due to the reasons mentioned above, the author felt a need to develop a new model that more appropriately addresses elders' technology adoption decisions. The new model is given in chapter 4, and a more detailed explanation for all the variables has been provided.

CHAPTER 4 RESEARCH MODEL

As elucidated in chapter 3, the previous technology acceptance models were not the best fit for the study. The author developed the model shown in figure 6 to understand and answer the research questions of this study. Each part of the model has been divided into subsections and presented with supporting literature in this chapter.

Figure 6 Proposed Technology Adoption Model

4.1 PSYCHOLOGICAL RESISTANCE

Ram et al. (1989) proved that consumers would resist the innovations because of functional and psychological barriers. In this model, the focus was on psychological barriers because the products with good functional capabilities were chosen for the study. It was assumed that while deciding on the aid device, elderly people will be guided by their family members, doctors, or care workers about the functional values of the product, and it will not be a resistance factor for technology rejection decisions. Literature research suggested psychological resistance in elders for the new smart technology can be due to the following:

4.1.1 FEAR OF HUMAN CONNECTION LOSS

Sharkey & Sharkey et al. (2012) found that elderly people try to resist the acceptance of new technology products that will reduce their connections with others (i.e., family members, care home workers such as support staff, nurses, doctors). Especially, elderly people living in care homes resisted new technology changes as they only meet other elders living with them in those homes. They valued their meeting with care workers and doctors very highly as these people were their only outside world connection. Barbosa Neves et al., (2019) discussed and highlighted the importance of social interactions for elders living in care homes. She presented the different strategies elders use to avoid loneliness and isolation for both participants living in the care home and residential home. Literature on elders' technology acceptance towards robotic devices finds social interaction as an important factor. Due to this reason, fear of human connection loss has been taken as a factor that can lead to the development of psychological resistance in elders.

4.1.2 FEAR OF EMPLOYMENT LOSS DUE TO TECHNOLOGY

Researchers from Harvard University found that elderly people resist automation as they have seen a lot of job cuts due to new technology and automation (*Elderly Care in the Age of Machine and Automation* | *Bill of Health*, 2017). These phenomena were first noticed in workplaces, but later it was found that they continued to dislike and avoid new technological products which might take away the employment of others around them (some examples are avoiding self-serve kiosks at airports, banks, stores, and socializing over the internet instead of in-person). During a study on ethical issues relating to replacing robots with care workers, a participant said, “I felt like this is not amazing; this is sad. We have been reduced to spectators of a conversation that has no meaning. Giving old people robots to talk to is a dystopian view that is being classified as utopian” (Bogue, 2013). Fear of employment loss due to technology and fear of human connection loss are frequent factors found in ethical issues in technology acceptance by elders.

4.1.3 LACK OF CONFIDENCE IN ADAPTING

Wandke et al., (2012) found that many elderly people do not feel confident enough to use new technology. They consider that they are old, and they will not be able to learn new things; The current world of connected devices has made their perception of technology as a very complex thing. While that is true but on the other side, González et al., (2012) found that the elders with enough confidence in their ability to learn something new will more easily accept the technology. This opposing behavior can be attributed to the ability of elders to do the task even if the machine fails. These abilities provide them with a sort of reinforcement that technology failure will not affect their life much. Elders with confidence that they would be able to get help from their social circle if they run into

problems with technology products show a tendency to accept technology easily, while the vice-versa is also true (Golant, 2017b). It provides a good reason to consider it as a factor.

4.1.4 FEAR OF TECHNOLOGY FAILURES

Marquié et al., (2002) found that older people underestimate their ability to adapt to new technology, and they fear that they might break fragile new technology products. Older adults also fear that they might end up with any monetary loss to themselves or their families as many new technologies need us to connect our bank accounts and credit card accounts with them (Zeissig, 2017). Tacken et al., (2005) discovered that older people don't like using new technology because they fear if they do not operate it properly, it might end up in a hazard that can harm themselves or their family members especially considering the big robots or smart kitchen appliances which they see as complicated and hard to operate products. Peek et al., (2014) found that elders' concern towards new technology products includes privacy concerns, losing control of technology. There is more than enough evidence available in the literature for elders' resistance towards technology due to their perception of its failure. Due to this reason, the author has considered it a factor that might contribute to elders' psychological resistance.

4.2 TRUST GENERATING FACTORS

Trust in technology has always been a critical aspect in technology acceptance decisions (Ziefle, 2011). In this section, the author has explained trust-generating factors with their detailed explanation and the literature support.

4.2.1 TRUST ON THE BRAND

Matzler et al., (2008) found that when a well-known brand introduces new products in the market, it gets a better reception than a new company trying to enter the same market. He also found that people do not mind paying high prices for the products of well-known brands compared to buying the same product from a new or unknown brand that offers it for cheaper. The impact of marketing and brand image affects users' perception of technology's perceived use, benefits, and trust. It means that well-known or well-marketed brands are seen as more useful and trustworthy compared to the others (Hough & Kobylanski, 2009). Due to those findings, the author felt the need to include trust on the brand in the research model.

4.2.2 TECHNOLOGY FAMILIARITY

During the literature research, the author found that familiarity with technology has a positive influence on users' technology acceptance decisions. It is important to note that the influence of science fiction movies can help curate people's perception of technology (Ghazizadeh, 2012). Mitzner et al., (2019) concluded that familiarity with technology could lead to faster and easier technology adoption, which can be seen in younger people. Usually, younger people who are more familiar with technology adapt to technology easier than older adults. Besides, Past positive interactions with technology build trust in users towards that or similar technology, and negative interactions provide knowledge about the

downside of similar technology products. Heinz et al., (2013) found that familiarity with technology is a good predictor for technology adoption. Based on the evidence, technology familiarity will usually help build trust into the user (both positive and negative based on the past interactions), which is why it was made a part of the model.

4.2.3 CURIOSITY ABOUT TECHNOLOGY

Saadé & Bahli et al., (2005) highlights that curiosity can aid the cognitive absorption process for learning the use of new technology or anything in general. González et al., (2012) found that elderly people's curiosity about new technology has a positive impact on their technology acceptance decisions. He also mentioned that curiosity would only help towards acceptance or trying new technology for the very first time. It doesn't have any positive or negative relation to their technology adoption for long-term or daily life usage. Kumar et al., (2013) found very some interesting results in their study. They found that many elders were curious to know more about new technologies despite their lack of digital literacy to understand the difference between many technical jargons. Based on the findings in the literature, it is imperative to consider curiosity about technology as an important factor in technology adoption.

4.2.4 SOCIAL INFLUENCE

Vroman et al., (2015) discovered that elders living with their family members are curious and motivated to learn new technological products that are used by their children and grandchildren. Elders are also motivated to learn how to use new technology products which their social circle use in their everyday life (such as learning how to use Facebook, Instagram, Zoom). The influence of family and friends, the influence of professional

caregivers, and use by peers are important factors found in technology acceptance literature (Peek, 2014).

4.2.5 TECHNOLOGY BENEFITS

The main reason behind any technology acceptance and adoption is users' perceived usefulness and perceived benefits of the technology (Venkatesh & Davis, 1996). All TAM models are created around the perceived usefulness of the technology, and the author also considers it a vital factor in assessing the technology acceptance (Venkatesh, 2012).

Based on all the above factors, the proposed model can be used to understand elderly people's acceptance of new technology and how more trust can be gained. It will make it easier for the elderly to adapt to new smart technologies more quickly and easily. This study will measure all these factors on the following moderating variables.

4.3 MODERATING VARIABLES

4.3.1 AGE

With the increasing age, the learning ability keeps deteriorating for most elderly (excluding some exceptions), and elders' physical requirements can change drastically based on their age. So, this moderating variable will help us understand the relationship between their age and their dependence on assistive devices. Lorenzen-Huber et al., (2011) found that the technology adoption decisions of the elderly are based on their age. As mental and physical health deteriorates with increasing age, elders feel a need to get assistance from personnel or device.

4.3.2 GENDER

Davison & Argyriou et al. (2016) found that men tend to be more technologically active than women, and men have higher chances of technology adoption than women. This study will try to capture if the same phenomena continue during the golden years or not.

4.3.3 PAST PROFESSION

O'Neill et al., (2014) found that past professions can have a huge impact on the elders' adoption decision. Different professions have very different work environments, and they give different technology exposure to people. Most people spend their huge part of life learning and working in the same career field, and the technology used at their workplace will have a big impact on their exposure thus their decisions as well. O'Neill et al., (2014) give examples of comparison between a housewife, a nurse, and a person with an administrative position at a large company. Each person would have lived in a very different technology environment in their life, which can create a moderating effect on their

technology adoption decisions. Chawla & Joshi (2018) studied the moderating effect of the past profession on technology adoption of adults and found it to be significant. However, their study did not have older adults as a specific target population. Based on the evidence in the literature, the past profession was considered an important moderating variable and it was included as a moderation variable in the proposed model.

4.3.4 INCOME

Chandola et al., (2007) studied the effects of social inequality on elders' mental and physical health. He found out that elders with better economic prospects had better health overall than elders with low income. Money or income is a factor that highly affects a person's confidence and perceptions of technology because money can be a huge influence on the person's daily life decisions. Chawla & Joshi (2018) found income as a good moderating variable in their study of mobile banking adoption. It is very important to study how the technology adoption decisions change with different economic prospects. Due to strong these strong reasons, income was added to the model as a moderating variable.

4.3.5 LIFESTYLE

A recent study by Hassani & Jafari et al. (2021) shows the importance of lifestyle in consumer buying and using decisions. This study focuses on the use of personal care robots, smart home technology products, wearables, and appliances; the acceptance or rejection decision can change a lot on how easily these products can fit in their lifestyle.

CHAPTER 5 RESEARCH QUESTIONS AND HYPOTHESES

Based on the literature review, the author proposed a model shown in figure 6. It indicates that the psychological resistance (Fear of human connection loss, Fear of employment loss due to technology, Lack of confidence in adapting, and Fear of technology failure) and the trust generating factors (Trust on Brand, Curiosity about technology, Technology benefits, Social influence, and Technology familiarity) will influence the elders' technology adoption decisions in the context of personal care.

The following research questions and hypotheses are proposed based on the literature relating to the elders' technology adoption:

1. Does psychological resistance affect elders' technology adoption decisions?

H1: Psychological resistance affects elders' technology adoption decisions.

2. Do trust-generating factors affect elders' technology adoption decisions?

H2: The trust-generating factors affect elders' technology adoption decisions.

3. To what extent the age of an older adult affects the relationship of their psychological resistance and trust generating factors with their technology adoption decisions?

H3PR: Age has a moderating impact on the relationships between psychological resistance and technology adoption decisions.

H3TG: Age has a moderating impact on the relationships between trust generating factors and technology adoption decisions.

4. To what extent the gender of an older adult affects the relationship of their psychological resistance and trust generating factors with their technology adoption decisions?

H4PR: Gender has a moderating impact on the relationships between psychological resistance and technology adoption decisions.

H4TG: Gender has a moderating impact on the relationships between trust generating factors and technology adoption decisions.

5. To what extent the past profession of an older adult affects the relationship of their psychological resistance and trust generating factors with their technology adoption decisions?

H5PR: Past professions have a moderating impact on the relationships between psychological resistance and technology adoption decisions.

H5TG: Past professions have a moderating impact on the relationships between trust generating factors and technology adoption decisions.

6. To what extent the income of an older adult affects the relationship of their psychological resistance and trust generating factors with their technology adoption decisions?

H6PR: Income has a moderating impact on the relationships between psychological resistance and technology adoption decisions.

H6TG: Income has a moderating impact on the relationships between trust generating factors and technology adoption decisions.

7. To what extent lifestyle of an older adult affects the relationship of their psychological resistance and trust generating factors with their technology adoption decisions?

H7PR: Lifestyle has a moderating impact on the relationships between psychological resistance and technology adoption decisions.

H7TG: Lifestyle has a moderating impact on the relationships between trust generating factors and technology adoption decisions.

CHAPTER 6 RESEARCH METHODOLOGY AND DATA ANALYSIS

In this chapter, the author has presented participant's demographic information, the method used for data collection, data preparation, and data analysis. As part of a more extensive study, the ethics clearance was obtained by principal investigators from Carleton University Ethics Board to perform an online survey. A copy of ethics clearance is given in Appendix B.

6.1 PARTICIPANT'S DEMOGRAPHIC

For this study, older adults living in their homes independently, with their family, or in care homes with age more than 65 were asked to participate, but due to the current COVID-19 pandemic and government lockdowns, most care homes either refused or did not allow us to collect data from their residents. Because the gap in average income per elder is different in different parts of the world, all participants are from the United States of America and Canada. Participants were further classified on the language; the most responses (81%) were received from the native English speakers, and the rest of the responses were received from non-native English speakers.

6.2 DATA COLLECTION

Online surveys were used to collect data for this study. The link for the online survey was sent out to elders through various methods. Most participants were recruited through the email sent out to various organizations via emails. The invitation to participate was posted in the common areas of residential buildings and community boards; later, emails were sent out to older adults who had shown interest in participating. In total, emails were sent out to more than 130 individuals working at different organizations, and 27 responses were received. The remaining 54 responses were received from older adults who saw the invitation to participate and contacted the author to participate. It took a little more than two months to collect 81 responses.

Online surveys were taken using the Qualtrics survey tool (*Qualtrics XM // The Leading Experience Management Software*). The survey was divided into multiple sections. The first part of the survey asked participants for their demographic information like age, gender, language preference, current residential living status, income, education, profession. The second part of the survey was divided into four subsections, and each subsection asked questions about psychological resistance factors to measure them. Similarly, the third part of the survey was divided into five subsections, and each subsection asked questions about trust generating factors to measure them. In the end, there were four questions included to understand their acceptance or rejection decision. The survey questionnaire has been attached in Appendix C.

6.3 DATA PREPARATION

In this section, the data cleaning for outliers and missing values have been presented. A total of 81 responses were collected from the target population, and of those 81 responses, one response had all answers given as five or strongly agree. Before removing it, the response was checked into the Qualtrics survey tool to gather more evidence to consider it as an outlier. It was found that the entire survey was filled within 74 seconds, while the average participant response time to fill the survey should be 8-9 minutes (480-540 seconds). Due to this reason, this response was taken out from further analysis.

Similarly, the remaining 80 responses were scanned for outliers, but none was identified. Now the eighty responses were checked for missing values using SPSS. There were multiple missing values found in the responses. Downey & King et al. (1998) advocate discarding responses with more than 20% missing answers/values in Likert scale surveys when missing values will be filled by mean substitution method. Responses with more than 20% missing values or surveys that were not filled more than 80% were taken out from further data analysis. Now only 74 responses were remaining, and some of them still had few missing values, but they were filled more than 80% by participants. The missing values were estimated by mean substitution for the particular question. Raaijmakers et al. (1999) recommend the use of mean substitution for Likert scale surveys. This approach produces accurate estimates when the number of missing values is relatively low.

6.4 DATA ANALYSIS

For this study, the descriptive analysis on the data was performed; a reliability test using Cronbach Alpha, hypotheses testing, and regression analysis were performed to understand the relationship between dependent variable Adoption decision and independent variables (i.e., psychological resistance factors and trust generating factors).

6.4.1 DESCRIPTIVE ANALYSIS OF PARTICIPANTS

The survey was sent out to seniors living in Canada and the US. The survey instrument collected seven different descriptive information about participants, which are age, gender, language, education, income, and current residential status. The descriptive analysis of each variable has been given below.

6.4.1.1 AGE

Out of the older adults that participated in the survey, 37 (50%) were between the age of 65 and 69, while 27 (36%) participants were between the age of 70 to 74; 5 (7%) participants were between the age of 75 to 79; 3 (3.57%) participants were between the age of 80 to 84, and 3 (4%) participants were more than 85 years old. Data has been tabulated in table 2 and shown in the pie chart in figure 7.

Table 2 Participant age distribution

Age	Participants Count	Percentage
65-69	37	50%
70-74	27	36%
75-79	5	7%
80-84	2	3%
85+	3	4%
Total	74	100%

Figure 7 Participant age distribution

6.4.1.2 GENDER

Out of 74 participants, 34 (46%) participants were male, and 40 (54%) participants were female. Data has been tabulated in table 3 and shown in the pie chart in figure 8.

Table 3 Participant gender distribution

Gender	Count	Percentage
Male	34	46.00%
Female	40	54.00%
Total	74	100.00%

Figure 8 Gender distribution

6.4.1.3 LANGUAGE PREFERENCE

Out of the older adults that participated in the survey, 60 (81%) participants chose English as their primary language, while only three (4%) participants chose French as their primary language; 11 (15%) participants chose other languages (Gujarati, Urdu or Hindi) as their primary language. Data has been tabulated in table 4 and shown in the pie chart in figure 9. (Note: One participant who selected the other option was not given a text box to write the language by Qualtrics survey tool.)

Table 4 Participant language preferences

Language	Count	Percentage
English	60	81%
French	3	4%
Other	11	15%
Total	73	100%

Figure 9 Participant Language preference

6.4.1.4 EDUCATION

Out of 74 older adults who participated, 15 (20%) participants did not have any formal education; 25 (34%) participants had completed high school or college diploma; 25 (34%) participants had completed bachelor's degree in some field, and 9 (12%) participants had master's degree or Ph.D. Data has been tabulated in table 5 and shown in the pie chart in figure 10.

Table 5 Participant Education level

Education Level	Count	Percentage
No Formal Education	15	20%
High School or College Diploma	25	34%
Bachelor's degree	25	34%
Master or PHD	9	12%
Total	74	100%

Figure 10 Participant Education level

6.4.1.5 INCOME

From 74 older adults who participated, 29 (39%) participants had an income of less than 50,000 dollars annually; 29 (39%) participants had an income of between 50,001 to 100,000 dollars; 12 (16%) participants had income between 100,001 to 150,000 dollars and 4 (6%) participants had income more than 150,000 dollars. Data has been tabulated in table 6 and shown in the pie chart in figure 11.

Table 6 Participant income

Annual Income	Participant Count	Percentage
Less than \$50000	29	39%
\$50001-\$100000	29	39%
\$100001-\$150000	12	16%
More than \$150000	4	6%
Total	74	100%

Figure 11 Participant Income distribution

6.4.1.6 RESIDENTIAL LIVING STATUS

Out of the 74 participants, 38 (51%) participants were living with their family members while 34 (46%) participants were either living alone or with their spouse independently; only two elders (3%) were living in the care home facilities. Data has been tabulated in table 7 and shown in the pie chart in figure 12.

Table 7 Participant residential status

Current residential status	Count	Percentage
Live with my kids	38	51%
Live with my spouse or independently	34	46%
Live in care home	2	3%
Total	74	100%

Figure 12 Participant residential status

6.4.2 DATA RELIABILITY

To test the reliability of the data, Cronbach Alpha coefficients were calculated for all the constructs using SPSS. The values were found between 0.56 and 0.953 for the constructs. The construct fear of employment loss due to technology got Cronbach Alpha's value less than 0.7. Although for newer constructs, a level of 0.60 or less may be also be considered adequate (Malhotra, 2004; Nunnally, 1975), so a cut-off of 0.5 was adopted, and fear of employment loss due to technology and fear of human connection loss construct was kept for the further analysis. The values of Cronbach alphas for each construct are shown below in table 8.

Table 8 Reliability of Constructs: Cronbach Alpha values

Composite Construct	Construct	Cronbach alpha	Number of indicators
Psychological Resistance	Fear of human connection loss	0.56	5
	Fear of employment loss due to technology	0.609	4
	Lack of confidence in adapting	0.926	4
	Fear of technology failure	0.816	4
Trust Generating factors	Trust on Brand	0.903	5
	Curiosity about technology	0.905	5
	Technology benefits	0.928	5
	Social influence	0.67	3
	Technology familiarity	0.966	8
Adoption Decision		0.953	4

6.4.3 DATA VALIDITY

Hu (2014) defines pretesting as the stage in survey research when survey questions and questionnaires are tested on members of the target population/study population to

evaluate the reliability and validity of the survey instruments before their final distribution. It is widely regarded as indispensable in survey questionnaire development and is also crucial to improve data collection for research (Hu, 2014). Pretesting was performed to ensure the validity of the constructs and survey tool. Most of the questions' format and wording was clear and easily understandable, and after minor modifications in some questions, the survey tool was considered valid for the study. An extensive literature review was performed, which supports the constructs of this study and provides validity to the study.

6.4.4 NORMALITY TEST AND KURTOSIS

The collected sample data should show normality in order to make it generalizable. However, it cannot be true every time in real life (Micceri, 1989; Stigler, 1977). Normality test usually helps understand if the results found in the study is generalizable for the entire population or not. Histograms are also a well time-tested method to see the data spread and understanding skewness, kurtosis. In this subsection, Shapiro Wilk and Kolmogorov-Smirnov test with Normality test is performed in SPSS. The results showed p-value was less than 0.05, which means the data is normally distributed. The results for the normality test are given in Appendix D. In this study, the data was collected on a 5-point Likert scale. A perfectly normal distribution may not be possible for the Likert scale question (University of Iowa, 2017). "Fortunately, this point is of little consequence, as it can be shown that the distribution of the t statistic possesses nearly the same shape as the theoretical t distribution for populations that are non-normal but possess a mound-shaped probability distribution" -(University of Iowa, 2017). Each indicator was scrutinized for a 'mound shape' visual pattern. The only factor trust on brand was not able to produce a

mound shape and was skewed towards a strongly agree adoption behavior. Results of the Shapiro Wilk and Kolmogorov-Smirnov test are placed in Appendix D. Histograms for each indicator have been shown in Appendix E. Table 9 shows composite constructs, constructs, and acronyms used in the analysis.

Table 9 Composite constructs, constructs, and acronyms

Composite Construct	Construct	Acronym used
Psychological resistance factors	Fear of loss of human connection	FLHC
	Fear of loss of employment due to technology	FLET
	Lack of confidence in adapting	LCA
	Fear of technology failure	FTF
Trust generating factors	Trust on Brand	TOB
	Technology familiarity	TF
	Curiosity about technology	CT
	Social influence	SI
	Technology Benefits	TB
Technology Adoption Decision	Technology Adoption Decision	TAD

6.4.5 RELATIONSHIP AMONG CONSTRUCTS

For improving readability, the proposed conceptual framework earlier shown as figure 6 in Chapter 4 is reproduced here below. The composite constructs of psychological resistance factors and trust generating factors were derived from literature.

Figure 6 Reproduced proposed model

Backward regressions with dependent variable technology adoption decisions were done for both psychological resistance factors and trust generating factors for a p-value of 0.1. The general multiple regression equation is $\hat{Y} = b_0 + b_1(x1) + b_2(x2) + b_3(x3) + \dots + b_K(xK)$

6.4.5.1 IMPACT OF PSYCHOLOGICAL RESISTANCE ON TECHNOLOGY ADOPTION DECISION

The results from linear regression are shown below in Tables 10 and 11.

Table 10 Regression Coefficients for psychological resistance construct

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.	R	R square
	B	Std. Error	Beta				
1	(Constant)	1.584	1.127		.164	0.48	0.230
	FLHC	.605	.250	.291	.018		
	FLET	-.247	.210	-.143	.243		
	LCA	.410	.129	.341	.002		
	FTF	-.249	.145	-.184	.090		
2	(Constant)	1.300	1.104		.243	0.464	0.215
	FLHC	.463	.220	.223	.039		
	LCA	.395	.128	.329	.003		
	FTF	-.254	.145	-.187	.085		

Table 11 ANOVA for psychological resistance factors' regression analysis

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.400	4	6.850	5.163	0.001
	Residual	91.547	69	1.327		
	Total	118.947	73			
2	Regression	25.558	3	8.519	6.386	<0.001
	Residual	93.388	70	1.334		
	Total	118.947	73			

After backward regression analysis, fear of loss of human connection, lack of confidence in adapting, and fear of technology failure are found as statistically significant predictors of psychological resistance factors on technology adoption decision. Fear of employment loss due to technology did not come out as a significant predictor of technology adoption decisions. The ANOVA of the psychological resistance factors shows both models to be significant, but the 2nd model has a lower p-value compared to the 1st model. It shows that the removal of fear of employment loss due to technology improves the model. The R-value for the 1st model in the psychological resistance factors is 0.48 and the R-square of 0.230, and for the 2nd model, it is R-value drops to 0.464, and the R-square drops to 0.215. The value of R-square is relatively low for the model, but according to Cohen et al. 1992, the R-square value of more than 0.13 for any new construct or exploratory study is acceptable, and it is considered to have moderate explanation power over the dependent variable. It also means that the data support hypothesis H1 and the null hypothesis can be rejected.

6.4.5.2 IMPACT OF TRUST GENERATING FACTORS ON TECHNOLOGY ADOPTION DECISION

The results from linear regression are shown below in Tables 12 and 13.

Table 12 Regression Coefficients of trust generating factors

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.	R	R Square
	B	Std. Error	Beta				
1	(Constant)	-.658	.393		.099	0.879	0.773
	TOB	-.015	.111	-.010	.893		
	CT	.505	.100	.428	.000		
	TB	.530	.118	.414	.000		
	TF	.054	.071	.053	.446		
	SI	.142	.095	.118	.137		
2	(Constant)	-.692	.301		.025	0.879	0.773
	CT	.503	.099	.427	.000		
	TB	.525	.112	.410	.000		
	TF	.052	.068	.050	.447		
	SI	.142	.094	.118	.135		
3	(Constant)	-.671	.299		.028	0.878	0.771
	CT	.517	.097	.439	.000		
	TB	.533	.111	.417	.000		
	SI	.155	.092	.128	.098		

Table 13 ANOVA for trust generating factors' regression analysis

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	91.968	5	18.394	46.361	0.000
	Residual	26.979	68	.397		
	Total	118.947	73			
2	Regression	91.961	4	22.990	58.783	0.000
	Residual	26.986	69	.391		
	Total	118.947	73			
3	Regression	91.732	3	30.577	78.649	0.000
	Residual	27.215	70	.389		
	Total	118.947	73			

After backward regression analysis, curiosity about technology, technology benefits, and social influence are statistically significant predictors of trust generating factors on technology adoption decisions. Technology familiarity and trust on brand were found to be non-significant. The ANOVA table shows significance values lower than 0.1 for all three models, but the F-value increases from model 1 to model 2 and from model 2 to model 3. That means 3rd model is statistically better than both 1st and second models. The R-value and R-square value are large for all three models, which shows that all three models have high explanation power over dependent variables. The R-square value does not change much with the elimination of non-significant factors. The large R-value suggests that the null hypothesis for H2 can be rejected.

6.4.5.3 IMPACT OF MODERATING VARIABLES

In the further analysis for moderating variables, the means of the dependent variables with change in moderating variables were compared to check whether there is

indeed any difference. The graphical comparison of means for age, gender, income, and past profession are shown below in Figures 13, 14, 15, and 16, respectively. Regression analyses were also performed to understand the role of moderating variables and test the hypotheses created in chapter 5. The graphical comparison of Adoption behavior with increasing age is shown below in figure 13. For analysis in this subsection, items in TAD were combined, and their means were used.

Figure 13 Comparison of Adoption Decision based on age of elders

It was observed from figure 13 that the mean adoption decision of elders between age 65-69 years and 70-74 years was similar, but age 75-79 years is significantly lower. For the age higher than 79 years, adoption decision was slightly higher but not as high as age 65-69 years or 70-74 years. Later, regression analysis was performed by combining age groups, from 65 to 74 years and from 75 years above to verify the hypotheses H3PR and H3TG. Regression analysis is given in tables 16 to 19.

Figure 14 Comparison of Adoption Decision based on gender of elders

Figure 14 displayed the difference between adoption decisions in male participants and female participants. No significant difference in means was observed. Regressions were performed for males and females to see how different gender affect the relationship between psychological resistance factors and adoption decisions. The results of regression can be seen in tables 20 to 23.

Figure 15 Comparison of Adoption Decision based on annual income of elders

It was observed from figure 15 that the adoption decision of elders was not the same at different income levels. Elders with income less than 50,000\$ and income between 50,001-100,000\$ were similar, but adoption decision was exceptionally high for elders with income between 100,001-150,000\$. While adoption decisions for elders with income higher than 150,000\$ had slightly higher adoption decisions as elders with income less than 50,000\$ and elders with income between 50,001-100,000\$. Later, regressions were performed by combining the first two groups and the other two groups (less than 100,000\$ and more than 100,000\$) to validate if the differences are significant or not. The regression results can be seen in Tables 24 to 27.

Figure 16 Comparison of Adoption Decision based on the past profession of elders

(For the past profession in above figure 16, The technology exposure was given as Very low or none = 1, Low = 2, Moderate = 3, and High = 4)

The moderating variable past profession was categorized based on the technology exposure a profession would provide. The responses were ranging from housewives (assigned one due to very low or no exposure) to engineers (assigned four due to high exposure) and from farmers (assigned 1) to small business owners and CEOs (assigned 3 or 4). Figure 16 showed a considerable difference between elders with none, low past exposure to technology, and moderate, high exposure to technology. The increased technology adoption decision can be seen with higher technology exposure. Based on the change in the graph, the moderating variable was grouped for none, low technology exposure, and moderate, high technology exposure to perform regression analysis and test hypotheses H5PR and H5TG.

The moderating variable lifestyle was measured using multiple questions on the Likert scale (5-point scale), and the use of graphical representation to compare the means couldn't deduce anything meaningful. The variable was divided at cut-off point value 2 for the independent t-test. Independent t-tests were performed to understand the difference between higher and lower technology-related or linked lifestyles. T-test showed that there is a significant difference between elders with a lower technology-linked lifestyle and a highly technology-linked lifestyle. The results of the t-test are given in Appendix F. The regression analysis with a cut-off point at two was performed, and its results are given in tables 32 to 35.

Various other relations were compared using the independent t-test to grasp a better understanding of the moderating variables. Moderating variables were grouped based on the results from the graphical comparison of mean technology adoption decisions in previous figures 13 to 16. They have been summarized in table 14.

Table 14 t-test results on relationships between moderating variables and dependent and independent variables for respective moderating variable grouping

Moderating Variable	Relationship	P-value	Decision	Moderating variable groups
Age	The age of an older adult affects his/her technology adoption decision.	0.091	Supported	65-74 years & 75+ years old
Age	The age of an older adult affects his/her psychological resistance.	0.03	Supported	65-74 years & 75+ years old
Age	The age of an older adult	0.005	Supported	65-74 years & 75+ years old

	affects his/her trust generating factors on technology.			
Gender	The gender of an older adult affects his/her technology adoption decision.	0.971	Not supported	Male & Female
Gender	The gender of an older adult affects his/her psychological resistance.	0.946	Not supported	Male & Female
Gender	The gender of an older adult affects his/her trust-generating factors on technology.	0.864	Not supported	Male & Female
Past profession	The past profession of an older adult affects his/her technology adoption decision.	0.012	Supported	(1,2) & (3,4)
Past profession	The past profession of an older adult affects his/her psychological resistance.	0.051	Supported	(1,2) & (3,4)
Past profession	The past profession of an older adult affects his/her trust generating factors on technology.	0.461	Not supported	(1,2) & (3,4)
Income	The income of an older adult	0.155	Not supported	<100,000\$ & >100,000\$

	affects his/her technology adoption decision.			
Income	The income of an older adult affects his/her psychological resistance.	0.023	Supported	<100,000\$ & >100,000\$
Income	The income of an older adult affects his/her trust-generating factors on technology.	0.079	Supported	<100,000\$ & >100,000\$
Lifestyle	The lifestyle of an older adult affects his/her technology adoption decision.	<0.001	Supported	Cut-off point at 2
Lifestyle	The lifestyle of an older adult affects his/her psychological resistance.	<0.001	Supported	Cut-off point at 2
Lifestyle	The lifestyle of an older adult affects his/her trust-generating factors on technology.	<0.001	Supported	Cut-off point at 2

The results from the t-test show some interesting results. For moderating variable age, it significantly affects elders' psychological resistance, trust generating factors, and overall effect on their technology adoption decisions. Gender as moderating variable has not received support in any relationship, so it would be hard to say that gender has any effect on elders' technology adoption decisions, psychological resistance, or trust generating factors. Similar results were found in the graphical comparison of males and

females for technology adoption decisions in figure 14. For past professions, the t-test shows that the psychological resistance factors and technology adoption decisions differ with different degrees of past technology exposure. Elders' trust generating factors do not have a significant effect from the past profession. For the income of elders, the t-test shows that elders' psychological resistance and trust generating factors vary with their income level, but their technology adoption decision does not have a significant impact. For the lifestyle as moderating variable, elders' psychological resistance, trust generating factors, and technology adoption decision change significantly change with change in their lifestyle.

Regression analyses were performed with the moderating variables to see their impact on the relationships between dependent variables and independent variables. The grouping for moderating variables was done based on a graphical comparison of TAD with a change in moderating variable. Table 15 has been created to provided details of the regressions, and the results have been given in Tables 16 to 35. Moderating variables were combined based on the significant change in adoption behavior seen in the graphical comparisons. The interpretation of results is given in more detail in chapter 7.

Table 15 Regressions conducted for testing moderating variables

No.	Dependent Variable	Predictor variables	Moderating variable	Grouping
Age1	TAD	FLHC, LCA, FTF	Age	65-74 years
Age2	TAD	FLHC, LCA, FTF	Age	75 years & Older
Age3	TAD	SI, TB, CI	Age	65-74 years

Age4	TAD	SI, TB, CI	Age	75 years & Older
Gender1	TAD	FLHC, LCA, FTF	Gender	Male
Gender2	TAD	FLHC, LCA, FTF	Gender	Female
Gender3	TAD	SI, TB, CI	Gender	Male
Gender4	TAD	SI, TB, CI	Gender	Female
Income1	TAD	FLHC, LCA, FTF	Annual Income	Less than 100,000\$
Income2	TAD	FLHC, LCA, FTF	Annual Income	Higher than 100,000\$
Income3	TAD	SI, TB, CI	Annual Income	Less than 100,000\$
Income4	TAD	SI, TB, CI	Annual Income	Higher than 100,000\$
PE1	TAD	FLHC, LCA, FTF	Past profession	1&2
PE2	TAD	FLHC, LCA, FTF	Past profession	3&4
PE3	TAD	SI, TB, CI	Past profession	1&2
PE4	TAD	SI, TB, CI	Past profession	3&4
Lifestyle1	TAD	FLHC, LCA, FTF	Lifestyle	0 to 2
Lifestyle2	TAD	FLHC, LCA, FTF	Lifestyle	>2 to 5
Lifestyle3	TAD	SI, TB, CI	Lifestyle	0 to 2
Lifestyle4	TAD	SI, TB, CI	Lifestyle	>2 to 5

6.4.5.3.1 Regression between Psychological Resistance, Trust generating factors and Technology Adoption with Age as a Moderating variable

From tables 16 and 17, it was observed that FLHC, FTF, and LCA showed significant results for elders with age between 65 to 79 years, while FTF was not significant for elders with age more than 80 years. From Tables 16 and 17, the change in coefficients of variables can be observed, which indicates a significant difference in the two regression lines. That means hypothesis H3PR is supported.

Table 16 Results for regression Age1

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	1.174	1.101	1.066	.290
	FLHC	.550	.225	.265	.017
	FTF	-.313	.152	-.226	.043
	LCA	.382	.141	.299	.008

a. Dependent Variable: TAD

b. Selecting only cases for which Your Age (years) <= 75-79

Table 17 Results for regression Age2

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	27.216	1.063	25.597	.025
	FLHC	-5.431	.217	-1.569	.025
	FTF	-.505	.088	-.477	.110
	LCA	1.297	.142	.765	.070

a. Dependent Variable: TAD

b. Selecting only cases for which Your Age (years) > 75-79

Tables 18 and 19 showed that CT, TB were significant for elders with age between 65 to 79 years, while none of the trust generating factors came out significant for elders with age more than 80 years. From comparing results of table 18 and 19, it can be said that trust generating factors' impact reduces with an increase in age and becomes irrelevant after age 80 years. Here, hypothesis H3TG is supported. Based on the graphical comparison of means and regression analysis, age can be considered a good moderating variable for technology adoption decisions.

Table 18 Results for regression Age3

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.700	.301		-2.326	.023
	CT	.541	.104	.444	5.179	.000
	TB	.548	.116	.433	4.721	.000
	SI	.123	.092	.103	1.340	.185

a. Dependent Variable: TAD

b. Selecting only cases for which Your Age (years) <= 75-79

Table 19 Results for regression Age4

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.462	1.895		-.772	.582
	CT	.162	.376	.164	.431	.741
	TB	-.335	.596	-.222	-.562	.674
	SI	1.886	.728	.989	2.593	.234

a. Dependent Variable: TAD

b. Selecting only cases for which Your Age (years) > 75-79

6.4.5.3.2 Regression between Psychological Resistance, Trust Generating factors and Technology Adoption with Gender as a Moderating variable

Table 20 Results for regression Gender1

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	3.804	1.441		.013
	FLHC	.097	.327	.050	.769
	FTF	-.495	.217	-.380	.031
	LCA	.342	.199	.281	.098

a. Dependent Variable: TAD

b. Selecting only cases for which Your Gender = Male

Table 21 Results for regression Gender2

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-1.110	1.701		.518
	FLHC	.771	.323	.340	.022
	FTF	.007	.194	.005	.972
	LCA	.503	.161	.443	.004

a. Dependent Variable: TAD

b. Selecting only cases for which Your Gender = Female

Table 22 Results for regression Gender3

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.545	.355		.136
	CT	.435	.115	.386	.001
	TB	.504	.126	.462	.000
	SI	.233	.107	.206	.038

a. Dependent Variable: TAD

b. Selecting only cases for which Your Gender = Male

Table 23 Results for regression Gender4

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.689	.568		.233
	CT	.633	.169	.535	.001
	TB	.552	.221	.345	.017
	SI	.035	.162	.028	.829

a. Dependent Variable: TAD

b. Selecting only cases for which Your Gender = Female

From tables 20 to 23, it can be observed that FTF, LCA, CT, TB, SI were significant factors for males while FLHC, LCA, CT, TB were significant factors for females. However, the graphical comparison of means did not show any difference in TAD. An independent t-test was run to see if there is any significant difference in the two regression lines or not. It did not show any difference between technology adoption decisions between males and females. Hypotheses H4PR and H4TG were not supported. Thus, gender did not have a strong justification as a moderating variable. It was removed from the proposed model. The results of the independent t-test are given in Appendix F.

6.4.5.3.3 Regression between Psychological Resistance, Trust Generating Factors and Technology Adoption with Income as a Moderating variable

Table 24 Results for regression Income1

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	2.407	1.397		.091
	FLHC	.173	.289	.077	.553
	FTF	-.179	.183	-.127	.330
	LCA	.360	.154	.304	.023

a. Dependent Variable: TAD

b. Selecting only cases for which Annual Income <= 50001-100000\$

Table 25 Results for regression Income2

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-1.025	1.588		.531
	FLHC	.695	.273	.421	.026
	FTF	-.447	.175	-.424	.025
	LCA	.909	.259	.582	.004

a. Dependent Variable: TAD

b. Selecting only cases for which Annual Income > 50001-100000\$

Table 26 Results for regression Income3

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.549	.364		.138
	CT	.594	.107	.527	.000
	TB	.428	.132	.314	.002
	SI	.165	.104	.142	.118

a. Dependent Variable: TAD

b. Selecting only cases for which Annual Income <= 50001-100000\$

Table 27 Results for regression Income4

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	.297	.595		.627
	CT	-.434	.246	-.314	.103
	TB	1.550	.264	1.327	.000
	SI	-.247	.184	-.187	.205

a. Dependent Variable: TAD

b. Selecting only cases for which Annual Income > 50001-100000\$

Table 24 to 27 represents the regression results for the annual income of elders on their adoption decision. Tables 24 and 25 show that FLHC, FTF, and LCA were significant for elders with income higher than 100,000\$, while only LCA was significant for elders with income less than 100,000\$. It can be interpreted as regression lines for both age groups are totally different. So, hypothesis H6PR is supported. For trust generating factors, only TB was significant to elders with income higher than 100,000\$ while CT and TB both were significant to elders with income less than 100,000\$. It can be interpreted from the data, as with an increase in income, curiosity about technology decreases or becomes irrelevant, and it supports our hypothesis H6TG (Income has a moderating impact on the relationship between trust generating factors and adoption decisions). The graphical comparison of means and regression results showed that their income moderates the technology adoption decision of elders. Thus, Annual income was kept in the model as a moderating variable.

6.4.5.3.4 Regression between Psychological Resistance and Technology Adoption with the past profession as a Moderating variable

Table 28 Results for regression PE1

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	.252	2.025		.901
	FLHC	.757	.426	.253	.083
	FTF	-.234	.207	-.162	.266
	LCA	.240	.172	.199	.170

a. Dependent Variable: TAD

b. Selecting only cases for which Past profession <= 2.00

Table 29 Results for regression PE2

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	2.358	1.243		.071
	FLHC	.298	.227	.243	.203
	FTF	-.301	.170	-.326	.090
	LCA	.427	.252	.315	.104

a. Dependent Variable: TAD

b. Selecting only cases for which Past profession > 2.00

Table 30 Results for regression PE3

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.549	.404		.181
	CT	.543	.127	.475	.000
	TB	.395	.183	.277	.036
	SI	.252	.151	.208	.101

a. Dependent Variable: TAD

b. Selecting only cases for which Past profession <= 2.00

Table 31 Results for regression PE4

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.529	.818		.525
	CT	.425	.227	.280	.074
	TB	.646	.162	.614	.001
	SI	.081	.122	.079	.517

a. Dependent Variable: TAD

b. Selecting only cases for which Past profession > 2.00

From tables 28 and 29, it was observed that only FLHC was significant for elders with none to low technology exposure in the past, while FTF was only significant for elders with moderate and high technology exposure. It means regression lines for both groups differ significantly. It can be interpreted that with the better past profession, the fear of human connection decreases and become irrelevant, and the fear of technology failure increase. The results supported hypothesis H5PR. Tables 30 and 31 showed that CT, TB were significant for all elders regardless of their past technology exposure at the past profession. The independent t-test was performed to check if there is any significant difference between the slopes of both regression lines, and it came out as significant. So, Hypothesis H5TG was supported. The results of the independent t-test are given in Appendix F. Based on the graphical comparison of means, independent t-test, and regression analysis, the past profession was considered as moderating variable for technology adoption decisions.

6.4.5.3.5 Regression between Psychological Resistance, Trust Generating factors and Technology Adoption with Lifestyle as a Moderating variable

Table 32 Results for regression Lifestyle1

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	4.166	2.080		.056
	FLHC	-.002	.395	-.001	.995
	FTF	-.263	.278	-.185	.354
	LCA	-.106	.287	-.074	.715

a. Dependent Variable: TAD

b. Selecting only cases for which lifestyle <= 2.00

Table 33 Results for regression Lifestyle2

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.371	1.334		.783
	FLHC	.668	.251	.340	.011
	FTF	-.220	.153	-.184	.159
	LCA	.617	.207	.384	.005

a. Dependent Variable: TAD

b. Selecting only cases for which lifestyle > 2.00

Table 34 Results for regression Lifestyle3

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-.437	.381		.262
	CT	.432	.135	.398	.004
	TB	.499	.139	.451	.001
	SI	.195	.118	.183	.109

a. Dependent Variable: TAD

b. Selecting only cases for which lifestyle <= 2.00

Table 35 Results for regression Lifestyle4

Coefficients					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-1.000	.548		.075
	CT	.596	.149	.458	.000
	TB	.627	.195	.429	.003
	SI	.068	.168	.047	.686

a. Dependent Variable: TAD

b. Selecting only cases for which lifestyle > 2.00

Table 32 to 35 represents the regression results for the lifestyle of elders on their adoption decision. Tables 32 and 33 showed that no factors were significant to elders with lifestyle values less than two, while FLHC and LCA were significant for elders with lifestyle values of more than two. The change in slope of the regression line was found significant in the t-test. That means hypothesis H7PR was fully supported. For trust generating factors, CT and TB were significant to all elders, but SI was close to becoming significant for elders with a lifestyle value of less than two. The t-test for trust generating factors also showed a significant difference in the slope of the regression lines. The hypothesis H7TG was fully supported. It can be said that as elders' lifestyles become more linked with technology, the relationship between social influence and technology adoption becomes less relevant. The graphical comparison of means, independent t-test, and regression results all three showed that the change in lifestyle moderates the technology adoption decisions of elders. Thus, it was kept in the model as a moderating variable.

CHAPTER 7 RESULTS

In this chapter, the author has presented how the results of data analysis can be interpreted. In chapter 6, it was found that only three factors (Fear of human connection loss, Fear of technology failure, and lack of confidence in adapting) showed a statistical significance for the psychological resistance factors. The factor fear of loss of employment due to technology has good literature support, but it did not show statistical significance in the regression analysis. It can be attributed to several reasons, such as the study's uniqueness or the small sample size (Pallant, 2005). Further research is required to understand the reason behind the non-significance of the fear of loss of employment. Looking at other factors, it was found that the fear of human connection loss and lack of confidence in adapting positively affects their rejection decision while fear of technology failure negatively affects it in a small capacity. Fear of human connection loss has the biggest coefficient out of three significant factors, reinforcing Sharkey & Sharkey's (2012) study results. Wandke et al. (2012) found that elders do not have enough confidence in themselves that they would be able to adopt new technology in their daily life. The regression results of this study support his claim that lack of confidence in adapting acts as psychological resistance and affects the dependent variable technology adoption decision. More research on this factor can reveal how elders' confidence increase or decrease with an increase in age and how it affects their technology adoption decision. Looking at the demographic data to better understand regression results, the 72 participants out of 74 were either living with their kids or their spouse. That means most participants of this study can be considered living with at least a loved one who can support them. It solidifies Golant's (2017) findings that if elders with support from their social circle are less fearful of trying

to use the same technology compare to elders with less or no social support. The knowledge that they will receive help even when they are not correctly using technology helps in their technology acceptance/adoption decision and it is reflected in the regression results for fear of technology failure factor.

In regression analysis, it was found that three trust generating factors that showed statistical significance were social influence, curiosity about technology, and technology benefits; Trust on brand and technology familiarity did not show statistical significance. Looking more deeply into data, it can be seen that the histogram of trust on brand factor is skewed towards agreeing and strongly agreeing for good brand products. Norwood & Lusk et al. (2011) performed a study on social desirability bias and found out that most people usually prefer to put themselves as socially desirable (“Look good”) and imagine themselves in an overly favorable self-image. They found that during hypothetical situations, most people choose to go with the most desirable products like the best clothes, cars, watches, etc. The same thing was observed in the collected data. More research on this factor is needed to understand if it is a sample bias or a population bias, as suggested by Norwood & Lusk (2011). For the scope of this study, Trust on Brand factor was taken out from the model. Looking more deeply into the technology familiarity factor, it also did not receive significance in regression analysis. So, it was taken out of the proposed model. More research should be done on the technology familiarity factor as it has received good literature in the past. The factors those received significance supports past claims made in the literature. Peek et al. (2014); Vroman et al. (2015) both found that social influence around elders helps them adopt new technology, and it was further reinforced in the regression results of this study as well. For the technology benefits factor, perceived

benefits of technology have been a core factor in all TAM models and studies since the introduction of the first TAM model by Venkatesh & Davis (1996).

Going into moderating variables, psychological resistance factors were to be affected by all moderating variables (age, past profession, income, and lifestyle) except the gender of elders. It was observed from the comparison of mean adoption decisions that with the increase in age, the tendency to adopt new technology decreases that are similar to the results from Anderson & Perrin (2017). The independent t-test and regression also reinforced the claim with similar results. While the mean adoption for males and females were similar but the regression showed that FTF and LCA were significant in the psychological resistance of males while FLHC and LCA were significant for females. Davison & Argyriou et al. (2016) suggested that men have a higher tendency to accept new technology than women, but this study did not find enough evidence to sustain that claim. More detailed research is required to conclude whether gender should be considered as a moderating variable or not. The results and data from this study do not provide enough evidence to keep gender as a moderating variable. Anderson & Perrin et al. (2017) found that technology adoption in elders increases with an increase in their income, and similar results can be seen in the graphical comparison of technology adoption decisions while compared on different income groups. The regression analysis also showed the same results. The data analysis shows that the past profession and lifestyle are also very good moderators. The psychological resistance and trust generating factors of elders change with change in their age, income, past profession, and lifestyle. This study shows similar results to the study performed by Anderson & Perrin (2017) at Paw research center in Washington DC, USA.

Based on the results from data analysis, the regression equation for technology adoption decision can be written as $TAD = -(1.3 + 0.463FLHC + 0.395LCA - 0.254FTF) + (-0.671 + 0.517CT + 0.533TB + 0.155SI)$. The proposed model was updated based on regression analysis, and it is shown in figure 17.

Figure 17 Updated technology adoption model

CHAPTER 8 CONCLUSION

In this study, various factors that can affect an elders' decision to adopt new technology products that were not included in the past similar studies were studied. These factors were divided into two main categories: 1. The psychological resistance factors, and 2. The trust generating factors. Online surveys were used to collect opinions of elders of both genders with different income levels, living statuses, past professions, and lifestyles. The collected data were analyzed using regression analysis, independent t-tests, descriptive statistics, and graphical comparisons for the adoption decision. Finally, based on the study results, a new model for technology adoption decisions is given. This chapter tries to conclude the study and provides research contribution to academic literature, limitations of this study, and pathways for future researchers. This chapter is mainly divided into two subsections below.

8.1 RESEARCH CONTRIBUTION TO ACADEMIC LITERATURE

The investigation on the effects of the increasing elderly population in western countries and how it is affecting their healthcare systems, economies were performed in the literature review. The effects of the increasing elderly population on healthcare systems were further solidified with the current COVID-19 pandemic and its risks to elders. Later, an extensive literature survey was performed to better understand the work done in academic research by researchers, and it was found that there were not many studies that tried to tackle the question of technology adoption for the elderly for personal care. Most studies on technology adoption were trying to understand an average consumer using TAM, TAM2, UTAUT, or their modified models. The few studies which were performed with elders as the target demographic were also using the same models. These models were

meant to understand technology adoption behaviors of employees in a work setting with many assumptions (Venkatesh, 2012), and those assumptions cannot always be valid for older consumers who are no more in the workforce. Due to this reason, exploratory research was performed to create a new model that helps better understand the technology adoption of elders specifically for their personal care. Psychological resistance factors that advocate technology rejection behavior and the trust generating factors that support technology adoption were found in the literature. A model was proposed, and Likert scale surveys were used to collect data.

During the data analysis, it was found that elders will resist technology adoption if it will reduce human connection in their life that reinstates the results found in the literature, studies explicitly done by Barbosa Neves (2019); Sharkey & Sharkey (2012). It can be implied as elders may not adopt robot caretaker which tries to take the place of the human caregiver or their family members, but they will adopt the technology products which aid them or their family members in doing daily task and make them independent. The lack of confidence in adopting and fear of technology failure were proven to increase technology rejection by increasing elders' psychological resistance. That is consistent with the findings of Golant's (2017) study that elders with not sufficient confidence that they will be able to get help from someone or they will not be able to solve problems during failures of the technology products have higher chances of rejecting the technology compared to others. In contrast, elder living with family members or has confidence that they will receive help easily accept and adopt the technology products. The factor fear of employment loss due to technology was refuted in the study, but the literature suggests something different. It can be due to most elders who participated in the study were either living with their spouse

independently or with their kids, and due to that reason, they may not have experienced caregivers losing their jobs to machines. More research should be performed with more elderly participants living in care home facilities to understand this factor better.

For the trust generating factor in the model, three out of five initially thought trust-generating factors were accepted. The trust on brand factor was rejected due to it being highly skewed towards one side. More detailed research on this factor is required to obtain better apprehension of the role of trust on brands in elders' technology adoption decisions. The factor technology familiarity was also rejected due to not obtaining a statistical significance. The literature provides a shred of massive evidence that technology familiarity takes part in everyone's technology adoption decisions, not only seniors (Ghazizadeh (2012); Heinz (2013); Mitzner (2019)). More research should be performed to understand whether psychological resistance increases or decreases with the technology familiarity. The study results reinforce Kumar's (2013) findings. The factor curiosity about technology has a high positive impact on technology adoption decisions of elders. The factor social influence was identified as a significant factor during the data analysis supporting the findings of Peek (2014); Vroman (2015). The perceived benefits of technology or technology benefits was a core factor of TAM models (Venkatesh, 2012; Venkatesh & Davis, 1996, 2000), and it was found significant in the study as well; aligned with the literature on technology adoption.

While studying the moderating variables in the model, initially, five (age, gender, income, past profession, and lifestyle) moderating variables were proposed. Out of five, only one (gender) moderating variable did not have any impact on the relationship between dependent variables and independent variables. Age of elder had a moderating effect on

relationships between psychological resistance factors, trust generating factors, and adoption decisions (dependent variable). It solidifies Lorenzen-Huber's (2011) claims that the age of elders acts as a moderating variable in their technology adoption decisions. With the increase in age, technology adoption of elders decreases. For moderation variable income, it had a positive impact on technology adoption. With the increase in income, technology adoption was increasing as well. Similar results were found in the literature by other researchers (Anderson & Perrin, 2017; Chandola, 2007). Past profession impacted the relationship between dependent variables and the independent variable. The lifestyle of elders has an impact on relationships between dependent variables and independent variables. With increasing technologically linked lifestyles, technology adoption decisions were growing positively.

To conclude, this exploratory study has tried to provide a different view towards technology adoption of the elderly for personal care by proposing a new framework. This study also provided enough evidence that previous TAM models cannot be used to understand technology adoption decisions of the elderly. Elders are very different from regular consumers, and many elders may have special needs.

8.2 LIMITATION AND FUTURE WORK

The study was limited due to time constraints; a study should be performed to collect a larger sample size. A larger sample size would allow the researcher to perform structural equation modeling (a more advanced statistical technique) and have an even better understanding of the results. In this study, only three elders living in care homes facility participated due to COVID-19 restrictions placed in Canada, making the study non-generalizable to all elders. Future researchers can conduct the same research with more

participants living in care homes to make the study more inclusive and obtain more generalizable results, which will shed more light on the fear of employment loss factor. Barbosa Neves et al. (2019) studied psychological factors of elders living in long-term care homes, and she found that there is a massive difference between the mental states of elders living in long-term care homes and living with their family members. A separate study on participants living in care homes should also be performed to find the difference in psychological resistance and trust generating factors. During this study, the technology familiarity factor did not come out significant as trust generating factor. Future researchers can work on the technology familiarity factor to grasp a better understanding of it and learn if it positively or negatively affects psychological resistance or not?

The technology adoption of elders is a very intricate process, and there can be factors that have not been discovered yet. More research is necessary on the model proposed to find more psychological resistance factors and trust generating factors. The factors relating to the software side of the technology were not covered in this study due to various constraints. The author also invites researchers to perform a longitudinal study to understand the adoption of technology with a focus on other factors such as software, user interface, and ease of use, etc. It can reveal if elders are adopting the technology for only a few simple functions, or they are utilizing the technology products to their full potential. Technology adoption of elders is becoming a very prominent area of research, but there are still many research gaps those need to be addressed. Thus, several potential research questions can be developed and worked upon as extensions and improvements to this study and the framework.

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APPENDIX A PICTURES OF TECHNOLOGY PRODUCTS

A brief description of various technological products which has the potential for helping elders in their personal care routine was given in chapter 2. For the reader's convenience, the numbering in this appendix is maintained to match with the subsections of chapter 2. The author does not endorse any of the following products, the products shown in this study are used for technology example demonstration purposes only. These products will be/might have been replaced by newer versions or discontinued.

2.1 Robotic Companion Pets

(Companion Pet Pup – Ageless Innovation LLC, 2016)

2.2 Care Robots

Ruby by INF Robotics

Care-O-Bot 4 by Fraunhofer Institute for Manufacturing Engineering and Automation

2.3 Smart Robotic Companions for emotional support

(ElliQ, the Sidekick for Happier Aging – Intuition Robotics)

2.4 Wearable devices

2.4.1 Smart Watch

Features

- GPS/GNSS
- Compass
- Always-on altimeter
- Water resistant
50 meters¹
- Blood oxygen sensor
(Blood Oxygen app)²
- Electrical heart sensor
(ECG app)³
- Third-generation optical heart sensor
- International emergency calling⁵
- Emergency SOS⁴
- Accelerometer
up to 32 g-forces with fall detection
- Gyroscope
- Ambient light sensor
- Speaker
- Microphone
- Apple Pay
- GymKit
- Capacity 32GB
- Ceramic and sapphire crystal back

Apple Watch Series 6 - Apple Inc.

2.4.2 Blood pressure and blood glucose trackers

Wrist Blood Pressure Monitor & Watch | HeartGuide by OMRON

FreeStyle Libre 2 System by Abbott

2.4.3 SOS devices

GPS Help button (Mobile Products - Bay Alarm Medical)

SOS watch (Mobile Products - Bay Alarm Medical)

In-Car alert with crash detection Mobile Products - Bay Alarm Medical

Generic Personal SOS keychain (Amazon.ca)

2.5 Smart home devices or Ambient intelligence devices

2.5.1 Smart speakers

Nest Audio, Amazing Sound at Your Command – Google Store

Echo Smart Home Devices & Systems, Amazon.com

2.5.2 Smart plugs

Generic smart plug (Smart Plug, Gosund WiFi Plug Smart Outlet Works with Alexa, Echo, Google Home, Alexa Plug with Timer Function, App Remotely Control ,No Hub Required, Etl and Fcc Listed (4 Pack): Amazon.ca: Electronics)

2.5.3 Smart home security systems

SimpliSafe Home Security Systems | Wireless Home Security | Burglar Alarms

2.5.4 Smart thermostat

(Nest Thermostat – Fine-Tune Your Comfort – Google Store)

SmartThermostat with Voice Control and SmartSensor | Ecobee

2.5.5 Smart lighting

Smart Lighting | Philips Hue

2.5.7 Robot vacuums and mops

DEEBOT OZMO T8 AIVI - ECOVACS

2.6 Bathing and feeding assistive devices

I-SUPPORT: a Robotic Platform of an Assistive Bathing Robot (Klein & Schlömer, 2018)

Portable Wheelchair Safe Shower Stall - AgingCare.Com

Obi – The First Dining Robot of Its Kind

APPENDIX B LETTER OF INVITATION TO PARTICIPATE IN THE STUDY

Subject: Invitation to participate in a research project on *Acceptance of Robotic Devices for Personal Care*. Protocol- 115658

Dear Sir/Mam,

I hope this email finds you well.

My name is Parth Shah, and I am a master's student at Sprott School of Business at Carleton University. On behalf of research team, I am approaching you to participate in our very important research study on the *Acceptance of Robotic Devices for Personal Care*.

The Covid-19 pandemic has caused havoc for the elderly (older adults) population in Canada, especially for those in care homes. Many care homes were and are understaffed. Cramped living space made social distancing impossible, and personal care workers at these homes were scared.

However, it seems help is on its way. A significant number of technology companies worldwide are developing robotic devices (which are autonomous, sensitive to surrounding, and self-learning) that can help us become more independent in our daily personal care routines; they can help us better connect with our social circle and can even act as a companion and provide emotional support for people living alone or living in care homes. These robotic devices would help the older adults in cleaning, bathing, grooming, massaging, eating, chatting, calling family contacts or help when in need, giving the company as a pet, etc.

In our experience and previous research, we have found that despite a good design and advertised benefits, the advances in technology *do not get accepted easily* by the public. *This research study is on this very issue of assessing the older adults' psychological resistance and factors that generate trust and confidence towards such robotic devices meant to serve them in their daily lives.* The study results will be useful to companies designing such products to make them more user-friendly, and to policymakers and program implementers in Senior Care Homes to ensure that adequate steps are taken for their acceptance by older adults.

For meaningful results, we need about 200+ older adults (living in care homes, independently, or with family) to give us their views about their comfort level in using such

devices in the future for personal care. We request you to participate in this survey, which is expected to take approx. 12 minutes.

The survey software used in this study is developed by Qualtrics. Your response will go directly to a database without your identity. Following the university research's ethical principles, we will not know who has participated in the survey. The database will be stored by Qualtrics on a server located in Canada but maybe disclosed via a court order or data breach. But recall, your identity is not recorded in the database. Once enough responses are collected, the database will be aggregated and analyzed. The results of this study may be published or presented at an academic conference or meeting, but the data will be presented in an aggregated manner so that it will not be possible to identify any participants. As a rule, all research records may be accessed by the Carleton University Research Ethics Board in order to ensure continuing ethics compliance.

The ethics protocol for this project has been reviewed and cleared by the Carleton University Research Ethics Board (CUREB-A) Clearance # 115658. Should you have any **ethical concerns** with the study, please contact the REB Chair, Carleton University Research Ethics Board-A by email: ethics@carleton.ca. For all other questions about the study, please contact the Lead Researcher, (Uma Kumar) or any team member.

Your participation in this survey is voluntary, and you may choose not to take part or not to answer any of the questions. Your responses will not go to the database unless you click the last 'Next' button and see a final screen of survey completion.

We urge you to participate in this very important study.

As a token of appreciation, we will also draw 25 ("TWENTY--\$10 AND FIVE--\$20") Starbucks or Tim Horton gift cards among all the participants. If you would like to enter the draw, you will be asked to enter your email address at the end of the survey. Your email address, in this case, will be separated from your response so that confidentiality is fully maintained.

If you kindly consent to participate, please click the Survey link below:

https://cuhealth.eu.qualtrics.com/jfe/form/SV_a3PFApjtoOkRIai

Sincerely,

Parth Vijaybhai Shah, MSc Candidate ParthVijaybhaiShah@cmail.carleton.ca

APPENDIX C SURVEY QUESTIONNAIRE

Title

Acceptance of Robotic Devices for Personal Care

Dear Sir/Mam

Thank you so much for agreeing to participate in the study. By clicking NEXT, you will come to next question, and at the end you will get an indication of survey completion. You may go back by clicking BACK if you wish to review or edit your responses. Thank you again for your cooperation.

Q1

Your Age (years)

- ☐ 65-69
- ☐ 70-74
- ☐ 75-79
- ☐ 80-84
- ☐ Over 85

Q2 Your Gender

- ☐ Male
- ☐ Female
- ☐ Prefer not to say

Q3 Please specify the language you are most familiar with

- ☐ English
- ☐ French
- ☐ Other (please specify in the box below)

Q3a Language

Q4 Highest Formal Education

- ☐ No Formal Education
- ☐ High School or College Diploma
- ☐ Bachelor Degree
- ☐ Master Degree or PhD

Q5 Please write your work profession, such as teacher, house-wife, doctor, engineer, carpenter, own business, (current or pre-retirement)

Q6 Average annual household income before taxes (current, if working or pre-retirement)

- ☐ Less than \$50,000
- ☐ \$50,001-\$100,000
- ☐ \$100,001-\$150,000
- ☐ Over \$150,000

Q7 What is your current status, please select one.

- ☐ Live with my kids and family
- ☐ Live with my spouse
- ☐ Live in a care home

Q8a

Familiarity with Technology To what extent you are familiar with the following Apps

	Not Familiar	Somewhat Familiar	Familiar	Very Familiar	Fully Familiar
Facebook	☐	☐	☐	☐	☐
WhatsApp/Messages	☐	☐	☐	☐	☐
Meeting Apps, such as Zoom	☐	☐	☐	☐	☐
Netflix or Amazon Prime	☐	☐	☐	☐	☐

Q8b To what extent you are familiar with the following Devices

	Not Familiar	Somewhat Familiar	Familiar	Very Familiar	Fully Familiar
Alexa or Google Home	☐	☐	☐	☐	☐
Smart Watch	☐	☐	☐	☐	☐
Robotic Vacuum Cleaner	☐	☐	☐	☐	☐
Electronic Thermostat	☐	☐	☐	☐	☐

Q8c To what extent you are familiar with the following Software

	Not Familiar	Somewhat Familiar	Familiar	Very Familiar	Fully Familiar
Word	☐	☐	☐	☐	☐
Excel	☐	☐	☐	☐	☐
PowerPoint	☐	☐	☐	☐	☐
On-line Shopping	☐	☐	☐	☐	☐

Q9 Human Connection versus Automation

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
Like humans, Robotic devices can also provide emotional support	☐	☐	☐	☐	☐
I prefer to deal with store cashiers rather than self-serve kiosk	☐	☐	☐	☐	☐
I prefer to talk to bank teller, rather than using ATM	☐	☐	☐	☐	☐
I prefer visiting my friends rather than chatting on Zoom, WhatsApp or phone	☐	☐	☐	☐	☐
I prefer socializing with friends/family rather than playing computer games or watching sports on TV.	☐	☐	☐	☐	☐

Q10 Loss of Employment

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
Robotic devices will take away human jobs	☐	☐	☐	☐	☐
I prefer sticking to standard way of doing routine work if my use of Robotic devices will take away jobs	☐	☐	☐	☐	☐
I don't mind paying a higher price for human help rather than dealing with machines	☐	☐	☐	☐	☐
Robots use on Assembly lines resulted in job losses in Auto industry	☐	☐	☐	☐	☐

Q11 Confidence in Technology

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
I consider myself a techy person	☐	☐	☐	☐	☐
I feel comfortable while using technology products	☐	☐	☐	☐	☐
Technology products are simple	☐	☐	☐	☐	☐
It is easy to learn the use of technology products	☐	☐	☐	☐	☐

Q12 Fear of Technology Failure

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
Robotic devices may harm my family or me physically	☐	☐	☐	☐	☐
Robotic devices may steal my financial information	☐	☐	☐	☐	☐
Robotic devices may steal my credit card information	☐	☐	☐	☐	☐
Robotic devices may take away my privacy	☐	☐	☐	☐	☐

Q13 Trust on the brand

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
Brand of the product is important for me	☐	☐	☐	☐	☐
Good brands are reliable	☐	☐	☐	☐	☐
Technical support is easily available for good brand technology products	☐	☐	☐	☐	☐
A good brand technology product is normally easy to operate	☐	☐	☐	☐	☐
A good brand technology product is designed to be safe.	☐	☐	☐	☐	☐

Q14 Curiosity about Technology

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
I may experiment with new Robotic devices for my personal care routines.	☐	☐	☐	☐	☐
When I visit big stores, I feel excited to know about new technology products that have been recently introduced.	☐	☐	☐	☐	☐
I like to learn about new technology products that can help my family or me.	☐	☐	☐	☐	☐
I like to read about new technology products that are coming into the market.	☐	☐	☐	☐	☐
It is fun to use and play with technology products.	☐	☐	☐	☐	☐

Q15 Social Influence

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
I feel encouraged to buy the new technology products that help me better connect with my social circle	☐	☐	☐	☐	☐
I have started using some social media apps to stay connected with my social circle.	☐	☐	☐	☐	☐
I often feel left out when my family or friends are using a new technology products that I do not know about.	☐	☐	☐	☐	☐

Q16

Technology Benefits

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
New Robotic devices will make me more independent	☐	☐	☐	☐	☐

in managing
daily
activities.

I will like to
use Robotic
devices
instead of
disturbing
family
members for
help in daily
chores

Robotic
devices can
help my
family
members
check on me
whenever
they want
from
wherever
they want

Robotic
devices can
make me
learn to
correctly
perform new
exercises

Use of
Robotic
devices
would avoid
exploitation
by some
notorious
human care
workers.

Q18 Acceptance Decision Making

To what extent do you agree or disagree with the following statements

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
I will use Robotic devices in my routine	☐	☐	☐	☐	☐
I intend to incorporate Robotic devices in my daily routine	☐	☐	☐	☐	☐
I plan to inform my family and friends about the uses of Robotic devices	☐	☐	☐	☐	☐
I think highly of Robotic devices	☐	☐	☐	☐	☐

Enter the Draw If you would like to enter the draw for one of the 25 (twenty \$10 or five \$20) Tim Hortons or Starbucks Gift cards, please enter your email address in the comment box below (your email address will not be linked to your responses).

Alternatively, you can contact me directly at ParthVijaybhaiShah@gmail.com using the subject line "Technology Acceptance Survey Gift Card Draw."

SUBMIT

**APPENDIX D RESULTS OF THE SHAPIRO WILK AND KOLMOGOROV-
SMIRNOV TEST**

Question	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TF1	.227	74	.000	.872	74	.000
TF2	.295	74	.000	.858	74	.000
TF3	.222	74	.000	.835	74	.000
TF4	.257	74	.000	.818	74	.000
TF5	.175	74	.000	.858	74	.000
TF6	.220	74	.000	.811	74	.000
TF7	.318	74	.000	.781	74	.000
TF8	.245	74	.000	.830	74	.000
TF9	.214	74	.000	.835	74	.000
TF10	.261	74	.000	.818	74	.000
TF11	.259	74	.000	.802	74	.000
TF12	.250	74	.000	.847	74	.000
FLHC1	.225	74	.000	.844	74	.000
FLHC2	.373	74	.000	.650	74	.000
FLHC3	.313	74	.000	.716	74	.000
FLHC4	.505	74	.000	.409	74	.000
FLHC5	.505	74	.000	.364	74	.000
FLET1	.202	74	.000	.878	74	.000
FLET2	.254	74	.000	.808	74	.000
FLET3	.203	74	.000	.870	74	.000
FLET4	.266	74	.000	.861	74	.000
LCA1	.193	74	.000	.849	74	.000
LCA2	.319	73	.000	.825	73	.000
LCA3	.222	73	.000	.894	73	.000
LCA4	.314	73	.000	.841	73	.000
FTF1	.189	74	.000	.908	74	.000
FTF2	.182	74	.000	.905	74	.000
FTF3	.189	74	.000	.903	74	.000
FTF4	.195	74	.000	.904	74	.000
TOB1	.252	74	.000	.767	74	.000
TOB2	.292	74	.000	.746	74	.000

TOB3	.277	74	.000	.767	74	.000
TOB4	.285	74	.000	.791	74	.000
TOB5	.308	74	.000	.728	74	.000
CT1	.311	74	.000	.824	74	.000
CT2	.199	74	.000	.904	74	.000
CT3	.299	74	.000	.801	74	.000
CT4	.221	74	.000	.896	74	.000
CT5	.260	74	.000	.807	74	.000
SI1	.355	74	.000	.768	74	.000
SI2	.356	74	.000	.796	74	.000
SI3	.221	74	.000	.902	74	.000
TB1	.287	74	.000	.850	74	.000
TB2	.255	74	.000	.832	74	.000
TB3	.267	74	.000	.822	74	.000
TB4	.265	74	.000	.856	74	.000
TB5	.260	74	.000	.872	74	.000

APPENDIX E HISTOGRAMS FOR INDICATORS

Frequency distribution of Technology Familiarity Q8a (Facebook)

Frequency distribution of Technology Familiarity Q8a (Whatsapp/Messages)

Frequency distribution of Technology Familiarity Q8a (Meeting Apps, such as Zoom)

Frequency distribution of Technology Familiarity Q8a (Netflix or Amazon Prime)

Frequency distribution of Technology Familiarity Q8b (Alexa or Google home)

Frequency distribution of Technology Familiarity Q8b (Smart Watch)

Frequency distribution of Technology Familiarity Q8b (Robotic Vacuum Cleaner)

Frequency distribution of Technology Familiarity Q8b (Electronic Thermostat)

Frequency distribution of Technology Familiarity Q8c (Word)

Frequency distribution of Technology Familiarity Q8c (Excel)

Frequency distribution of Technology Familiarity Q8c (Powerpoint)

Frequency distribution of Technology Familiarity Q8c (Online Shopping)

Frequency distribution of FLHC1

Frequency distribution of FLHC2

Frequency distribution of FLHC3 Q9

Frequency distribution of FLHC4 Q9

Frequency distribution of FLHC5 Q9

Frequency distribution of FLET1 Q10

Frequency distribution of FLET2 Q10

Frequency distribution of FLET3 Q10

Frequency distribution of FLET4 Q10

Frequency distribution of LCA1 Q11

Frequency distribution of LCA2 Q11

Frequency distribution of LCA3 Q11

Frequency distribution of LCA4 Q11

Frequency distribution of FTF1 Q12

Frequency distribution of FTF2 Q12

Frequency distribution of FTF3 Q12

Frequency distribution of FTF4 Q12

Frequency distribution of TOB1 Q13

Frequency distribution of TOB2 Q13

Frequency distribution of TOB3 Q13

Frequency distribution of TOB4 Q13

Frequency distribution of TOB5 Q13

Frequency distribution of CT1 Q14

Frequency distribution of CT2 Q14

Frequency distribution of CT3 Q14

Frequency distribution of CT4 Q14

Frequency distribution of SI1 Q15

Frequency distribution of SI2 Q15

Frequency distribution of SI3 Q15

Frequency distribution of TB1 Q16

Frequency distribution of TB2 Q16

Frequency distribution of TB3 Q16

Frequency distribution of TB Q16

Frequency distribution of TB5 Q16

APPENDIX F RESULTS OF INDEPENDENT T-TESTS

Independent Samples Test for Age (Grouping 65-74 years & 75+ years)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
									Lower	Upper
FLHC	Equal variances assumed	2.146	.147	1.179	72	.242	.24578	.20848	-.10161	.59318
	Equal variances not assumed			1.823	20.722	.083	.24578	.13485	.01360	.47797
LCA	Equal variances assumed	.137	.713	- 4.682	72	.000	-1.49219	.31870	-2.02323	-.96115
	Equal variances not assumed			- 5.534	13.865	.000	-1.49219	.26966	-1.96747	-1.01690
FTF	Equal variances assumed	.441	.509	-.320	72	.750	-.10312	.32186	-.63944	.43319
	Equal variances not assumed			-.347	12.766	.734	-.10312	.29705	-.62992	.42367
CT	Equal variances assumed	2.341	.130	- 3.243	72	.002	-1.12313	.34634	-1.70023	-.54602
	Equal variances not assumed			- 2.753	10.877	.019	-1.12313	.40797	-1.85655	-.38970
TB	Equal variances assumed	.027	.869	- 1.371	72	.175	-.46187	.33698	-1.02339	.09964
	Equal variances not assumed			- 1.374	12.013	.194	-.46187	.33609	-1.06084	.13709

SI	Equal variances assumed	.135	.714	-2.389	72	.020	-.83229	.34845	-1.41291	-.25167
	Equal variances not assumed			-2.685	13.191	.019	-.83229	.31003	-1.38073	-.28385
TAD	Equal variances assumed	.384	.538	-1.640	72	.105	-.70391	.42911	-1.41893	.01112
	Equal variances not assumed			-1.823	13.058	.091	-.70391	.38603	-1.38731	-.02051

Independent Samples Test for Gender (Male & Female)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
									Lower	Upper
FLHC	Equal variances assumed	.145	.705	-1.124	71	.265	-.15633	.13911	-.38816	.07551
	Equal variances not assumed			-1.115	65.941	.269	-.15633	.14023	-.39027	.07762
LCA	Equal variances assumed	.865	.355	-.466	71	.643	-.11780	.25279	-.53910	.30349
	Equal variances not assumed			-.472	70.745	.638	-.11780	.24951	-.53366	.29805
FTF	Equal variances assumed	.482	.490	1.128	71	.263	.25076	.22233	-.11978	.62129
	Equal variances not assumed			1.132	69.179	.262	.25076	.22161	-.11871	.62022
CT	Equal variances assumed	.731	.395	.489	71	.627	.12439	.25455	-.29985	.54863
	Equal variances not assumed			.490	68.829	.626	.12439	.25411	-.29929	.54807

TB	Equal variances assumed	5.501	.022	-.076	71	.939	-.01712	.22472	-	.35740
	Equal variances not assumed			-.074	57.083	.941	-.01712	.23157	-	.37006
SI	Equal variances assumed	.352	.555	-.869	71	.388	-.21616	.24870	-	.19831
	Equal variances not assumed			-.868	67.927	.389	-.21616	.24912	-	.19926
TAD	Equal variances assumed	.585	.447	-.036	71	.971	-.01061	.29507	-	.48116
	Equal variances not assumed			-.036	69.831	.971	-.01061	.29318	-	.47812

Independent Samples Test for Past Profession

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
FLHC	Equal variances assumed	8.915	.004	-2.102	71	.039	-.29750	.14152	-.53336	-.06165
	Equal variances not assumed			-1.809	34.193	.079	-.29750	.16443	-.57551	-.01950
LCA	Equal variances assumed	8.329	.005	3.983	71	.000	.94742	.23790	.55095	1.34390
	Equal variances not assumed			4.507	69.471	.000	.94742	.21019	.59701	1.29783
FTF	Equal variances assumed	.295	.589	.411	71	.682	.09574	.23286	-.29233	.48382

	Equal variances not assumed			.397	46.790	.693	.09574	.24094	-.30857	.50006
CT	Equal variances assumed	14.727	.000	3.560	71	.001	.86907	.24411	.46223	1.27591
	Equal variances not assumed			4.184	70.981	.000	.86907	.20772	.52288	1.21526
TB	Equal variances assumed	1.074	.304	2.529	71	.014	.56579	.22371	.19296	.93863
	Equal variances not assumed			2.551	53.007	.014	.56579	.22182	.19444	.93715
SI	Equal variances assumed	1.641	.204	1.953	71	.055	.49427	.25314	.07239	.91615
	Equal variances not assumed			2.044	58.911	.045	.49427	.24181	.09017	.89838
TAD	Equal variances assumed	8.294	.005	2.582	71	.012	.75716	.29322	.26849	1.24583
	Equal variances not assumed			2.836	66.129	.006	.75716	.26698	.31178	1.20254

Independent Samples Test for Income (Groups: <=100,000\$ & >100,000\$)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
									Lower	Upper
FLHC	Equal variances assumed	1.774	.187	.048	71	.962	.00806	.16883	- .27332	.28944
	Equal variances not assumed			.041	20.173	.968	.00806	.19639	- .33052	.34664
LCA	Equal variances assumed	4.722	.033	3.222	71	.002	.91667	.28449	.44253	1.39080
	Equal variances not assumed			3.850	32.759	.001	.91667	.23810	.51364	1.31970
FTF	Equal variances assumed	4.525	.037	-.974	71	.333	-.26124	.26808	- .70801	.18554
	Equal variances not assumed			-.848	20.423	.406	-.26124	.30799	- .79189	.26942
CT	Equal variances assumed	2.192	.143	1.610	71	.112	.48509	.30131	- .01708	.98725
	Equal variances not assumed			1.849	30.248	.074	.48509	.26239	.03986	.93032
TB	Equal variances assumed	.245	.622	1.455	71	.150	.38772	.26642	- .05630	.83174
	Equal variances not assumed			1.364	22.164	.186	.38772	.28419	- .10011	.87555
SI	Equal variances assumed	1.597	.210	1.523	71	.132	.45066	.29599	- .04264	.94396
	Equal variances not assumed			1.676	28.006	.105	.45066	.26884	- .00666	.90798
TAD	Equal variances assumed	.529	.470	1.225	71	.225	.43037	.35130	- .15510	1.01585
	Equal variances not assumed			1.255	24.948	.221	.43037	.34288	- .15535	1.01610

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
FLHC	Equal variances assumed	.001	.977	.546	72	.586	.08090	.14807	-.16582	.32762
	Equal variances not assumed			.530	51.594	.599	.08090	.15277	-.17498	.33678
LCA	Equal variances assumed	4.639	.035	8.082	72	.000	1.50155	.18580	1.19196	1.81114
	Equal variances not assumed			7.614	46.932	.000	1.50155	.19721	1.17064	1.83246
FTF	Equal variances assumed	.272	.603	- 1.072	72	.287	-.24146	.22525	-.61680	.13388
	Equal variances not assumed			- 1.071	57.080	.288	-.24146	.22536	-.61826	.13534
CT	Equal variances assumed	8.532	.005	3.367	72	.001	.81801	.24293	.41322	1.22281
	Equal variances not assumed			3.094	43.204	.003	.81801	.26440	.37358	1.26245
TB	Equal variances assumed	14.177	.000	2.560	72	.013	.58975	.23037	.20589	.97361
	Equal variances not assumed			2.305	40.465	.026	.58975	.25589	.15899	1.02051
SI	Equal variances assumed	12.590	.001	3.766	72	.000	.87836	.23323	.48973	1.26699
	Equal variances not assumed			3.368	39.621	.002	.87836	.26081	.43910	1.31763
TAD	Equal variances assumed	5.203	.026	3.062	72	.003	.88742	.28979	.40455	1.37030
	Equal variances not assumed			2.932	49.531	.005	.88742	.30267	.38009	1.39476