HEALTH INFORMATION TECHNOLOGY AND ELDERLY CARE: OLDER ADULTS' AND LONG-TERM CARE NURSES' PERSPECTIVES ON TECHNOLOGY ADOPTION AND IMPACTS

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Thesis submitted to the University of Ottawa
in partial Fulfillment of the requirements for the Doctorate in Philosophy degree in Electronic Business

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Abstract

The population of older adults is growing worldwide, particularly in North America. Health information technology (HIT) is a group of technologies and systems that enhance care by electronically storing, managing, and exchanging data. HIT presents opportunities to support older adults' healthcare needs in communities and long-term care (LTC) environments. Despite their potential benefits, these technologies remain limited in LTC and older adults' healthcare contexts. Evidence is scattered on the factors that affect older adults' adoption of HIT. Little research has investigated the adoption of these technologies by formal healthcare providers and the technologies' impacts on LTC. A multi-method approach was employed in this thesis research, using a combination of a systematic qualitative review, an inductive semi-qualitative Delphi survey, and a quantitative deductive study to manage each research question in order to address these gaps.

The systematic literature review used the PRISMA guidelines to identify and critically appraise studies that examined the effect of various HIT adoption factors among older adults in the community. The search involved five databases and a combination of keywords, resulting in the selection of critically appraised articles based on their evidence level and research rigor. A coding scheme was developed to extract information from the selected articles. The results showed that the main factors affecting HIT adoption by older adults relate to performance expectancy, effort expectancy, and high price/cost value. It also highlighted the importance of considering privacy/security and product design when evaluating HIT adoption by older adults.

In light of the limited available studies on HIT adoption and impacts in the context of LTC, a Delphi study was developed to collect data from key formal healthcare providers (i.e.,

nurses) working in LTC at one of the largest and most progressive older adult healthcare facilities in Ontario, Canada. The Delphi study aimed to identify and prioritize the key factors that affect nurses' adoption of new technologies in support of older adults' care. A panel of nurses was solicited to participate in the Delphi study, which involved three rounds of data collection: brainstorming, narrowing down, and ranking. A total of 20 nurses completed the Delphi study, and the top factors that the LTC nurses identified were mainly related to the organizational and technological dimensions, including the complexity of HIT, the training and support provided, the interoperability of HIT systems, the cost of implementation, and the availability of HIT infrastructure.

For the last part of this research, quantitative secondary data analysis was conducted on a Canadian national survey of nurses to examine their perceived impacts of HIT adoption by nurses in LTC. The survey included questions related to the current state of electronic medical records (EMR) and EMR adoption, the state of virtual care technologies, attitudes and perceptions related to access and the impact of the adoption of digital health technologies in practice, benefits and effects of EMR adoption, and barriers preventing nurses from getting total value from electronic health. A subset of 166 nursing homes/long-term care facilities/older adult residences and homecare nurses were selected for this analysis. Data management and analysis were conducted using IBM SPSS v28. The results showed that HIT adoption by nurses in LTC was positively associated with perceived benefits and organizational support. However, HIT adoption was negatively associated with perceived complexity and privacy/security concerns.

This thesis research suggests that HIT adoption by older adults and nurses in LTC is complex and multifaceted, requiring attention to individual, organizational, and technological factors. There is a need for improved communication and collaboration among LTC team members and better working conditions to improve staff well-being and reduce turnover. The findings from the systematic review and Delphi study contribute to the theoretical understanding of the factors influencing the adoption of HIT in LTC facilities. The survey results provide valuable insights into the current state of HIT use in LTC facilities and can be used to inform the development of targeted interventions to improve HIT adoption and use. Overall, this study contributes to the growing body of knowledge on HIT adoption in LTC facilities and provides important recommendations for policymakers, administrators, and LTC staff to improve the use of HIT and ultimately enhance the quality of the care supplied to LTC residents.

Acknowledgement

It is with immense gratitude that I acknowledge several individuals who have been instrumental in helping me complete this project. I express my profound gratitude to my family, with a special mention of my wife and son, whose unwavering love and support have been a consistent source of strength and inspiration to me. I am also grateful to my mother and two sisters for their encouragement and guidance throughout my journey. They have stood by me through thick and thin, and I could not have completed this thesis without their unwavering encouragement.

I would also like to sincerely thank my supervisor, professor Mirou Jaana, whose guidance, feedback, and motivation have been invaluable to me. Her expertise and dedication have challenged me to produce my best work and helped me grow professionally and personally. Furthermore, I would like to acknowledge the invaluable contributions of my committee members, Professor Bijan Raahemi, Professor Daniel Amyot, Professor Gregory Richards, and Professor Mathieu Templier, whose insightful feedback and constructive criticism have helped me to refine my work and make it better. Their attention to the detail and rigorous examination of my work have pushed me to achieve a higher standard of excellence.

Finally, I would like to extend my gratitude to all who have supported me in this project, including my colleagues, friends, and mentors. Their encouragement, advice, and camaraderie have made this journey more enjoyable and rewarding.

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List of acronyms

ADF: asymptotically distribution-free

AQIISTI: Association québécoise des infirmières et infirmiers en systèmes et technologies de l'information

BMI: Body Mass Index

BN: Bachelor of Nursing degree

BScN: Bachelor of Science in Nursing degree

CDSSes: Clinical decision support systems

CHI: Canada Health Infoway

CMA: Canadian Medical Association

CNIA: Canadian Nursing Informatics Association

CNS: Clinical nurse specialists

COP: Commissionaires Ottawa Place

CPOE: Computerized physician/provider order entry

CPS: Cognitive Performance Scale

C-TAILS: Cycle of Technology Acquirement by Independent-Living older adults

DIT: Diffusion of Innovation Theory

DoI: Diffusion of Innovation

EDS: Electronic documentation system

EHR: Electronic health record

EMR: Electronic medical record

GLS: Generalized least squares

HIS: Health information system

HIT: Health information technology

HITAM: Health Information Technology Acceptance Model

ICT: Information Communication Technology

IDT: Innovation Diffusion Theory

IRB: Institutional Review Board

LPN: Licensed practical nurse

ML: Maximum likelihood

MPCU: Model of Personal Computer Utilization

m-Health: Mobile health

MM: Motivational Model

NP: Nurse practitioners

OLS: Unweighted least squares

OIIQ: Ordre des infirmières et des infirmiers du Québec

PHR: Personal health record

PRN: Psychogeriatric Registered Nurse

PRVHC: Perly and Rideau Veterans' Health Centre

PICO: Population, Intervention, Comparison, and Outcomes

REB: Research Ethics Committee

RPN: Registered Practical Nurse

RN: Registered Nurse

SAFE: Sub-Acute care for Frail Elderly

SCM: Sunrise Clinical Manager

SBSU: Specialized Behavioural Support Unit

SCT: Social cognitive theory

SEM: Structural equation modelling

SLS: Scale-free least squares

SR: Systematic review

TAM: Technology Acceptance Model

TM: Telemonitoring

TPB: Theory of Planned Behavior

TRA: Theory of Reasoned Action

UTAUT: Unified Theory of Acceptance and Use of Technology

VCoPs: Virtual communities of practice

1. Introduction

1.1. Ageing in Canada: Opportunities and Challenges for Older Adults

The population of older adults is increasing worldwide, especially in developed countries. Older adults (65 years and older) are a growing citizen group, especially in North America, and constitute 18 percent of Canada's population (Statistics Canada, 2020). This fast-growing age group will constitute 20 percent of Canada's entire population by 2024 and 25 percent by 2036 (Canadian Medical Association, 2016). By 2031, the number of older adults in the Atlantic provinces will increase by almost 100 percent. It will also grow in other provinces and regions, with especially more older adults in Ontario and Quebec (Canadian Institute for Health Information, 2011).

Older adults are at a higher risk for chronic diseases such as cancer, cardiovascular disease, and dementia, which are the leading cause of disability and death among this population. The prevalence of these conditions is expected to increase as the population ages. Risk factors for chronic diseases in older adults include lifestyle, genetics, environmental, and socio-economic factors. Effective prevention and management strategies for chronic diseases among older adults include promoting healthy lifestyles, increasing access to preventive healthcare services, and providing effective treatment and care for chronic conditions. Social support and community-based interventions can also play a significant role in preventing and managing chronic diseases in older adults. By addressing risk factors and providing effective interventions, it is possible to improve the health and wellbeing of older adults and reduce the burden of chronic diseases. (Public Health Agency of Canada, 2021).

Although older adults account for approximately 16% of the Canadian population, they

use almost 46% of all public-sector healthcare dollars spent by provinces and territories (Canadian Institute for Health Information, 2017). In addition, 24 percent of older adults recorded three or more of these disorders and a risk that at least one illness would also arise as a function of age growth (Canadian Institute for Health Information, 2011). Total health spending in Canada hit $265.5 billion in 2019, or $7,064 per person. Canada's healthcare system is not ready to face the challenges associated with population aging and older adults' needs, whereas 30 percent of Canadians have their required healthcare needs fulfilled by family members, potentially doubling in the next 30 years (Canadian Medical Association, 2016). Canada has longer wait times for health services (e.g., doctor appointments, specialists' visits, and emergency departments) than peer countries in the Commonwealth (Canadian Medical Association, 2016).

The 2011 census counted roughly five million (4,945,000) older adults aged 65 and older in Canada. Among them, 92.1% lived in individual houses or dwellings (as part of a couple, alone, or with others), while 7.9% lived in collective accommodation, such as older adult citizen residences or healthcare and related facilities (Statistics Canada, 2020). There is a general belief that significant improvement needs in the Canadian healthcare environment necessitate substantial reform in Canada's healthcare system (Antwi & Kale, 2014).

Older adults' residences in the community are a helpful alternative in providing healthcare. Health Canada mentioned 4,845 residential care places in Canada, comprising about 270,000 beds, where nearly half (46 percent) of these facilities are homes for mature residents, conveying administration specifically to older adults. Among inhabitants in all offices (excluding those in Quebec) across Canada, 42 percent are older adults aged 85 and older, and 78 percent

are female. There are various administrations and beds in homes for older adults. On average, 46 beds are staffed in operation per 1,000 older adults aged 65 and older, ranging from 35 beds in Quebec to 89 in Prince Edward Island (Canadian Institute for Health Information, 2011).

1.2. Overview of healthcare information technologies in the context of older adults' care

Health information technology (HIT) is a collection of technologies and systems that improve patient care by electronically storing, managing, and transferring data. HIT refers to various technologies that electronically collect and share patient information. Some of these technologies measure vital signs regularly; others send reminders and alerts or make relevant information readily and remotely available, thus supporting timely and integrated care. HIT is a general term for health-related technologies such as e-Health (electronic health), m-Health (mobile health), and telemonitoring (TM) (Mihailidis, Cockburn, Longley, & Boger, 2008; Tseng, Hsu, & Chuang, 2013; Queirós, Alvarelhão, Cerqueira, Silva, Santos, & da Rocha, 2017). HIT is a rising area at the intersection of clinical informatics, public health requirements, and business concerning health services and health information, giving healthcare providers opportunities to support older adults' healthcare needs and care. Scholars and researchers have used and applied these definitions of health information technology.

- E-Health is a term that refers to the application of information and communication technologies in the health sector. It encompasses a range of purposes, from purely administrative to online healthcare delivery (El Morr, 2018).
- Telehealth mainly refers to video conferencing and online control of signs and symptoms, which deal strictly with remote patient care. Some scholars reserve

telehealth for health practitioners' programmes (e.g., nurses and therapists) (El Morr, 2018).

- Scalvini, Vitacca, Paletta, Giordano and Balbi (2004) defined telemedicine as the use of information and communication technologies to exchange valid information for the diagnosis, treatment, and prevention of disease and injury, research and evaluation, and continuing education of healthcare providers, all in the interest of advancing the health of individuals and their communities.
- Telemonitoring regularly uses information and communication technology (ICT) to monitor and distribute patient health problems between geographically separate individuals (Chaudhry et al., 2006; Pandor et al., 2013).
- Telecare comprises various services and technologies for two-way communication, monitoring, consultation, and diagnostics (Stowe & Harding, 2010).
- Assistive technology combines different healthcare technologies (e.g., electronic sensors) to assist older adults' healthcare requirements in their daily life (Miskelly, 2001).
- In more transformative technology, mobile technology has brought several advantages to healthcare services. Mobile health (aka m-Health) is a combination of information and communication technologies related to healthcare via various applications through mobile phones (Nisha, Iqbal, Rifat, & Idrish, 2015). It is a valuable tool for two-way communication, monitoring, and distance health service delivery. M-Health systems enable patient interactions to be recorded and support proactive treatment, as health providers can provide patients with guidance and recommendations in near-real-time

(El Morr, 2018).

- Fall-detection systems consist of a monitoring technology with the primary goal of warning when a fall incident occurs. The drop detectors can significantly reduce the fear of falling and offer immediate assistance after a fall (Igual, Medrano, & Plaza, 2013).
- According to eHealth Ontario, An electronic health record (EHR) refers to the systems that make up the secure and private lifetime record of a person's health and healthcare history. These systems store and share such information as lab results, medication profiles, key clinical reports (e.g., hospital discharge summaries), diagnostic images (e.g., X-rays) and immunization history. This information is available electronically to authorized healthcare providers (eHealth Ontario, n.d.).
- An electronic medical record (EMR) is an office-based system that enables a healthcare professional, such as a family doctor, to record the information gathered during a patient's visit. This information might include a person's weight, blood pressure, and clinical data and would previously have been handwritten and stored in a file folder in a doctor's office. Eventually, the EMR will also allow the doctor to access information about a patient's complete health record, including information from other healthcare providers stored in the EHR (Centers for Medicare & Medicaid Services, n.d).
- A personal health record (PHR) is a complete or partial health record kept under the custodianship of a person (e.g., a patient or family member) that holds all or a portion of the relevant health information about that person over their lifetime. It is also a person-centric health record, but unlike the EMR, which the healthcare provider controls, the patient has control or "custodianship" over the document (Office of the National

Coordinator for Health Information Technology, 2013).

- Clinical decision support systems (CDSS) enable integrated workflows, assist during treatment, and guide the care plan. A CDSS, or clinical decision support system, is a tool designed to help medical practitioners in decision-making. It can be standalone or integrated within an EMR. Typically, a CDSS contains a knowledge base of rules related to specific health situations, which helps medical professionals to make informed decisions (e.g., drug-interaction rules). It also uses an inference engine that uses the patient data and the knowledge base to infer if a specific health situation applies to a particular patient (e.g., not using two prescription medications together). These promising technologies present opportunities to address older adults' healthcare needs (e.g., social isolation and chronic disease), improve older adults' quality of life and reduce healthcare costs (Marschollek, Mix, Wolf, Effertz, Haux, & Steinhagen-Thiessen, 2007). Moreover, these technologies enhance communication with caregivers (i.e., nurses) and older adults (see, e.g., Heart & Kalderon, 2013; Phichitchaisopa & Naenna, 2013; Zhang, McGrath, Lo, & Li, 2013; Jaana, Sherrard, & Paré, 2017; Vorrink, Antonietti, Kort, Troosters, Zanen, & J-WJ, 2017).

HIT makes healthcare records more accurate, up-to-date, and complete than traditional paper-based systems (Foglia, Alder, & Ruiz, 2013; King, Patel, Jamoom, & Furukawa, 2014). HIT decreases the unnecessary time for patients (i.e., older adults) who require healthcare services and reduces medical error with improved service quality among healthcare providers (i.e., nurses) (e.g., Phichitchaisopa & Naenna, 2013). HIT provides opportunities to support older adults living in the community (such as telemonitoring for self-management and fall detection)

and present tools to help healthcare professionals work in the context of an aging population and a growing number of older adults. This is more critical in light of the increased older adult population (Czaja, Beach, Charness, & Schulz, 2014; Vassli and Farshchian, 2017). Despite their potential benefits to help healthcare practitioners' jobs and the care provided to older adults, their adoption in long-term care (LTC) and older adult care remains limited. Nurses are an essential group of healthcare professionals whose jobs might be aided by HIT. Today's healthcare organizations continually seek and deploy new HIT to reduce costs and increase staff productivity and process efficiency for excellent service quality (Barakat, Woolrych, Sixsmith, Kearns, & Kort, 2013; Gartrell, Trinkoff, Storr, & Wilson, 2015). In today's dynamic healthcare environment, we face uncertainties, new demands, and shifting priorities that may impact individuals, organizations, and healthcare technologies. The growth of new technologies that enable communication, remote connection, and elder care is more vital than ever. Emerging technologies are being widely used to tackle some of the fundamental problems healthcare systems worldwide are experiencing (Barakat et al., 2013; Kang, Taylor, Osterhage, & Turner, 2019; Seto et al., 2019).

Only a small amount of information is available regarding the implementation of HIT in Canadian LTC institutions. Most research on the performance of HIT in healthcare settings has concentrated on intensive care settings. As a result, there is a powerful knowledge vacuum regarding the difficulties and possibilities associated with implementing HIT in LTC institutions. Long-term care institutions frequently have insufficient financing and resources, which can impact their capacity to implement and utilize HIT systems. Because this can result in adoption patterns that are different from those seen in other healthcare environments, specific studies

and questions are required to understand better the variables that influence adoption in LTC institutions. Adopting HIT in Canadian LTC institutions may improve patient treatment and safety, increase productivity, and strengthen collaboration between healthcare professionals. These are referred to as "potential benefits." Consequently, understanding the variables that either promote or inhibit the acceptance of HIT in these contexts is essential to achieving the goals mentioned above.

Overall, the one-of-a-kind setting of LTC facilities in Canada, the limited amount of research that has been done on the topic, the limited amount of funding and resources that are available, and the potential benefits of implementing HIT in these kinds of settings all highlight the need for specific studies and inquiries to understand better how HIT is implemented in long-term care facilities in Canada.

1.3. Nursing-in-Canada

Nursing is an essential profession that is critical in the healthcare system. In Canada, the nursing workforce is predominantly female, and many nurses are approaching retirement age. The demand for nurses is growing, particularly in remote and rural areas with high job-vacancy rates. The nursing profession in Canada is expected to continue to evolve and adapt to the changing healthcare landscape, and nurses will remain essential in providing high-quality care. Nursing is among the most critical and demanding professions in the healthcare industry. Nursing is vital in providing care and support to patients in different healthcare settings. In Canada, nursing is regulated by provincial and territorial regulatory bodies that set standards for nursing practice, education, and registration.

Number of Nurses in Canada According to the Canadian Nurses Association (CNA), there were 439,975 registered nurses (RNs) and licensed practical nurses (LPNs) in Canada in 2020. This number represents a 1.5% increase from the previous year. RNs accounted for 77% (338,065), while LPNs comprised 23% (101,910) of the nursing workforce.

The nursing profession in Canada is predominantly female. In 2020, 92% of RNs and 98% of LPNs were women. The age distribution of nurses in Canada is also worth noting. About 32% of RNs and 22% of LPNs were aged 55 and above, indicating that many nurses are approaching retirement age. On the other hand, 17% of RNs and 23% of LPNs were aged 30 or younger, suggesting. In 2020, 67% of RNs and 59% of LPNs worked full-time, while 33% of RNs and 41% of LPNs worked part-time. There has been increasing demand for nurses in Canada, particularly in remote and rural areas. According to the Canadian Institute for Health Information, there were 12,106 RN job vacancies in Canada in 2020, with the highest vacancy rates reported in the territories and Atlantic provinces.

1.4. Long-Term Care Settings for Aging Populations

LTC refers to various services that assist in meeting the medical and non-medical needs of individuals who cannot care for themselves for extended periods due to a chronic illness or disability (Shi & Singh, 2022). A wide range of services are included in LTC and are intended to meet a person's health or personal care needs over a short or long period. LTC is characterized by providing individualized and coordinated services that encourage patients' autonomy, improve their quality of life, and attend to their requirements over time. When a person can no longer carry out daily tasks independently, these services help them live as independently and safely as possible. Caregivers provide LTC in various locations depending on a person's needs.

Among these caregivers, nurses are the primary healthcare providers. Personal care, also known as “activities of daily living,” is the most typical form of long-term care. This type of care involves assistance with daily tasks (e.g., showering, getting dressed, and grooming). LTC is frequently required when a person has a severe and enduring health condition or disability. LTC may become necessary suddenly, such as following a heart attack or stroke. But it most frequently occurs gradually as people age and become frailer or as a disease or disability worsens.

Studies conducted in various nations identified and used a unique set of health information technology in the context of LTC (Table 1). However, there is no clear link between the technology chosen for the study and the location where it was used or applied.

Table 1: Applied and used health information technology in different countries

Reference	Country of origin	Technology
Alaiad and Lina Zhou, 2019	US	Home healthcare robots
Asan et al., 2017	US	Health information management
Asua et al., 2012	Spain	Telemonitoring
Barakat et al., 2013	Netherlands	E-health (telecare and ambient assisted living (AAL), mobile health, and fall detection systems)
Courtney et al., 2012	Tasmania	Information and communication technology
Dowding et al., 2015	US	Integrated electronic health record
Gartrell et al., 2015	US	Electronic medical records
Göransson et al., 2017	Sweden	Health application
Ibrahim et al., 2019	Canada	Electronic medical records
Johannessen et al., 2019	Norwegian	Telecare
Kang et al., 2019	US	Health information management
Koru et al., 2016	US	Information and communication technology
Leite et al., 2017	Brazil	Assistive technology
Luciano et al., 2020	US & Brazil	Telehealth
Mahony et al., 2014	South Africa	Electronic medical records
O'Sullivan et al., 2018	Germany	Information and communication technology
Seto et al., 2019	Canada	Telemonitoring
Thoma-Lürken, et al., 2018	Netherlands	Decision support App
Vasalampi et al., 2017	Finland	Mobile and wearable technology
Wang et al., 2016	US	Mobile and wearable technology
Yada & Head, 2019	Canada	Healthcare virtual communities of practice

HIT has become indispensable in meeting the complex healthcare needs of older adults in the US. From EMR to patient portals, HIT provides healthcare professionals with innovative and efficient means to manage patient care better. By improving the accuracy and accessibility of patient information, HIT enables healthcare providers to make informed decisions and deliver better quality care to patients (Cipriano, Bowles, Dailey, Dykes, Lamb, & Naylor, 2013). Tak, Benefield and Mahoney (2010) studied US long-term care technologies. They listed available HIT in research centers and LTC settings along with examples (Table 2).

Table 2: Available LTC technologies in the US healthcare system*

Areas	Technology description
Safety/Prevention/Detection	
▪ Falls	Gait and motion sensors, Global Positioning System (GPS), displays and actuator networks
▪ Wandering	Wireless motion, sensors and GPS location system
▪ Pressure Ulcer	Biosensors
▪ Wellness monitoring	Biosensors, behavioural sensors, and bodily diagnostics information fusion and inference engines
Activities of daily life	
▪ Bathing	Sensors, information transfer, decision guidance systems
▪ Eating	Sensors, wireless information transfer, and decision guidance systems
▪ Mobility	Sensors, robotics, and mechanical engineering
▪ Sleeping	Wireless sensors
▪ Medication	Biosensors and medication dispensers with motion sensor
▪ ADL helper	Artificial motion sensor intelligence and robotic engineering adaptive, distributed interfaces
Cognition	Ambient displays and actuator networks cognitive orthosis technology
Social connectivity/communication	Wireless broadband, remote community and collaboration

* **Tak, Benefield and Mahoney, 2010**

1.4.1. Challenges and Opportunities in Long-Term Care for Aging Populations in Canada

The existing studies on Canada's healthcare technologies are minimal and recognized technologies differ. Seto et al., 2019 used telemonitoring technology and identified numerous barriers to TM system implementation in home-care nursing. Moreover, Yada and Head (2019) used virtual healthcare communities of practice (VCoPs) technology and mentioned that ability and expertise with CoPs and VCoPs was found to affect the intention to use the system directly. However, it is unclear whether the identified technologies are available and accessible in the Canadian healthcare system.

While long-term care underfunding and staffing shortages have been ongoing issues in the healthcare system, the COVID-19 pandemic has magnified these problems and created additional challenges. The healthcare system was already struggling to meet the needs of patients before the pandemic, but the overwhelming demands placed on the system during the COVID-19 crisis have exposed the extent of the existing issues and underscored the urgent need for reform (Ochieng, Chidambaram, & Musumeci, 2022). Although LTC facilities have historically

served people with varying care needs, the proportion of residents requiring more intensive support has increased significantly in the past few years (Badone, 2021). Moreover, almost half of the province's nursing facilities are over 20 years old and need replacement. It is projected that 20,000 beds in older LTC facilities still need to be improved, and numerous projects to remodel or rebuild such facilities are now awaiting clearance (Coyte, Laporte, Baranek, & Croson, 2002). Some jurisdictions in Canada have started to evaluate and utilize HIT. For instance, in New Brunswick, telehomecare services named EMPcare@home have assisted and supported evaluating patients with congestive heart failure and chronic obstructive pulmonary disease. The results show reduced healing-center confirmations, crisis-room visits, and better self-management (Canadian Institute for Health Information, 2011). In a 2014 survey, the physicians' adoption rate of EMR was 73 to 75 percent in Canada. At the provincial level, the technology adoption rate was 87 percent in Alberta, 85 percent in British Columbia, 83 percent in Ontario, 68 percent in Newfoundland and Labrador, 64 percent in Quebec, and 62 percent in New Brunswick (El Morr, 2018). In Ontario, EMR was used in three services, E-Care, E-Consultation, and E-Visit, with a 56 percent adoption rate in 2013.

Long-term care facilities are designed to help people with complex needs and requirements. Medical care, assistance with daily living activities, emotional and social support, and other services may be required. Because of these needs, providing care in LTC facilities requires highly complex and specialized expertise. Unlike different healthcare settings, such as hospitals or clinics, LTC facilities are designed to provide LTC to individuals who require ongoing support and assistance. As a result, care in LTC facilities is more comprehensive, and residents' needs are more complex (Hsu, Lane, Sinha, Dunning, Dhuper, Kahiel, & Sveistrup, 2020).

Furthermore, many people in LTC require care beyond what the facility can provide. Coordination of care with other healthcare providers, emotional support to family members and caregivers, access to community resources and services, and advocacy for policies and practices that support the needs of people in LTC facilities are all examples of what this entails (Molinari & Prattm, 2021). For example, many older adults in LTC facilities have family members or other caregivers who provide support outside the facility. These caregivers may require assistance and training to provide necessary care and support to their loved ones. Furthermore, many people in LTC facilities need transportation, meal delivery programs, and community-based social activities to help them maintain their overall health and well-being.

Overall, providing care and support to individuals in LTC facilities necessitates complex relationships, resources, and support systems that extend far beyond traditional healthcare.

1.4.2. Challenges and Priorities in Long-Term Care for Aging Populations in Ontario

The Canadian healthcare transfer from the federal government to the provinces and territories funds LTC settings (Allin & Rudoler, 2015). Afterwards, provinces and territories allocate funding for long-term services. Ontario's LTC homes provide care and assistance to more than 115,000 individuals and their families annually. LTC offers nursing care and supervision 24 hours a day, seven days a week; primary medical care; assistance with daily activities and interests; and a safe, caring environment. Most individuals in LTC facilities have a cognitive impairment, physical frailty, and chronic conditions that severely compromise their health (Ontario long term care association, 2018). As part of the healthcare system, the Ministry of Health and LTC licenses and finances long-term care services to provide care for people who require more assistance. Although most of us hope to age indefinitely at home, it is

impossible for everyone, especially those with Alzheimer's disease and other forms of dementia.

Our elderly population requires LTC facilities to meet their ever-increasing, complex healthcare needs and provide safe, high-quality care when they expect and demand it most. The provincial government's responsibility is to regulate and finance long-term care homes in Ontario. The local government pays for all nursing and personal care and supplies, resident social and recreational programs and support services, and raw food (used to make meals). Additionally, long-term care facilities receive additional government funding for specific requirements, such as fall-prevention equipment. Approximately 70% of dementia patients will eventually require long-term care. Different types of chronic disease exist among LTC residents (Table 3).

Table 3: Ontario's long-term care residents with chronic disease (2019) *

90% have some form of cognitive impairment
86% of residents need extensive help with daily activities such as getting out of bed, eating, or toileting
80% have neurological diseases
76% have heart/circulation diseases
64% have a diagnosis of dementia
62% have musculoskeletal diseases such as arthritis and osteoporosis
61% take ten or more prescription medications
40% need monitoring for an acute medical condition
21% have experienced a stroke

* **Ministry of Health and Long-Term Care (2019)**

In Ontario, long-term care homes are part of the health system and are provincially regulated and funded (Ministry of Health and Long-term Care). A greater emphasis on "aging at home" and stricter requirements for entry into long-term care residences were implemented in Ontario (Marier, 2021). In Ontario, residents must additionally pay a charge for their housing. Owners and operators of long-term care institutions in Ontario include individuals, family-owned businesses, private corporations, publicly traded companies, non-profits and charitable organizations, local governments, and First Nations communities. More than 38,500 individuals in Ontario are now on the LTC waiting list (Government of Ontario, 2021). It is projected that the population of older adults aged 80 and older will increase by more than 100% over the next 16 years, dramatically increasing the need for long-term care services. There is an immediate need to construct new facilities and increase the number of LTC beds in Ontario (Ontario Long-Term Association, 2018).

1.5. The COVID-19 Pandemic: Impact, Response, and Lessons Learned

According to the World Health Organization report, as the coronavirus disease (COVID-19) pandemic surged worldwide in 2019, more than six hundred million positive cases and 6,722,949 deaths were reported (WHO, January 24, 2023). The COVID-19 pandemic affected the population, especially older adult citizens, who are the most susceptible to the disease

(Cardinali, Brown, Reiter, & Pandi-Peruma, 2020; Daoust, 2020). Di Santo, Franchini, Filiputti, Martone and Sannino investigated the effects of COVID-19 and quarantine on older adults' lifestyle and mental health. One possible effect they mentioned is an increased risk of dementia (Di Santo, Franchini, Filiputti, Martone, & Sannino, 2020). Di Santo et al. noted that older adults with subjective cognitive decline and mild cognitive impairment had experienced behavioural changes potentially detrimental to their mental deterioration (Di Santo et al., 2020). Moreover, COVID-19 is associated with isolation and sleep problems in older adults, in which fears and resilience are moderators (Grossman, Hoffman, Palgi, & Shrira, 2020). Sadly, older adults living in LTC facilities account for 79 percent of the death toll of COVID-19 in Canada (Walsh & Semeniuk, 2020).

The COVID-19 pandemic generated an urgent need for organized structures to react to the outbreak (Fagherazzi, Goetzinger, Rashid, & Aguay, 2020; Salway, Silvestri, Wei, & Bouton, 2020). Researchers discussed HIT's helpfulness during the COVID-19 crisis, presenting opportunities to support older adults' healthcare (Aubertin-Leheudre & Rolland, 2020; Holt, Neumann, McNeil, Cheng, Unit, & Prahan, 2020). Fagherazzi et al. mentioned "digital health solutions", especially telemedicine, as a successful approach for patients' treatment in both emergency and primary care during the COVID-19 pandemic (Fagherazzi et al., 2020). They proposed a healthcare model during the pandemic by including a digital health ecosystem (e.g., artificial intelligence and electronic prescribing) by shifting to remote healthcare services (e.g., virtual visits and virtual care), mobile apps (e.g., remote patient monitoring) and websites and chatbots (e.g., risk assessment, screening, and triage) (Fagherazzi et al., 2020). Salway et al. (2020) mentioned improved workplace performance, standardization in clinical practice,

enhancement in customer care, and bridging knowledge systems as benefits of HIT in crises like COVID-19.

Due to the COVID-19 pandemic, countries tackled this issue differently (Yan, Zhang, Wu, Zhu, & Chen, 2020). Social distancing and temporary lockdowns are examples of these approaches. There are successful cases of using HIT in dealing with the COVID-19 crisis. South Korea has gained worldwide attention regarding the COVID-19 pandemic. Infections in South Korea dropped from 900 per day in late February to under 20 per day in late April (Bae et al., 2021). This achievement came through using HIT in patients' monitoring and tight social isolation. Specifically, implementing a new electronic health record template, hospital information system dashboards, cloud-based medical image sharing, mobile apps, and intelligent vital sign monitoring devices reduced coronavirus disease spread in South Korea (Bae et al., 2021). Time and skilled healthcare providers are crucial in fighting COVID-19, and emerging digital health approaches provide better ways to manage time and these limited human resources. The COVID-19 pandemic showed the capability of HIT in helping healthcare providers and how HIT may help providers deliver healthcare in similar situations. More severe outbreaks during COVID-19 were linked to community dispersion, personnel levels, and older house age (Statistics Canada, 2020). There is an immediate need to increase the number of LTC beds in Ontario and to rebuild older homes that posed a threat of catastrophic outbreaks during COVID-19 because of difficulties with infection control in overcrowded facilities (Chu, Ronquillo, Khan, Hung, & Boscart, 2021). Various technologies would necessitate older adults' adoption of HIT in some instances or changes in the activities and delivery of care processes nurses are involved in when providing care to older adults. In light of the COVID-19 crisis, the

role of these HIT is becoming even more critical, emphasizing the changing requirements in healthcare delivery, especially in LTC.

1.6. Research Questions and Rationale

The low adoption rate of HIT among older adults and their healthcare providers is still evident, despite the potential benefits that technology can offer in addressing the healthcare needs of this group (e.g., Arksey & O'Malley, 2005; Cimperman et al., 2016; Vassli & Farshchian, 2017). Prior studies have demonstrated that older adults prefer to live independently in their homes or communities if they receive the necessary assistance and support (e.g., Ehrenhard, Kijl, & Nieuwenhuis, 2014; Fischer, David, Crotty, Dierks, & Safran, 2014; Khosravi & Ghapanchi, 2016). Therefore, it is essential to understand what factors affect their adoption of technology that can assist them and support their stay in the comfort of their homes. Overall, there is limited information available from nurses in direct contact with older adults in the community and LTC environments on the role that HIT can play in supporting the care they provide to older adults (e.g., Cork, 2005; Turner, 2015; Mrayyan, 2020). Some scholars examined HIT adoption by nurses (e.g., Sun, Wang, Guo, & Peng, 2013; De Leeuw, Woltjer, & Kool, 2020) and discussed nurses' resistance to HIT adoption (e.g., Robinson, 2007; Sweis, Isa, Azzeh, Shtyh, Musa, & AlBtoush, 2014). Moreover, other scholars investigated older adults' concerns regarding HIT's effectiveness in assisting with their required healthcare services (e.g., Ehrenhard et al., 2014; Fischer et al., 2014). While previous research has investigated HIT and nurses, it is unclear what factors affect the adoption of distinct HIT by nurses in LTC. Moreover, the impact of the adoption and usage are missing among healthcare providers (i.e., nurses), and scholars in prior studies suggested additional research in this area.

Prior studies have investigated the factors that affect older adults' adoption of various technologies (e.g., telemonitoring and wearables). Still, little is known about the magnitude and convergence of evidence to provide a comprehensive summary of all the primary research that is currently available. Moreover, technology adoption by nurses (targeted users in this environment as essential healthcare providers and professional caregivers for older adults) and the impacts of technology use by nurses in this environment need further studies and investigations. On the other hand, considerable research has looked at technology adoption by nurses in general (Abramson, Edwards, Silver, & Kaushai, 2014; Sun et al., 2015; Vest, Jung, Wiley, Kooreman, Pettit, & Unruh, 2019). By LTC nurses in Canada (Gallant, Hadjistavropoulos, Stopyn, & Feere, 2022), even fewer studies exist on the impacts of technology adoption and use by nurses in Canadian LTC environment (Vest et al., 2019; Buchanan, Howitt, Wilson, Booth, Risling, & Bamford, 2020). Many scholars have suggested additional analyses and research to study and investigate the adoption factors among older adults and their healthcare providers (e.g., Antwi & Kale, 2014; Peek et al., 2014; Khosravi & Ghapanchi, 2016).

This research investigates the context of HIT in older adults' care. Specifically, its objectives are 1) to critically appraise and synthesize the evidence on the factors that affect the adoption of technologies by older adults in the community, 2) to explore the factors that affect the adoption of technologies by nurses working in LTC, and 3) to investigate the perceived impacts of technology use by nurses working in LTC settings (e.g., burnout and net benefits). Therefore, this research addresses the following questions:

Question (1): What is the evidence on the most significant factors that affect the adoption of various technologies by older adults in the community?

Question (2): What are the most significant factors that affect nurses' adoption of health information technology in support of older adults' care in long-term care?

Question (3): What are the perceived impacts of health information adoption and use by nurses in LTC?

These studies (LR, SR, Delphi, and survey) are designed to cover and collect data to effectively address the research problem by integrating the various components of the study coherently and logically. It serves as the blueprint for data collection, measurement, and analysis and ensures that I will address the research problem. The literature reviews (LR and SR) and Delphi studies are exploratory, inductive, and qualitative research types, followed by explanatory, deductive, and quantitative surveys (Table 4).

Table 4: Research approach within different stages

Study type	Broad research approach	Research approach	Type of Research	Data analysis method
Literature review (LR & SR)	Exploratory	Inductive	Qualitative	Qualitative synthesize
Delphi	Exploratory	Inductive	Qualitative	Qualitative synthesize
Survey	Explanatory	Deductive	Quantitative	Descriptive and multivariate

Broad research approaches: Exploratory and explanatory
Unit of analysis: Older adults and long-term care nurses who provide healthcare requirements to older adults
Research approach: Inductive in the systematic review, literature review, and Delphi study, and deductive in the survey research
Research Strategy: A literature review, systematic review, Delphi study, and a survey questionnaire
Data collection method: Existing literature, a Delphi study, and 2020 nurses' national survey analysis
Type of research: Multimethod—qualitative (literature reviews), semi-quantitative (Delphi), and quantitative (survey)
Data analysis method: A qualitative synthesis, descriptive and multivariate statistical analysis

A combination of qualitative and quantitative approaches is applicable in this research since the objective is to assess older adults and nurses' perceptions of HIT adoption and impact

and the extent to which adoption affects LTC nurses in different layers, such as satisfaction and burnout. In general concept, the research design is in social behavioural science with the following sections: a) introduction to the topic background, the rationale of the research, questions, and research location; b) conduct a systematic literature review on older adults' technology adoption; c) develop and conduct a Delphi research survey with three rounds among LTC nurses; d) analyze the results of the 2020 national survey regarding LTC nurses' HIT adoption and the results of the adoption; and e) conclude the research in different stages and report the results, main findings, and recommendations for researchers, practitioners in healthcare service providers, and policy- and decision-makers.

In the preliminary phase of research, when the research problem is not apparent, the Delphi research has benefits for explanatory research. Delphi research enables an in-depth understanding of complex issues and triggers responses or ideas. The Delphi research provides information to examine and develop the questionnaire and verify the research intent. Combining multiple research methods—quantitative (survey questionnaire), semi-quantitative (Delphi), and qualitative methods (LR and SR)—present better opportunities to answer research questions and evaluate the extent of findings (Saunders, Lewis, & Thornhill, 2009). The deductive research method will use survey data to answer research questions. This approach provides a compelling test of theories/models and plausible explanations of existing data to confirm or falsify the proposed hypothesis.

By observing the hypothesis and phenomena, this research investigates factors that impact older adults and their healthcare providers (i.e., nurses) toward health information technology and its impact at the individual, organizational, and technological dimensions.

Moreover, it analyzes the results of the adoption in identified dimensions.

Given the investigation of prior knowledge and studies regarding the information from older adults' technology adoption, a systematic review addresses this state of evidence on the adoption of technology by older adults in the community. A literature review was performed in the context of LTC nurses (essential healthcare providers and professional caregivers for older adults) and the impacts of technology use by nurses in this environment. A systematic literature review was then conducted to synthesize and integrate evidence on the effect of various HIT adoption factors among older adults. The systematic literature review critically appraises and synthesizes/integrates existing evidence in a research area scattered in the literature and provides research-based evidence.

Due to minimal available studies, especially in the Canadian healthcare system, a Delphi study followed the literature review results by collecting data from one of Ontario, Canada's most significant older adult healthcare facilities. The Delphi research with nurses practicing at a long-term care facility assessed factors that affect their adoption of new technologies and methods for delivering care. Quantitative data analysis was conducted on the Canadian nationwide survey to determine the impact of HIT adoption among LTC nurses.

The exploratory and explanatory approaches were used to develop and test hypotheses regarding the nature of the variables' relationships and the impact of their interactions. I selected a multimethod method that offers more significant evidence on the adoption and usage of HIT in the care support of older people to highlight how crucial it is for older people and their healthcare professionals (i.e., nurses) to use it (Figure 1).

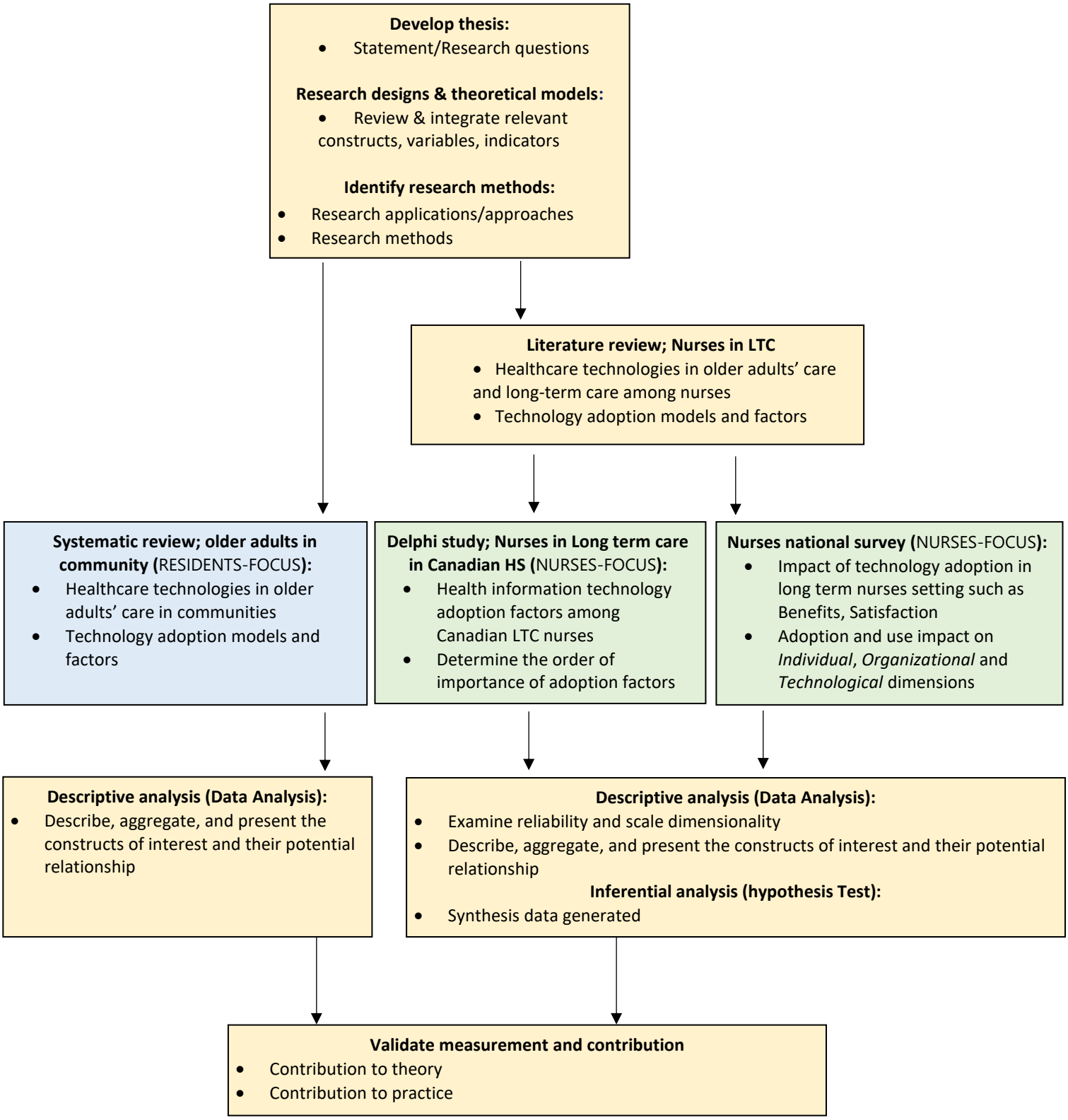

Figure 1: Research approach and validation measurement

1.7. Technology adoption and its impact

1.7.1. Technology adoption models

Technology adoption is the acceptance and use of new products or innovations, which may be affected by various factors related to, among others, the work environment, context, type of technology, condition of users, and individual preferences (Skoumpopoulou, Wong, Ng, & Lo, 2018). These factors may act as facilitators or barriers to the adoption of HIT. Examples include the technology's ease of use, perceived usefulness, and nurses' prior experience with technology.

Prior studies developed various technology adoption models and frameworks to research the technology adoption factors in the context of business organizations (e.g., Davis, Bagozzi, & Warshaw, 1989; Venkatesh, Morris, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Despite most of the research has developed and tested models within the business contexts, some researchers applied them in the healthcare domain (e.g., Cimperman, Brenčič, & Trkman, 2016). Technology Adoption Model/Technology Acceptance Model (TAM) is one of the most widely used adoption models. TAM represents users' intention to adopt new technologies, including the main factors: perceived usefulness and perceived ease of use (Davis et al., 1989). The perceived usefulness is related to the system's effectiveness in increasing productivity, and ease-of-use concerns how easy the system is to use. An extension of TAM includes different factors such as subjective norms and voluntariness (Venkatesh & Davis, 2000).

Rogers (1995) introduced the Diffusion of Innovation Theory (DIT) based on individuals' attitudes toward specific (e.g., technological) innovation, which leads to the decision on whether to adopt or not. Roger proposed DIT to verify adoption/access factors among

individuals and organizational levels. This theory explains different acceptance/adoption stages within social behaviour changes over time (Roger, 1995).

The Theory of Reasoned Action (TRA) model investigates humans' intentional attitudes toward adoption. TRA includes general human behaviour driven by an intention to perform an attitude toward the behaviour and subjective norm (Ajzen & Fishbein, 1975). The Motivational Model (MM) aims to shed light on the often-overlooked influence of human motivation on technology adoption and use (Davis, Bagozzi, & Warshaw, 1992).

Due to more research in the business domain, the Theory of Planned Behavior (TPB) uses an individual's decision-making level with a costs and benefits analysis (Ajzen, 1985, 1991). The Decomposed Theory of Planned Behaviour (DTPB) breaks down the latent variables from TPB to explain behaviour based on the relationship between beliefs, attitudes, and intentions at the user level (Taylor & Todd, 1995). Moreover, the Model of Personal Computer Utilization (MPCU) is a theory of human behaviour that differs from TRA by distinguishing capabilities between cognitive and affective components of attitudes (Compeau & Higgins, 1995).

Bandura introduced social cognitive theory (SCT) in response to increasing social influence at the organizational and individual levels (Bandura, 1989). SCT has four primary factors—self-observation, self-evaluation, self-reaction, and self-efficacy—with a potential impact on adoption (Bandura, 1989). Venkatesh et al. (2003) established the Unified Theory of Acceptance and Use of Technology (UTAUT) model with a combination of eight models, including TRA, TPB, TAM, IDT, SCT, MPCU and MM, to increase the prediction capabilities (R-squared) of the existing adoption models in the organizational level (Venkatesh et al., 2003).

UTAUT was proposed and included four factors to predict behavioural intention. These

factors are 1) performance expectancy, similar to perceived usefulness (i.e., individuals' belief of the extent to which the system helps attain benefits in performance); 2) effort expectancy, similar to perceived ease of use (i.e., the degree of system ease of use); 3) social influence (i.e., individuals' perception of whether other people, who are essential to them, think that they should use the system); and 4) facilitating conditions (i.e., individuals' belief of whether the organization and technical infrastructures exist to support system use). UTAUT2 is a modified UTAUT model focusing on individual-level adoption with three additional factors: hedonic motivation, price value, and habit (Venkatesh et al., 2012).

1.7.2. Impacts and benefits of HIT

Overall, prior studies are primarily focused on the factors that affect technology adoption and use. In contrast, the impact of HIT adoption is significantly less examined in studies and research. The challenge of a growing population of older adults and the limited resources and organizations to care for them has led to efforts to address these issues, including using HIT. As a solution to the problem of limited healthcare resources, HIT is designed to make the existing facilities and services more efficient and effective by utilizing advanced technology, such as electronic health records, telemedicine, and other digital platforms. HIT's implementation can potentially improve the quality and accessibility of healthcare services, reduce costs, and enhance patient outcomes. Through its use, healthcare providers can better coordinate care, reduce medical errors, and improve patient communication, resulting in a more efficient and effective healthcare system.

The findings of most of these studies are either inconclusive or contradictory. Brenner et al. reviewed the effects of health information technology on patient outcomes, and they

mentioned there are still many applications of HIT that have not been thoroughly researched (Brenner et al., 2015). An interesting systematic review by Kruse et al. in the US covers the impact of electronic health records on LTC (Kruse et al., 2017). Kruse et al. (2017) reported that EMR had improved clinical documentation management and decision-making in LTC. However, they identified that EMR still lags in other vital healthcare areas, such as accessibility, training and support, quality of care, communication, and integration with other healthcare technologies. For instance, patients in LTC facilities may have limited access to EMR due to a lack of technology or internet access.

Additionally, LTC nurses may require extensive training to use EMR effectively, and ongoing support may be necessary to address any issues. While EMR can improve documentation, it may not necessarily enhance patients' quality of care. Inadequate communication among healthcare providers, patients, and their families can also be challenging in LTC settings. Furthermore, EMR may not integrate well with other healthcare technologies, such as telehealth or remote monitoring devices, which can limit their potential benefits in LTC facilities (Kruse et al., 2017). Research has shown that EMR have been implemented successfully in limited LTC institutions. Despite the challenges of implementing EMR, such as cost, training, and interoperability, the LTC facilities that have adopted them have seen several benefits (Kruse et al., 2017). For example, EMR improved the accuracy and completeness of patient records, leading to better decision-making and quality of care. EMR can also provide real-time access to patient information, allowing healthcare providers to make informed decisions quickly. Additionally, EMR has been found to reduce medication errors and improve medication management, which is particularly important in LTC facilities where patients may be

taking multiple medications.

Moreover, EMR have been found to enhance communication among healthcare providers, patients, and their families. They can facilitate the timely and efficient sharing of patient information and updates, leading to better care coordination and patient outcomes. Despite the successes of EMR in some LTC facilities, their implementation remains limited. Further research is needed to understand the reasons behind this and to develop strategies to overcome the challenges associated with EMR implementation in LTC settings.

The IS (information system) success model integrates different multidimensional models to propose a comprehensive conceptual model for the information system. The IS success model includes different dimensions, including information quality, system quality, and service quality and their potential impact on the intention to use and user satisfaction (DeLone & McLean, 2003). Scholars suggested further studies on this subject (Marani, McKay, &Marchildon, 2021; Oandasan et al., 2009).

The researchers used and modified existing adoption models to investigate HIT usage among older adults, with the majority using the TAM and UTAUT adoption models. However, existing studies did not consider older adults' specific healthcare requirements (e.g., system design per older adults' needs, limited movement abilities, and cognitive impairment). Even though privacy is critical in determining older adults' technology acceptance, this concern has not been considered enough in these frameworks and models (e.g., Beer & Takayama, 2011; Cimperman et al., 2013; Charness, Best, & Evans, 2016).

Lau, Price, and Keshavjee used the IS success model Clinical Adoption Framework to make sense of the health information system (HIS) success in Canada (Lau, Price, & Keshavjee,

2011). They added contextual factors, including people, organization, implementation, and the macro environment, to Canada Health Infoway's Benefits Evaluation Framework to influence clinician HIS adoption. Canada Health Infoway (CHI) adopted the IS success model used in healthcare technology evaluation (Lau, Price, & Keshavjee, 2011). Canada Infoway used this model to evaluate quality, access, and productivity in creating a pan-Canadian EMR evaluation framework (Spil, LeRouge, Trimmer, & Wiggins, 2009). To summarize, previous studies on adopting HIT in healthcare have primarily concentrated on various technical aspects and potential business prospects resulting from the adoption. Until now, there has been inadequate data on the factors that significantly impact the adoption of HIT by older adults and their healthcare providers, which is the focus of this thesis.

In addition, the impact of successful HIT adoption has some requirements for consideration. The prior studies only investigated the adoption factors; however, the effects of adoption are missing. Various studies recommended additional research and reflections on the impact of the adoption (e.g., Peeters, de Veer, van der Hoek, & Francke, 2012; Piscotty, Kalisch, & Gracey-Thomas, 2015).

1.8. Discussion

The increasing population of older adults in Canada is putting pressure on the healthcare system, and significant improvements are necessary to address older adults' healthcare needs. HIT can also improve patient care and provide more timely and integrated care to older adults. However, despite their potential benefits, the adoption of HIT in LTC and older adults' care remains limited. HIT significantly benefit healthcare providers and patients by making healthcare records more accurate, up-to-date, and complete. HIT save time and reduce

medical errors, improving service quality among healthcare providers, especially nurses. HIT also provide opportunities to support older adults living in the community, such as self-management and fall detection, helping them live independently and safely. Nurses are a crucial group of healthcare professionals who could significantly benefit from the adoption/use of HIT in LTC settings, reducing costs, increasing staff productivity, and improving process efficiency, resulting in excellent service quality. Despite its potential benefits, several challenges, such as user-friendliness, must be addressed to ensure its successful adoption in LTC settings.

This research takes a comprehensive approach to examine HIT adoption in the context of older adults' care in the community and LTC environment. It highlights the importance of a holistic approach to successfully adopting HIT technology, considering individual, organizational, and technological dimensions. This study includes providing adequate training and support to users, assessing the technology's compatibility with existing infrastructure and culture, and evaluating technical factors such as system reliability, data security, and user interface. This study also discusses the impact of HIT adoption on the benefits and quality of healthcare, emphasizing the need for more research in this area. The research provides valuable insights into variables influencing their acceptance of new technology and healthcare delivery techniques. It fills a gap in the literature by examining HIT adoption by nurses who interact with older adults and that adoption’s implications on LTC.

In this thesis, the first part involving the literature review (LR), systematic review (SR), and Delphi study is aimed at contributing to the existing theory and literature surrounding the factor impact of HIT adoption and its impact. By synthesizing and analyzing previous research,

this study seeks to identify gaps and prioritize critical areas for further investigation. The findings of the Delphi study involving LTC nurses will guide future research on implementing HIT and treating older adults, promoting independent living, higher safety, and better quality of life.

The second part of the thesis, which involves a secondary data analysis of the survey, aims to test the theoretical frameworks developed in the first part and provide empirical evidence to support or refute these theories. The national study of Canadian nurses accessing virtual care in 2020 and using electronic medical record systems offers valuable insights into the benefits and barriers of health information technology implementation in healthcare. It highlights the positive impact of health information technology on healthcare quality, particularly in processes, documentation, and patient care continuity. However, it also identifies challenges LTC nurses face in adopting health information technology, such as inadequate consultation and training, concerns over the cost of implementation, and dissatisfaction with current health information technology systems. The study's findings underscore the importance of addressing individual, organizational, and technological factors in implementing health information technology in healthcare. By understanding and addressing these factors, healthcare organizations can optimize health information technology to improve healthcare quality, patient care, and healthcare delivery. This approach will contribute to a more comprehensive understanding of the impact of HIT adoption on the healthcare workforce and inform the development of effective policies and strategies for its implementation.

2. Technology Adoption Factors and Their Impact on Long-Term Care Nurses

This chapter presents a comprehensive review of the literature on the adoption of technology by nurses in LTC and a current overview of research in this field. By synthesizing the existing literature, this chapter aims to offer valuable insights into the factors that influence the adoption of HIT by nurses in LTC settings, including barriers and facilitators. Identifying these factors will help inform potential solutions to overcome the obstacles and promote the successful adoption of HIT among nurses in LTC.

2.1. Introduction to Literature Review: Advancing Research Knowledge

This chapter reviews the literature on the evidence related to the adoption of technology by nurses in LTC. Moreover, it includes and integrates a summary of the studies' results regarding the current research in this area. The review of prior studies helps to provide a theoretical foundation to understand variables influencing nurses' adoption and use of HIT in LTC and its impact. Technology adoption at the individual level (i.e., nurses) is a critical step in healthcare transformation (Maillet, Mathieu, & Sicotte, 2015; Salmond & Echevarria, 2017). Nurses are vital in the adoption process to increase organizational resilience and promote change to brace for growth (Thomas, Seifert, & Joyner, 2016; Salmond & Echevarria, 2017). HIT adoption among nurses includes a variety of steps, such as continuous training courses for personnel and a focus on collaboration, open communication, quality control, strategic planning, advanced nursing experience, and participatory management, including joint decision-making and policy development (Mrayyan, 2020). Amarneh (2017) mentioned that nurses’ readiness to adopt HIT is essential in organizational change when introducing, managing, and maintaining the changes. Fickenscher and Bakerman (2011) mentioned that

nurses' HIT adoption is highly personal and related to their feelings with a sense of gain or loss, leading to organizational-level changes. Similarly, Odeh et al. undertook qualitative research consisting of semi-structured interviews to discuss nurses' awareness of telehealth, their experience with technological difficulties, and the effect of telehealth adoption (Odeh, Kayyali, Nabhani-Gebara, & Philip, 2014). Despite nurses' positive experience with HIT, challenges and barriers to using telehealth identified by the nurses must be addressed to ensure HIT adoption, continuity of use, and success (Odeh et al., 2014).

From the lens of technology adoption, it is imperative to understand how HIT effectively supports the care provided to older adults in LTC. Long-term care nurses are vital in healthcare services, and their adoption and acceptance of healthcare technologies in their surroundings support older adults' critical healthcare requirements. However, limited information is available from LTC nurses and long-term care environments on HIT's role in supporting the care they provide older adults (e.g., Cork, 2005; Turner, 2015; Mrayyan, 2020). Prior studies suggested several facilitators, such as training and team members' engagement, and barriers, such as lack of funding and facilitating conditions (Odeh et al., 2014). In addition, the impact of the adoption and use, such as net benefits, quality improvement, burnout, and barriers, are lacking in these studies.

2.1.1. Technology Adoption: Understanding the Factors that Influence the Adoption and Use of Health Information Technology

Technology adoption is the acceptance and use of new products or innovations, which may be affected by various factors related to, among others, the work environment, context, type of technology, and individual preferences (Straub, 2009). These factors may act as

facilitators or barriers to the adoption of HIT. Examples include ease of use of the technology, perceived usefulness of the technology, and prior experience with the technology. A variety of adoption models included these factors and examined the relationship between these factors, use, and adoption.

2.1.2. Models of Technology Adoption among Long-Term Care Nurses

The literature on information systems has developed (and tested) models and frameworks that explore factors influencing technology adoption (e.g., Davis, Bagozzi, & Warshaw, 1989; Venkatesh et al., 2003; Venkatesh et al., 2012). Healthcare researchers have applied these adoption models from business to the healthcare domain (e.g., Cimperman et al., 2016; Hamblin, 2017). TAM (technology adoption model) and UTAUT (unified theory of acceptance and use of technology) are the main adoption models in studies. TAM forecasts the adoption of new technologies based on two primary criteria: perceived usefulness and perceived ease of use (Davis et al., 1989). Venkatesh et al. (2003) used eight models, including the theory of reasoned action, the technology acceptance model, the motivation, the goal-setting theory, the social cognitive theory, the theory of planned behavior, the model of PC utilization, and the innovation diffusion theory to improve the technology adoption model (Venkatesh et al., 2003). Four main factors predict individual behaviour in the UTAUT model: 1) performance expectancy, similar to perceived usefulness (i.e., individuals' belief of the extent to which the system helps attain performance benefits); 2) effort expectancy, similar to perceived ease of use, 3) social influence (i.e., whether other important people think they should use the system), and 4) facilitating conditions (i.e., hedonic incentive and price value) (Venkatesh et al., 2012). Despite these frameworks and models being applied and used in the healthcare domain,

limited information is available in the context of LTC.

2.1.3. The Impact and Benefits of Technology in Healthcare

The information success model has mainly been used in prior studies to guide and synthesize the effects and benefits of technology implementation in various settings (Ali, Tretiakov, & Whiddett, 2014; Ziadlou, 2021). The IS (information system) success model combines different models to propose a complete conceptual model of the information system. The IS success model shows how various adoption factors, including information, system, and service quality, impact usage intentions, system use, and user satisfaction. Moreover, it includes the impact of usage intention, system use, and user satisfaction on net system benefits (DeLone & McLean, 2003).

2.1.3.1. Information quality

Information quality refers to the quality of the information the system can keep, convey, or generate. Information quality influences users' pleasure with the system design and their desire to use the system, which affects the system's ability to provide advantages to both the user and the business (DeLone & McLean, 2003).

2.1.3.2. System quality

System quality refers to the overall quality of a system, which, like information quality, is one of the most frequent characteristics of information systems. System quality indirectly influences the system's ability to offer benefits through mediational interactions via intents and user satisfaction constructs (DeLone & McLean, 2003).

2.1.3.3. Service quality

In addition to information quality and system quality, information systems are often assessed based on service quality. Service quality influences use intentions and user satisfaction with the system, influencing the system's net benefits (DeLone & McLean, 2003).

2.1.3.4. System use and use intentions

In the information systems literature, intentions to utilize an information system and actual system utilization are well-established concepts. In the IS success model, information system and service quality impact system utilization and user intents. It is hypothesized that system use influences user satisfaction with an information system, influencing users' intentions. In combination with user satisfaction, system utilization directly affects the system's ability to offer net benefits (DeLone & McLean, 2003).

2.1.3.5. User satisfaction

In the same way that actual system use determines the net advantages of an information system, user satisfaction directly impacts those benefits. The degree to which a user is satisfied or contented with the information system is called satisfaction. Satisfaction is believed to be directly affected by the user's interaction with the system (DeLone & McLean, 2003).

2.1.3.6. Net system benefits

The net benefit an information system can give its users or business is an essential component of the system's total value to either of these groups. According to the information systems success model, the amount of system use and the level of user contentment with a

system impact the net benefits of that system. It is hypothesized that a user's intent to use a system may be affected by the user's level of satisfaction (DeLone & McLean, 2003).

2.1.4. Exploring a Multidimensional Technology Adoption Model in the Long-Term Care Setting

Some studies took a different approach and did not use well-known or traditional adoption models such as the UTAUT, TAM, or IS success models. They applied multidimensional models that included identification and classification of a variety of adoption factors such as 1) familiarity and use routines, 2) positive experiences, 3) negative experiences, 4) privacy, 5) training and 6) suggestions for improvement (Asan et al., 2017). Luciano, Mahmood and Rad introduced a model with eight hypotheses to establish a research framework. They identified a series of adoption factors, including infrastructure, technology, economy, organization, security, privacy, policy, and cultural issues, as the primary adoption factors (Luciano, Mahmood, & Rad, 2020).

Rouleau et al. mentioned that low intention to adopt HIT among nurses is attributed to the interaction between humans and technology, which are affected by various factors associated with the individual, technology, and organization/environment characteristics (Rouleau, Gagnon, Côté, Payne-Gagnon, Hudson, & Dubois, 2017). In the same way, Ibrahim, Donelle, Regan, & Sidani (2019) studied factors that influence registered nurses' intention to use HIT in their clinical practice. They grouped the adoption factors into 1) characteristics of nurses using technology, 2) characteristics of health information technology, and 3) characteristics of the organizational environment (Ibrahim et al., 2019). An interesting systematic review of patients' acceptance of consumer health information technology by Or

and Karsh (2009) categorized adoption factors into individual (e.g., socio-demographic characteristics, health- and treatment-related variables, and prior experience or exposure to computer/health technology), human-technology interaction, organizational, environmental, social, and task factors. Within the same approach, Courtney-Pratt et al. highlighted three domains that affected nurses' acceptance, utilization, and integration of information and communication technology into practice. They included environmental issues; factors in building capacity, confidence, and trust in the technology; and developing competence (Courtney-Pratt et al., 2012). Similarly, Huryk mentioned demographic factors, system design and integration into the workflow, and the environment as the primary adoption factors influencing nurses' attitudes toward healthcare information technology (Huryk, 2010).

This review used and applied the same approach and grouped HIT adoption factors into different dimensions and layers: *Individual* includes demographic, human-technology interaction, social influence, and burnout; *Organizational* includes process, task, and benefits; *Technological* includes functionality and design, and *Barriers* such as limited access to HIT (Popay et al., 2006; Or & Karsh, 2009; Courtney-Pratt et al., 2012; Snilstveit, Oliver, & Vojtkova, 2012; Campbell, 2020). These domains are defined and described below.

2.1.4.1. Individual

The Individual dimension refers to items at the individual and personal levels, such as concerns related to demographics, character traits, and personality attributes. The *demographics* include factors related to individual criteria such as age, gender, and level of education. *Human-technology interaction* includes factors such as learning, training, and self-confidence that describe an individual's views and expectations about technology. The *social*

level relates to a person's impact on the group of individuals they belong to and their influence on technology use, such as leadership support. In the *burnout* domain, nursing staff at long-term care facilities are exposed to much professional stress and report high burnout levels.

2.1.4.2. Organizational

The Organizational category refers to organizational-level considerations, such as policy and regulation. The Organizational dimension includes *process* and *task* as its layers. The *process* level relates to aspects of relationships among different processes in the organization and enabling circumstances created by organizations, as well as satisfaction with the quality of care within implementation methods, their organizational structures, and their end-user perceptions. The *task* level refers to the degree to which technology influences a task and individuals' perceptions of this effect. *Benefits* refer to how individuals feel that using a specific system would improve their work or company performance.

2.1.4.3. Technological

The Technological layer refers to technology's functionality and design. The *design* level refers to technology design that considers users' requirements and particularities. *Functionality* refers to different technical aspects, such as compatibility and accessibility.

2.1.4.4. Barriers

Barriers refer to factors which act as drawbacks against HIT adoption. Implementing health information technology in long-term care settings can be challenging (Chaudhry et al., 2006). LTC nurses often work independently and may not access technology or support easily. In addition, they may have limited experience with HIT and may be concerned about how it will

affect their workflow and communication with patients and physicians. Other barriers to the adoption of HIT in LTC settings include concerns about data security, the cost of implementing and maintaining the technology, and the need for ongoing training and support for nurses. In addition, there are several other factors that can impede the adoption of HIT in LTC settings.

- Lack of experience and technical skills: LTC nurses may have limited experience with HIT and may feel uncomfortable using new technology. This can make it difficult for them to adopt and use HIT effectively.
- Workflow disruptions: HIT can change the way nurses work and may disrupt established workflow patterns. This can make it difficult for nurses to integrate HIT into their daily routine and can lead to resistance to its adoption.
- Limited access to technology: LTC nurses may not have easy access to technology in their work environment, which can make it difficult to use HIT effectively.
- Time constraints: LTC nurses are often busy and may not have the time to learn and use new technology.
- Privacy and security concerns: LTC nurses may be concerned about the security of patient data and may be hesitant to adopt HIT because of these concerns.
- Resistance to change: Some LTC nurses may be resistant to change and may prefer to continue using traditional methods rather than adopting HIT.
- Lack of support: LTC nurses may not have adequate support in implementing and using HIT, making it difficult to overcome these barriers.

2.2. Reviewing the Evidence: HIT Adoption by Nurses in LTC and Its Impact on older adults' Care

Three major databases were consulted: PubMed, Scopus, and Web of Science. These bibliographic databases were chosen since they include healthcare and information technology domains. These databases were used in reviewing similar studies such as Georgiou, Thomas, Dahm, & Westbrook (2019), Hemmat, Ayatollahi, Maleki, & Sagha2f (2017) and Huryk (2010). The inclusion criteria consisted of studies published in English that reported the impacts of specific factors on HIT adoption among nurses in long-term care and its impact. Four groups of keywords were used in the research: Group (1): acceptance (e.g., accept* OR usability), Group (2): nurses as healthcare providers (e.g., healthcare professional*), Group (3): health information technology (e.g., ICT OR telemonitoring), and Group (4): long-term care centers (e.g., retirement home, nursing home). The unit of research in this review is at the individual level, nurses, who provide healthcare for older adults in LTC. The population comprises individuals enrolled in primary studies and to whom each study's intervention was administered (Paré et al., 2015). All quantitative and qualitative research method studies were included in this review, limited to only English language papers, to make this study more feasible. This review did not restrict specific technologies to have as much information as possible. All healthcare-related technologies nurses use in providing care in LTC were included in this review.

2.2.1. Health information technology in studies

The selected studies were conducted among a variety of Health information technology

such as assistive technology, decision-support apps, e-health, electronic medical records, health applications, virtual care, healthcare virtual communities of practice, health information management, home healthcare robots, information and communication technology, mobile and wearable technology, telecare, telehealth, telehomecare, and telemonitoring. Among them, information and communication technologies, health information management and electronic medical records are the most used technologies. The adoption of all these technologies was studied and verified with different adoption models.

2.2.2. Adoption models in the selected literature

The studies regarding nurses' HIT adoption primarily used UTAUT or TAM as their adoption model. Asua, Orruño, Reviriego and Gagnon (2012) used the TAM model with additional factors such as compatibility, adequate training, and technical support. Ibrahim et al. (2019) used the UTAUT adoption model to predict registered nurses' behavioural intention to use an electronic documentation system (EDS) in-home care. They mentioned that performance expectancy, attitude, social influence, and facilitating conditions had significant, positive, and direct effects on nurses' behavioural intentions. A study by Bennani and Oumlil among nurses in Morocco applied a modified UTAUT model (Bennani & Oumlil, 2014). They added trust as an additional factor to identify factors supporting the acceptance of HIT by nurses (Bennani & Oumlil, 2014).

On the other hand, effort expectancy and individual characteristics (e.g., age, education, and technology experience) were not found to have a direct or moderating influence on nurses' intention to use EDS in-home care.

Some studies did not mention any technology adoption model. Alaiad and Zhou used

items from the UTAUT adoption model, such as social influence and performance expectancy, with additional factors, such as trust, privacy, and ethical concerns (Alaiad & Zhou, 2014). Other studies mainly used factors from well-known adoption models such as the UTAUT and TAM models (e.g., Gartrell et al., 2015; Göransson, Wengström, Ziegert, Langius-Eklöf, Eriksson, Kihlgren, & Blomberg, 2017).

Some studies did not use any adoption model and focused on adoption factors (Koru, Alhuwail, Topaz, Norcio, & Mills, 2016). They investigated the challenges and opportunities in-home care to facilitate information technology adoption. They did not use any adoption model but recommended adoption factors such as focusing on quality improvement, maintaining a holistic organization-wide perspective, addressing education and training needs, and experimenting with telehealth if resources allow (Koru et al., 2016). Moreover, they mentioned that for successful IT adoption, the focus should be on accounting for organization size, reducing lengthy procedures, and excessive documentation (Koru et al., 2016).

Likewise, Wang et al. 2016 studied mobile and wearable technology needs for aging in place among older adults and their caregivers and providers. They mentioned that mobile and wearable technology tools could facilitate the needs of caregivers and providers to manage the healthcare of aging-in-place older adults and improve communications among them (Wang et al., 2016). In the same approach, Yada and Head (2019) applied a research model to investigate attitudes and intentions to use virtual healthcare. Their approach proposes that individuals' motivational and cognitive traits impact the path via which they absorb information and build attitudes, ultimately influencing their desire to utilize the system (Yada & Head, 2019). Yada and Head mentioned that their research found that user ability and motivation play a

significant and positive role in adopting healthcare (Yada & Head, 2019). They also said that understanding different factors that impact the attitudes toward HIT might provide light on optimally designing and structuring such systems to promote their successful use among healthcare professionals (Yada & Head, 2019). The identified adoption factors are varied between studies, and analysis of adoption models and technology does not show any relationship between adoption model and technology. The identified factors should be studied and synthesized in the context of LTC nurses and their specific environments.

2.2.3. Understanding Factors Affecting Technology Adoption: A Multidimensional Model in the Long-Term Care Setting

The identified factors from the literature review on long-term care nurses were categorized into Individual, Organizational, Technological, and Barriers dimensions as per scholarly suggestions (OR & Karsh, 2009; Bennani & Oumlil, 2014; Sharifian, Askarian, Nematolahi, & Farhadi, 2014; Rouleau et al., 2017; Strudwick et al., 2018; Ibrahim et al., 2019)

2.2.3.1. Individual-level Dimension

Almost all studies have reported adoption factors at the *Individual* dimension within their identified layers (demographic, human-technology interaction, social influence, and burnout).

2.2.3.1.1. Demographic

Demographic items such as gender, age, education, and stakeholder category have a direct or indirect impact on HIT adoption (e.g., Huryk, 2010; Asua et al., 2012; Alaiad & Zhou, 2014; Gartrell et al., 2015; Göransson et al., 2017; Ibrahim et al., 2019; Kang et al., 2019; Seto et

al., 2019).

Moreover, various levels of professional knowledge and experience in using technology across different users, such as age and countries of origin, have an impact on the adoption factors among LTC nurses and technology adoption and use (e.g., Huryk, 2010; Courtney-Pratt et al., 2012; Gartrell et al., 2015; Koru et al., 2016; Yada & Head, 2019).

2.2.3.1.2. Human-Technology Interaction

In the *human-technology interaction* layer, self-confidence is the main identified adoption factor. Göransson et al. (2017) mentioned that self-confidence is an adoption factor and that healthcare technology use increased due to self-confidence. Moreover, in the human-technology interaction layer, ease of use (i.e., system complexity) (e.g., Kang et al., 2019; Seto et al., 2019) and usefulness (e.g., Huryk, 2010; Asua et al., 2012; Barakat et al., 2013; Kamei, 2013; O'Mahony, Wright, Yogeswaran, & Govere, 2014; Allen, Golden, & Shockley, 2015; Dowding et al., 2015; Radhakrishnan, Edmonson, Afghah, Rodriguez-Osorio, Pinto, & Burleigh, 2016; Koru et al., 2016; Wang et al., 2016; Vasalampi, 2017; Thoma-Lürken, Bleijlevens, Lexis, de Witte, & Hamers, 2018; Alaiad & Zhou, 2019; Johannessen, Storm, & Holm, 2019; Seto et al., 2019; Kang et al., 2019; Moore, Tolley, Bates, & Slight, 2020) are main adoption factors.

Huryk (2010) mentioned that nurses must recognize that incorporating EMR into their daily practice benefits patients' healthcare outcomes and that HIT should not harm the communications between nurses or nurse-patient interactions (Huryk, 2010). Two studies in Canada (Ibrahim et al., 2019; Seto et al., 2019) and a study in the US (Kang et al., 2019) emphasized the ease-of-use factor of HIT adoption among nurses. Technology that is easy to use takes less effort from nurses, and it has a higher chance of being adopted.

In Venkatesh et al.'s technology adoption model, usefulness is one of the main adoption factors (Venkatesh et al., 2012). Several studies confirmed that usefulness is one of the key factors affecting the adoption of HIT. Overall, 17 (63%) studies included usefulness as an adoption factor (e.g., Huryk, 2010; Asua et al., 2012; Barakat et al., 2013; Kamei, 2013; Mahony et al., 2014; Alaiad & Lina Zhou, 2014; Allen et al., 2015; Dowding et al., 2015; Koru et al., 2016; Radhakrishnan et al., 2016; Wang et al., 2016; Vasalampi, 2017; Thoma-Lürken et al., 2018; Johannessen et al., 2019; Kang et al., 2019; Seto et al., 2019; Moore et al., 2020). Thoma-Lürken et al. mentioned that besides further technical development, implementing a HIT application into practice requires evidence supporting its efficacy, feasibility, and effectiveness (Thoma-Lürken et al., 2018).

Privacy and security are concerns among LTC nurses regarding HIT adoption. As one of the leading healthcare providers, nurses should feel secure in communication, and their privacy concerns must be addressed (e.g., Gartrell et al., 2015; Göransson et al., 2017; Alaiad & Zhou, 2019, Kang et al., 2019). Alaiad and Zhou (2019) mentioned that the intention to use home healthcare robots is a function of social influence, performance expectancy, trust, privacy concerns, ethical concerns, and facilitating conditions (Alaiad & Zhou, 2019). Older people use an application to participate in their healthcare requirements, and app-enabled learning is part of communication. Education and training give older people a sense of security, increased self-confidence, and improved nurses' attitudes toward HIT adoption (Kang et al., 2019).

Learning and training are a big part of technology adoption among nurses. Overall, ten studies (37%) emphasized the impact of learning and training in HIT adoption among nurses (e.g., Asua et al., 2012; Barakat et al., 2013; Koru et al., 2016; Asan et al., 2017; Leite et al.,

2017; Göransson et al., 2017; O'Sullivan, Gellert, Hesse, Jordan, Möller, Voigt-Antons, & Nordheim, 2018; Johannessen et al., 2019; Seto et al., 2019; Kang et al., 2019).

Barakat et al. (2013) mentioned that providing healthcare personnel with appropriate training in e-Health care can enhance service delivery and maximize cost savings associated with e-Health care. Additionally, incorporating e-Health care capabilities into healthcare professionals' training and education ensures that the advantages of new technologies situated them within the more comprehensive care system (Barakat et al., 2013). Similarly, Huryk (2010) said improved computer experience is the primary demographic indicator for positive attitudes toward HIT adoption among nurses (Huryk, 2010). Likewise, Yada and Head (2019) mentioned a significant correlation between formed attitudes and intention to use HIT systems with higher expertise and user ability and motivation playing a substantial and positive role in the attitude toward and adoption of healthcare (Yada & Head, 2019).

Safety, knowledge, and experience with technology are important factors regarding HIT adoption, where telecare protects older adults from harm and insecurity (Johannessen et al., 2019). The participants see telecare as keeping older adults secure from danger and alleviating their uneasiness (Johannessen et al., 2019). Moreover, telecare improves security; if technology is dependable and tailored to the nurses' skills and experience, they will use it.

2.2.3.1.3. Social Influence

At the individual level, *social influence* includes a variety of adoption factors, including culture, developing competence, ethical concerns, motivation, project champions, environmental influence, and leadership support. Luciano et al. (2020) identified culture as an adoption factor. They conducted a quantitative survey in the US and Brazil and mentioned that

culture plays an essential role in telemedicine adoption. Their study results show that telemedicine adoption is influenced by policies and culture in both countries (Luciano et al., 2020). Ethical concerns (Alaiad & Zhou, 2019), developing competencies (Courtney-Pratt et al., 2012), and motivations (Yada & Head, 2019) are factors that were mentioned in one study. Likewise, two and three studies identified project champions and social influence as adoption factors. Allen et al. (2015) and Gartrell et al. (2015), within their qualitative and quantitative approaches among nurses, mentioned that project champions significantly impact HIT adoption. Moreover, having support from leadership and clinical champions is an essential step in transformational change regarding adoption (Allen et al., 2015). Similarly, having champions with expertise and enthusiasm for new technology can promote the adoption of electronic PHRs (ePHRs) among healthcare providers and their patients (Gartrell et al., 2015) with a significant, positive, and direct impact on nurses' behavioural intention (Ibrahim et al., 2019) and leadership support (Allen et al., 2015).

2.2.3.1.4. Burnout

The nursing staff at LTC facilities are exposed to significant professional stress and report high burnout levels. However, little is known about the relationship between HIT adoption and use and burnout. Woodhead, Northrop, and Edelstein examined the relationships between job demands (occupational and personal stress), job resources (sources and functions of social support), and burnout in a sample of nursing staff in a long-term care facility (Woodhead, Northrop, & Edelstein, 2016). Similarly, Kennedy studied the stress and burnout of nursing staff working with geriatric clients in LTC (Kennedy, 2005). They mentioned that stress is significantly correlated with burnout and that nurses had more stress and burnout than other

professional healthcare providers (Kennedy, 2005). Less emotional weariness and tremendous personal success were connected with job resources (support from supervisors and friends or family members, affirmation of value, and chance for nurturing). LTC employees should benefit from interventions to minimize burnout that emphasize stress management and social support outside of work (Woodhead et al., 2016). Burnout is a big concern among nurses, especially in long-term care. This concern needs further study and investigation of the results of the COVID-19 crisis, which put additional pressure on the LTC nurses. Long-term care nurses are more susceptible to burnout (emotional exhaustion) than nurses in acute care facilities (Hare & Pratt, 1988); however, they have gotten less attention from researchers. During the COVID-19 pandemic, caregivers experienced burnout due to increasing workloads, staffing shortages, and the emotional toll of caring for people suffering substantial isolation, sickness, and death. Respondents highlighted organizational communication and cooperation as significant variables influencing their capacity to operate. They also recounted the depressing effect of inadequate media coverage of nursing homes, in contrast to the heroism rewarded to hospital employees (Wetle, Reddy, & Baier, 2021).

2.2.3.2. Organizational Dimension

The *Organizational* adoption dimension includes process, task, and benefits layers with various adoption factors, including cost and price value, practice change, policy and regulation, users' engagement, and quality improvement.

2.2.3.2.1. Process Layer

In the process adoption layer, despite various rules and regulations regarding healthcare

service funding, nurses within different environments have concerns regarding cost and price value. Three studies (e.g., Barakat et al., 2013; Kamei, 2013; Koru et al., 2016) mentioned that cost reduction would increase nurses' attitudes toward HIT use. Even though nurses may not be directly involved in the cost and price value of HIT procurement and maintenance in different healthcare settings, they are impacted by high costs. Overall, the technology cost should bring users value (e.g., Barakat et al., 2013; Kamei, 2013; Koru et al., 2016).

Communication improvements among nurses and between nurses and patients play a significant role in nurses' HIT adoption. Interestingly, three qualitative studies among nurses in a hospital setting in the US and Sweden emphasized the rule of communication improvement regarding HIT adoption. In the same approach, HIT adoption also improved the communication among the nurses and interactive communication between nurses and patients (e.g., Dowding et al., 2015; Koru et al., 2016; Göransson et al., 2017).

Moreover, organizational perspective (Koru et al., 2016) and policy and regulations (e.g., Koru et al., 2016; Luciano et al., 2020) were mentioned and included in HIT adoption factors at the organizational level. Telehealth enables healthcare professionals to extend their service offerings and collaborate with customers remotely (Allen et al., 2015).

A process-level perspective regards existing policies and procedures, which are part of the necessary change and adoption. Luciano et al. (2020) mentioned that policy and regulations are driving factors in technology adoption among nurses. Their study in the US and Brazil showed that policy impacted the adoption in both countries (Luciano et al., 2020). In the same way, quality improvement at the organizational level is a concern for nurses as well as patients. HIT improves the quality of care in the organization through various approaches, such as

spending time with patients and increasing the quality of care provided by nurses (Dowding et al., 2015; Koru et al., 2016; Yada & Head, 2019). The facilitation conditions, such as training and technical support, were mentioned in three studies (e.g., Asua et al., 2012; Alaiad & Lina Zhou, 2014; Ibrahim et al., 2019). These studies found a direct and positive impact from facilitating conditions toward technology adoption. The more facilitation conditions the organization provides, the higher the chance for technology to be adopted.

2.2.3.2.2. Task Layer

The task layer includes practice change and users' engagement at the Organizational dimension. Asua et al. (2012) mentioned that HIT adoption requires a practice change within the organization. The practice change negatively affects HIT adoption among nurses. To facilitate HIT adoption, the organization should facilitate nurses' practice change (Asua et al., 2012). The users' engagement is a driving factor regarding nurses' HIT adoption (e.g., Göransson et al., 2017; Ibrahim et al., 2019; Yada & Head, 2019), and organizations should obtain nurses' engagement for a successful HIT adoption (Yada & Head, 2019). Although it would be beneficial to have home healthcare nurses (HCNs) with access to electronic protected health information (PHI) and train older adults to use patient portals at home, most HCNs believed it would be difficult for them to help older adult patients with using computers or online portals because of time constraints, lack of training, and concerns about patient privacy (Kang et al., 2019).

2.2.3.2.3. Benefit Layer

A "benefit" is defined as a "quantifiable and measurable improvement resulting from

the completion of deliverables that is perceived as positive by a stakeholder" (APM Body of Knowledge, sixth edition). This concept has been used in the healthcare domain for years, but it has had limited incorporation in healthcare research. Sapountzis, Harris, & Kagioglou (2008) studied the benefits identification process for healthcare programs and/or projects and the merits of a common approach for providing the required time, quality, and cost outputs. More recently, Canada Health Infoway established a Benefits Evaluation Framework for health information technology and recommended specific indicators for evaluating the benefits associated with new technologies (Canada Health Infoway, 2012), based on DeLone and McLean's Information Systems Success Model (Delone & McLean, 2003). This framework has dimensions related to service quality (system, information, and services), system use (use and user satisfaction), and net benefits (care quality, access, and efficiency).

While HIT adoption can potentially improve healthcare services for older adults, it is crucial to understand the benefits and impacts of its adoption by LTC nurses. Currently, there is limited research on the experiences of LTC nurses in using HIT in general and in the Canadian context, which limits our understanding of the factors that influence successful adoption. Therefore, a comprehensive analysis of existing evidence on the adoption of HIT by LTC nurses is necessary to identify the key factors determining the successful use of these technologies. This can help to inform future strategies to increase the adoption and effective use of HIT among LTC nurses, leading to improved healthcare outcomes for older adults. There is a shortage in the HIT-benefit healthcare domain, especially among LTC nurses. The studies in this domain are mostly related to other disciplines, such as acute care. For example, Shagerdi, Ayatollahi, & Hemmat (2022) surveyed the opportunities for using HIT for elderly care in

emergency departments. They identified 4 main themes, 9 subthemes, and 20 categories. The primary domain was the typical process of older adult care in emergency departments, the data necessary for elderly care in emergency departments, the elderly treatment team, and current information technology employed in emergency departments for the care of the elderly (Shagerdi et al., 2022). In addition, the results indicated no specific workflow for elderly care in emergency departments. The departments' high volume of work prevents clinicians from conducting cognitive and functional assessments (Shagerdi et al., 2022). In addition, geriatricians were not involved in the care process, and none of the current information systems were designed with elderly healthcare requirements in mind. Using HIT for geriatric care in the emergency room may assist in overcoming existing obstacles (Shagerdi et al., 2022). Identifying the potential benefits of using HIT for nurses in LTC will result in more efficient use of financial, physical, and human resources and improve staff performance. These systems must be built and used for many goals, including reducing workload, hospitalization and readmissions. These tools also improve data accessibility and cooperation among various specializations. However, further study is necessary to determine the efficacy of technology in this field.

2.2.3.3. Technological Dimension

The adoption in the Technological dimension includes two main layers: design and functionality. The implications for design consider the LTC technology design requirements, such as ease of technology cleaning, hearing and vision barriers, cognitively impaired residents, portability, and mobility to the bedside. Also important is system design as per nurses' requirements (e.g., Huryk, 2010; Barakat et al., 2013; Gartrell et al., 2015; Radhakrishnan et al.,

2016; Asan et al., 2017; Johannessen et al., 2019; Huter, Krick, Domhoff, Seibert, Wolf-Ostermann, & Rothgang, 2020).

2.2.3.3.1. Technology Design

Scholars suggested that system design should consider nurses' requirements within the particularities of the LTC environments, such as ease of technology cleaning, hearing and vision barriers, cognitively impaired residents, portability, and mobility to the bedside (e.g., Huryk, 2010; Barakat et al., 2013; Gartrell et al., 2015; Radhakrishnan et al., 2016; Asan et al., 2017; Johannessen et al., 2019; Huter et al., 2020). Gartrell et al. mentioned that user-friendly system designs increase nurse adoption (Gartrell et al., 2015). They also stated that designing user-friendly systems should consider nurses' security and privacy concerns, which can be achieved with input from nurses who have personal experience with ePHR; this results in nurses' further engagement and adoption (Gartrell et al., 2015). Radhakrishnan et al. (2016) mentioned tailoring healthcare services to patients (telehomecare services were deemed acceptable for a subset of persons or medical conditions, as opposed to everyone) influences HIT adoption.

2.2.3.3.2. Technology Functionality

In the technology functionality layer, technology reliability (e.g., Courtney-Pratt et al., 2012; Alaiad & Zhou, 2019; Johannessen et al., 2019), technology compatibility (e.g., Asua et al., 2012; Barakat et al., 2013; Seto et al., 2019), and technology accessibility (e.g., Dowding et al., 2015; Kang et al., 2019) are the main adoption factors within the technology dimension. The compatibility of new technologies within the LTC environment, their integration with existing records, their adaptability with various devices, and their ability to share information directly

and send orders to the pharmacy are essential. Asua et al. (2012) mentioned that perceived usefulness and compatibility with existing technologies are significant predictors of intention to use HIT among nurses (Asua et al. 2012). Technology accessibility is the availability in the facility for all groups (e.g., computers for point-and-click care and cell phones to communicate with staff) (e.g., Dowding et al., 2015; Kang et al., 2019). Nurses' accessibility to HIT in providing healthcare requirements to older adults increases the adoption and improves the quality of provided healthcare for nurses (Dowding et al., 2015; Kang et al., 2019). Reliability of the technology, such as concerns regarding system crashes, technology breaking down and issues within connections during power disruption and outages, are critical aspects that impact HIT adoption among nurses (Courtney-Pratt et al., 2012; Johannessen et al., 2019). Johannessen et al. mentioned that the nurses saw telecare keep the elderly secure from danger and alleviate their uneasiness (Johannessen et al., 2019). However, telecare poses risks to older adults due to technical limits and difficulty in controlling and comprehending the technology. Telecare improves safety but must be developed considering the user's abilities, skills, and resources. Using telecare protects older adults from harm and insecurity, and the use of telecare was seen as posing risks to older adults (Johannessen et al., 2019). Likewise, Courtney-Pratt et al. used trust to explain the reliability of the technology among nurses (Courtney-Pratt et al., 2012). Nurses rely on HIT as their preferred choice to deliver the required healthcare to older adults, and HIT should be reliable and trustable to be adopted by nurses (Courtney-Pratt et al., 2012).

2.2.3.4. Barriers

In addition to these identified adoption factors, some studies emphasized barriers to HIT adoption and use among LTC nurses. Seto et al. identified barriers to implementing HIT

systems in home-care nursing and numerous obstacles to adopting the telemonitoring system (Seto et al., 2019). These obstacles included difficulties in nurses' communication, such as reaching patients and doctors, retention concerns, and challenges in integrating the TM system into a complicated home care nursing workflow. However, certain potential advantages of TM via a home care nursing agency were identified, including increased patient education, nurses having a better grasp of the patient's health state, and fewer home visits (Seto et al., 2019). Likewise, Huryk mentioned that computer experience is the most critical predictor of HIT adoption. In contrast, poor system design, slowness, and outages are the most typical barriers to HIT adoption and use (Huryk, 2010) (Table 5).

Table 5: Technology adoption dimensions and factors

Dimensions	Layer	factors
Individual	Demographic	Age
		Gender
		Level of education
	Human-technology interaction	Self-confidence
		Ease of use (system Complexity)
		Usefulness
		Knowledge and experience with technology
		Privacy & security
		Learning and training
	Social influence	Culture
		Developing competence
		Ethical concerns
		Motivation
		Project champions
		Environmental influence
		Leadership support
	Burnout	Burnout
Organizational	Process	Cost and price value
		Policy and regulation
		Facilitating condition
		Quality improvement
		Organizational perspective
	Task	Practice change
		Time constraints
		Users' engagement
	Benefits	Improved communication
Technological	Functionality	Technology compatibility
		Technology accessibilities
		Technology reliability
	Design	System design as per user requirements
Barriers	Barriers	Barriers

2.3. Identifying Research Gaps and Future Directions: Advancing Knowledge in the Field

The adoption of HIT by LTC nurses, with respect to its potential benefits in improving healthcare services for older adults, remains limited. This highlights the need for further research on the factors influencing HIT adoption among LTC nurses and the impact of HIT on healthcare outcomes for older adults. The prior studies have mentioned a list of adoption factors that facilitate HIT adoption among LTC nurses; however, these studies are limited and were conducted among a small number of nurses with specific technology and in particular domains. In addition, most studies were conducted outside Canada without considering Canada's healthcare environment. The studies were mostly conducted in the US. So, whether

the identified factors apply to Canada's healthcare is unclear. In addition, the identified adoption factors vary among different studies and healthcare technologies.

Most studies were primarily conducted with nurses or combinations of nurses and older adult nurses within different settings. The studies specifically for LTC nurses are minimal, with fewer participants. Additionally, the technology used varies with a minimal number of participants, which does not allow any connections between the used technology and the applied adoption model. The selected studies used UTAUT and TAM (confirmatory analyses) to justify their identified factors. This may exclude factors influencing LTC nurses' intention to use HIT. In addition, TAM and UTAUT have also been criticized for being too simple (in the case of TAM) and for focusing only on the beliefs, perceptions, and use intentions of each adopter (e.g., Shachak, Kuziemsky, & Petersen, 2019). Moreover, these models have been used in thousands of studies, and they no longer add anything new to what we know.

In addition, prior research on HIT adoption in healthcare has focused mainly on different technical aspects and business opportunities due to the adoption. To date, there is limited information on factors that significantly affect the adoption of HIT by nurses in LTC and the models that have been tested and used in this context.

Several studies have investigated the characteristics that impact nurses' desire to utilize HIT in their approach; nevertheless, it is unclear which set of factors is more relevant. Since LTC nurses mainly deal with older adults with special needs and healthcare requirements (such as limited movement abilities or cognitive abilities) and LTC nurses' specific work conditions (e.g., extra time for training requirements and workload), several academics have proposed that there should be new and necessary factors affecting technology adoption, as well as a model

that is adapted to the capacities, expertise, and resources (e.g., Courtney-Pratt et al., 2012; Barakat et al., 2013; Ibrahim et al., 2019; Huter et al., 2020; Luciano et al., 2020).

On the other hand, some studies reported negative impacts of HIT adoption. For example, Morre et al. mentioned that HIT systems increased nurses' documentation time (Moore, Tolley, Bates, & Slight, 2020). The process change and increased workload are the other factors (i.e., barriers) that negatively impact HIT adoption among nurses. Moreover, there are significant challenges in implementing HIT in home-care nursing, resulting in low older adults and clinician recruitment and a high dropout rate. These include difficulty reaching older adults and doctors, retaining nurses, and integrating the HIT system into a complicated home care nursing workflow.

Moreover, knowledge transfer and training were challenges to HIT adoption (Courtney-Pratt et al., 2012; Ibrahim et al., 2019). Further studies are needed to understand what factors influence nurses' adoption of HIT in LTC homes and the impacts of technology use in this environment. In addition, the results of the studies regarding HIT adoption factors among nurses are inconsistent. For example, some studies mentioned ease of use as the primary adoption factor. However, some other studies did not report any impact of ease of use on the adoption. Likewise, despite other factors that seem to impact adoption, only one study by Luciano et al. mentioned the role of culture among nurses as an essential adoption factor (Luciano et al., 2020).

Scholars recommended further studies and research regarding nurses' HIT adoption and LTC nurses. Even in the studies among LTC nurses, the identified adoption factors vary from each other and are inconsistent. On the other hand, the impact of adoption and use are missing

in the studies, and the result of the adoption and use by LTC nurses is unclear. There is a need for additional studies to identify and collect information among LTC nurses without limiting ourselves to the pre-identified adoption factors or models (Please see appendix 1 for more details).

Despite the numerous benefits of HIT in improving healthcare services for older adults, the adoption rate among LTC nurses remains limited (Alexander et al., 2020). Despite various studies identifying adoption factors, there is no consensus on which set of factors is most relevant. Even among LTC nurses, the identified factors vary from each other and are inconsistent. Additionally, most studies were conducted outside Canada, making it unclear whether the identified factors apply to Canada's healthcare environment. The adoption factors also vary among different studies and healthcare technologies. Most studies were primarily conducted with nurses or combinations of nurses and patients within diverse settings, with few focusing solely on LTC nurses and the Canadian context. Moreover, the models used to examine the adoption factors (e.g., UTAUT and TAM) have been criticized for being too simplistic and not considering all factors influencing nurses' intentions to use HIT.

Additionally, prior research on HIT adoption in healthcare has focused mainly on technical aspects and business opportunities, with limited information on factors that significantly affect the adoption of HIT, taking into consideration the nurses' perspectives. Therefore, there is a need for additional research involving LTC nurses without limiting ourselves to the pre-identified adoption factors or models. It is essential to understand what factors influence nurses' adoption of HIT in LTC homes and the impacts of technology use in this environment. This knowledge can support the development of effective strategies for

promoting HIT adoption and improving healthcare services for older adults. In this thesis, the literature review thoroughly evaluates and integrates the available evidence regarding the adoption of HIT by LTC nurses. The study identifies performance expectancy, effort expectancy, and price/cost value as the factors most commonly investigated concerning HIT adoption. It highlights their considerable impact based on the evidence.

Note: This chapter was published in Health & social care in the community
Kavandi, H., & Jaana, M. (2020). Factors that affect health information technology adoption by seniors: A systematic review. *Health & social care in the community*, *28*(6), 1827-1842.

3. Factors that Affect Health Information Adoption by Older Adults

This chapter comprises a comprehensive appraisal and synthesis of existing literature investigating the determinants that impact the uptake of diverse HIT, such ICT, telemonitoring, telecare, e-health, assistive technology, m-health, and home telehealth by older adults. This systematic literature review will enable a deeper understanding of the factors that affect the successful implementation and adoption of HIT, providing valuable insights for healthcare professionals, policymakers, and researchers to improve healthcare delivery and enhance the quality of life for older adults. Furthermore, the review will examine various models of adoption proposed in previous HIT studies concerning older adults.

3.1. Study Aims and Rationale

3.1.1. Older Adults and Health information technology

Population ageing is a worldwide phenomenon resulting in demands at the social and healthcare levels (Breyer, Costa-Font, & Felder, 2010). For example, Canada's healthcare system faces challenges associated with population ageing and an increasing number of older adults, with 75-80% living with one or more chronic health conditions (Canadian Medical Association, 2016). Other countries (e.g., Japan, Italy etc.) have also observed considerable growth in their elderly populations, leading to increased demands on their healthcare systems (OECD, 2018).

In light of these changes, there is an increasing need to shift healthcare services to the community while ensuring adequate support. Prior studies discussed the older adults' preference for living independently in their own homes or communities as long as they get the

necessary support and services to address their health needs (e.g., Tran, Buckley, Bertera, & Gonzales, 2009; Satariano, Scharlach, & Lindeman, 2014; Claes, Devriendt, Tournoy, & Milisen, 2015). HIT present opportunities to address the healthcare needs of older adults in the community and support them through innovative technologies (Alsulami & Atkins, 2016; Jaana, Tamim, Sherrard & Paré, 2017; Vassli & Farshchian, 2017). These technologies consist of a variety of applications and tools (e.g., Information Communication Technology (ICT), telemedicine, telehealth, Electronic Health (E-Health)) that address the challenges that the elderly face when living with chronic conditions and different levels of frailty (Zhang et al., 2013; Choi, Hegel, Marti, Marinucci, Sirrianni, & Bruce, 2014; Hamblin, 2017; Keränen, Kangas, Immonen, Similä, Enwald, Korpelainen, & Jämsä, 2017).

Several studies on HIT and older adults have been published in the literature, which primarily focused on HIT's effectiveness in assisting older adults (Botsis & Hartvigsen, 2008; Loader, Hardey, & Keeble, 2008; Khosravi & Ghapanchi, 2016) or examined older adults' acceptance of ageing-in-place technologies (Fischer et al., 2014; Peek, Wouters, Van Hoof, Luijkx, Boeije, & Vrijhoef, 2014).

Mann et al. draw a sample from Rehabilitation Engineering Research Center on Aging Consumer Assessments Study among older adults with 73.5 years old as a mean age. They mentioned that HIT adoption/use with older adults is crucial, given that such devices can benefit many elderly individuals. Elders who perceive HIT negatively—may be less inclined to use or allow them to be placed. The participants appear to have a high level of acceptability for the idea of home health monitoring and the associated monitoring equipment. When questioned about the device's appearance, most respondents believed the HIT would be

appropriate in their houses, and most initial responses were positive. Characteristics of the equipment have been recognized as one of the identifying perceived intrusiveness aspects of home monitoring devices (Mann, Marchant, Tomita, Fraas, & Stanton, 2002).

Loader, Hardey, & Keeble (2008) conducted a review of Information Communication Technology facilitation care for older adults. They mentioned that policymakers are considering ICTs as a tool to alter the cost-effective delivery of health and social care in response to the increased demand for welfare services caused by the aging of populations in several nations (Loader et al., 2008). Botsis and Hartvigsen reviewed the current status and future perspectives in telecare for elderly adults suffering from chronic diseases (Botsis & Hartvigsen, 2008). They mentioned older adults were generally satisfied with home telecare but preferred a combination of home telecare and traditional healthcare delivery (Botsis & Hartvigsen, 2008). Users reported that telecare resulted in cost savings on several instances owing to time savings and the avoidance of travel. Although home telecare has significant benefits, organizational, ethical, legal, design, usability, and other issues must be addressed before widespread deployment can occur (Botsis & Hartvigsen, 2008). Results suggest that older adults will use technology if they grasp its benefits for improving their health and remaining independent, allowing them to age in place (Tran, Buckley, Bertera, & Gonzales, 2009). Tran et al. discussed attitudes, advantages, and constraints to health IT adoption for low-income, minority, and older adults in affordable housing. Likewise, Vedel, Akhlaghpour, Vaghefi, Bergman, & Lapointe (2013) mixed systematic review on HIT mentioned interoperability and ease of use of these technologies are two areas that need further development (Vedel et al., 2013).

There is a growing body of literature on using HIT for older adults, but less is known

about the adoption factors regarding technologies that support older adults' healthcare. Researchers and practitioners can better target their efforts toward meeting older adults' healthcare by categorizing the available HIT into the *Individual*, *Organizational* and *Technological* dimensions. HIT's goal to reconcile these adoption dimensions highlights the significance of recognizing HIT's benefits.

The marginalization of prior studies on older adults in HIT adoption provides the critical findings of related studies literature analysis documenting the deployment of health informatics applications to enhance health and social care for the elderly. There is less evidence that these aspects have been realized in practice, and the apparent contradiction between them is more likely to result in costly and poor health informatics results. Many studies lack a theoretical foundation. The lack of qualitative studies, especially in Canada, results from lacking a theoretical framework. Thus, I advocate conducting further study in this field. To my knowledge, no prior reviews have specifically examined the different adoption models in the literature concerning various types of technologies nor synthesized the evidence on the factors that significantly affect older adults' adoption of these technologies. This review addresses this gap and complements previous systematic reviews in this area by critically appraising and synthesizing the evidence on the factors that affect the adoption of different types of technologies by older adults in the community. Specifically, it addresses the following questions:

- What is the empirical evidence on the most significant factors that affect the adoption of various technologies older adults use?

- What research models and factors are considered in the literature concerning HIT adoption and older adults, and do these models and factors vary across various types of technologies studied?

3.1.2. Systematic Review Rationale

Systematic reviews (SR) have been getting more attention in recent years in both academia and practice. Moher, Liberati, Tetzlaff, & Altman (2009) developed guidelines presenting Preferred Reporting Items for Systematic Review Reviews and Meta-Analyses (PRISMA). They included a checklist within 27-item validation based on the process (what was done) and final results (what was found) (Moher et al., 2009). They used this approach to research the outcome level assessment for evaluating the reliability and validity of the data based on the used model and the risk of bias. Their explanatory guidelines include good reporting practice, research rationale, inclusion and supporting evidence. This systematic literature review helps researchers understand the existing knowledge based on the proposed empirical research, justifies research problems, and cumulates/frames valid research methodologies, approaches, objectives and analysis (Levy & Ellis, 2006). It is a valuable tool in either deductive or inductive methods for theory building and testing (Paré et al., 2015). Review articles and research have become essential tools for collecting and interpreting existing knowledge and information with the increasing use of evidence-based tools and techniques. In this SR, I critically appraise and synthesize existing evidence in the HIT adoption that has been scattered in the literature and provide research-based answers to specific questions on the magnitude and direction of the effect within various IT adoption factors.

3.2. Methodology

This SR critically appraises and synthesizes the factors that affect older adults' HIT adoption in the community. The SR will follow the systematic reviews' best practices and uses PICO (Population, Intervention, Comparison, and Outcomes), coding scheme and quality assessment, and PRISMA guidelines approach.

3.2.1. PICO Approach

The PICO approach was used to form research questions within the: a) population: older adults living in the community; b) Intervention: HIT (e.g., ICT, telemonitoring, E-health) usage; c) comparison: (no HIT usage), and d) outcome: reported adoption and intention to use HIT by older adults. The inclusion criteria include 1) empirical studies published in English, 2) studies that consider older adults in the community, and 3) studies that report on the adoption factors related to HIT. The opinion/non-empirical commentary, editorial, workshop summary, and expert opinion research will be eliminated from the SR.

3.2.2. PRISMA Guidelines

Following the PRISMA guidelines (Moher et al., 2009), five databases (Web of Science, Scopus, Medline, PubMed, and CINAHL) with the following combination of keywords will be included: group (1): adoption (e.g. usability, use), group (2): older adults (e.g. elderly, ageing), group (3): HIT (e.g. communication technology, ICT), and group (4): community-dwelling (e.g. home, retirement home). Due to the SR process, empirical evidence regarding older adults' HIT adoption was collected and synthesized. The SR provides essential information for this thesis research regarding the technology adoption factors among older adults.

3.2.3. Coding Scheme and Quality Assessment Criteria

A coding scheme was developed and used to extract information from the selected articles within the following information; (1) general information (e.g., journal name, research type), (2) methods and technology (e.g., data collection techniques, level of evidence, sample size, technology-oriented) and (3) result on adoption (e.g., adoption factors, significant effect). Thomsen and Greer's (2015) quality assessment method was adapted to evaluate the selected studies' level of evidence. Articles graded based on their level of evidence and rigour of the research from their research design and proposed analysis into five groups. The highest grade is for randomized controlled trial studies, and the lowest levels will be dedicated to non-analytical or case reports. Although no research will be removed based on the evidence level, the assigned grade will be reported in the result section.

Following the PRISMA guidelines (Moher et al., 2009), I applied the recommended step-wise approach in conducting this SR. Five major scientific databases (Web of Science, Scopus, Medline, Pubmed, and CINAHL) were searched between December 2017 and February 2018; an additional search update was conducted until December 2019. The following combination of keywords was used: *1)* adoption (e.g., usability, use); *2)* elderly (e.g., older adults, aging)*; 3)* health information technology (e.g., E-Health, ICT); and *4)* living in the community (e.g., home, retirement home; see Appendix 2 for details on used keywords and their combinations). I followed the PICO (Population, Intervention, Comparison, and Outcomes) model to frame the research questions as follows: a) the population consisted of older adults living in the community; b) the intervention was HIT (e.g., ICT, telemonitoring, E-Health); c) the comparison was the absence of HIT, and d) the outcome was reported HIT adoption and intention to use by

older adults.

The inclusion criteria consisted of 1) empirical studies published in English, 2) studies that considered older adults in the community, and 3) studies that reported results on adoption factors that affect HIT adoption by the elderly. Examples of adoption factors included, among others, performance expectancy, effort expectancy, social influence etc. Exclusion criteria included non-empirical articles (commentaries, editorials, workshop summaries, expert opinion articles) and articles published in other languages. Overall, 1573 articles were selected from all five databases (Figure 2). After removing duplicates and performing title/abstract screening, the total number of studies was reduced by 631 and 893 articles, respectively. The content review further excluded 20 articles. Following the snowballing method and the search update, 41 articles were included in this review (Figure 2). The relevant information from these articles was extracted using a coding scheme that covered the following: 1) general information (journal information, study type); 2) methods and technology (data collection techniques, level of evidence, sample size, technology orientation); and 3) results related to adoption (adoption factors, significant impacts).

To assess the quality of the studies, I adapted the method proposed by Thomsen and Greer to evaluate and rank the level of evidence in selected articles (Thomsen & Greer, 2015). The studies were rated on five levels (in line with the hierarchy of "evidence-based practice") based on the quality of evidence produced, considering the research design and rigour. The highest rank ("1-") was achieved by randomized controlled trials, and the lowest ("3") by non-analytical studies or case reports.

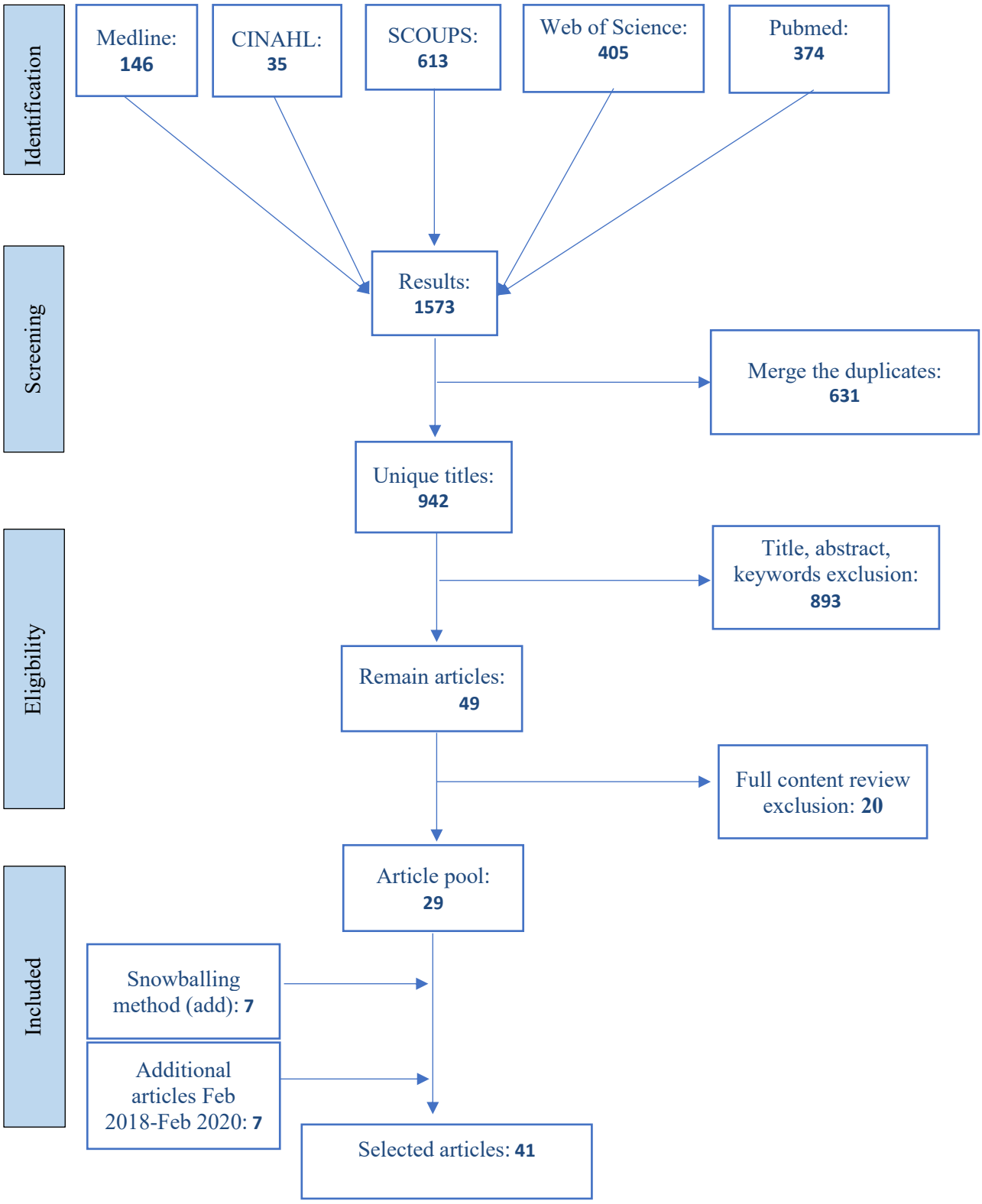

Figure 2: PRISMA guidelines to report review steps

3.3. Results

3.3.1. General Overview

A total of 41 articles met the inclusion criteria and were included in this review. They spanned over 18 years (Figure 3), with a trend towards an increase in the number of publications over time, as evidenced by 66% being published in the last six years. Most studies had a cross-sectional study design (66%) and a survey-based approach (51%). A total of 20 studies (49%) used original or modified existing theoretical adoption models.

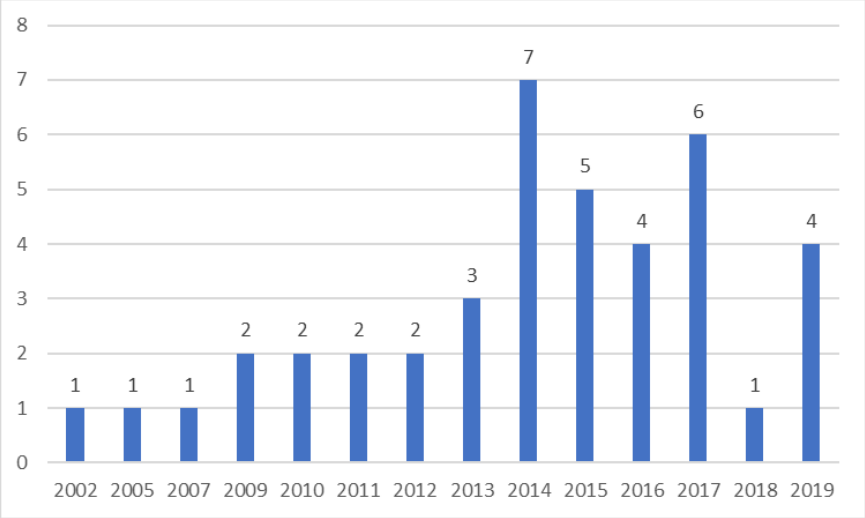

Figure 3: Trend of HIT adoption studies among older adults over time

Studies were published in various journals, with around 32% appearing in medical informatics journals. They focused on technologies such as ICT, telecare, telemonitoring, and E-health (Figure 4) and were conducted in Europe and the US (Figure 5).

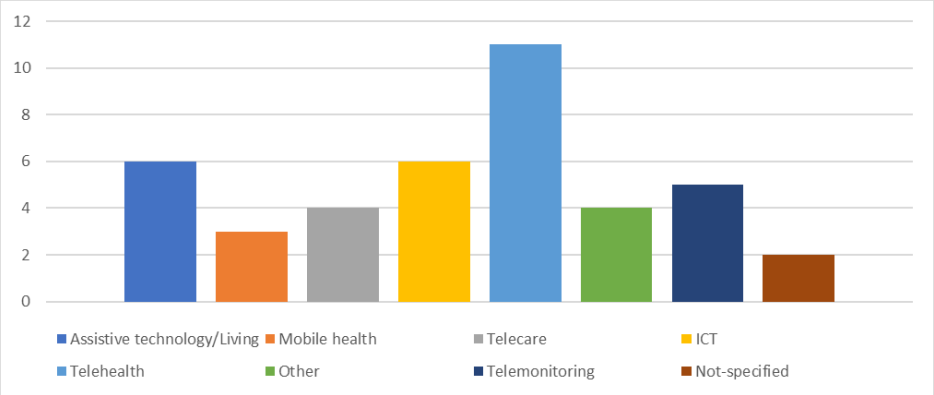

Figure 4: Types of HITs investigated concerning older adults' adoption in the community

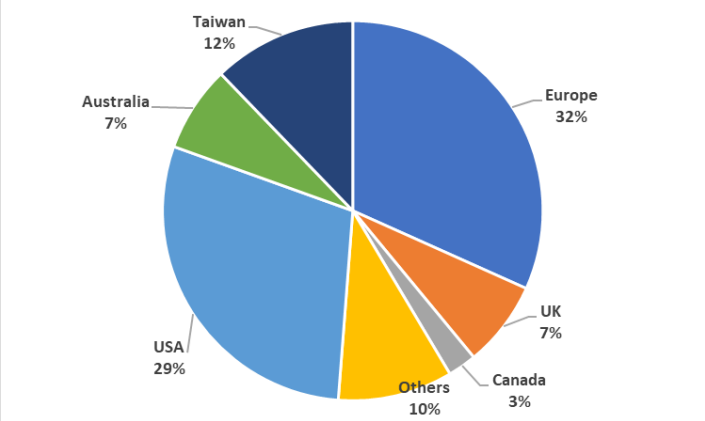

Figure 5: Countries of origin in the studies on HIT adoption among the older adults

Table 6 presents a general overview of the studies included in this review (older adults health condition, study design, sample size, mean age, and used technology). While almost half the selected studies had a post-assessment design, the remaining employed only pre-/post-assessment or pre-assessment. The majority (67%) used a quantitative study design. Overall, the quality assessment of the articles published in this area showed a low to moderate level of evidence (Table 6). The sample sizes also varied considerably, with an average of 195 participants and a mean age of 72 years (in studies that reported age). The length of the studies varied from one month to four years, with several articles omitting information on the duration

of their studies.

Table 6: Overview of studies on HIT adoption among older adults in the community

Reference	Population/specific health condition	Study design/ level of evidence	Sample size	Mean age	Technology	Study duration
Alsulami & Atkins (2016)	Older adults	Post-assessment (Quantitative) 2+	194	N/A[1]	Ambient assisted living	N/A[1]
Beer & Takayama (2011)	Older adults	Post-assessment (Qualitative) 2-	12	73.38	Mobile remote presence	N/A[1]
Bertera et al. (2007)	Older adults with chronic disease	Pre-assessment (Quantitative) 2+	85	73	Telecare/environmental sensors	Four months
Blanson Henkemans et al. (2014)	Older adults with diabetes	Pre-assessment (Quantitative) 2+	28	67	Adaptive Computer Assistant/ICT	N/A[1]
Cabrita et al. (2019)	Older adults with chronic disease	Pre/Post-assessment (Qualitative) 2-	12	69	Ambulatory/ Mobile technology	One month
Cimperman et al. (2016)	Older adults	Pre-assessment (Quantitative) 2++	400	61.13	Home telehealth services	N/A[1]
Cimperman et al. (2013)	Older adults	Pre-assessment (Qualitative) 2-	87	65	Home telehealth services	N/A[1]
Charness et al. (2016)	Older adults	Post-assessment (Quantitative) 2++	215	53.41	Home healthcare technology	Six months
Choi et al. (2014)	Older adults with depression	Pre/Post-assessment (Quantitative) 1-	121	65.21	Telehealth	24 weeks
Claes et al. (2015)	Older adults	Pre-assessment (Quantitative) 2+	245	72.4	Contactless monitoring	Three months
Czaja et al. (2014)	Older adults with hypertension	Post-assessment (Quantitative) 2-	34	72	Telehealth/ telemedicine	Six months
de Veer et al. (2015)	Older adults	Pre-assessment (Quantitative) 2++	1014	67	E-health	N/A[1]
Etemad-Sajadi et al. (2019)	Older adults	Post-assessment (Quantitative) 2+	213	82	Assistive alarm/ telecare	N/A[1]
Hamblin (2017)	Older adults susceptible to falls or with cognitive impairment	Pre/Post-assessment (Qualitative) 2-	60	N/A[1]	Telecare	Nine months
Heart & Kalderon (2013)	Older adults	Post-assessment (Quantitative) 2+	123	80	ICT	Two years
Heerink et al. (2010)	Older adults	Pre/Post-assessment(Quantitative) 2++	188	N/A[1]	Assistive social agent technology	N/A[1]

Reference	Population/specific health condition	Study design/ level of evidence	Sample size	Mean age	Technology	Study duration
Hoque & Sorwar (2017)	Older adults	Pre-assessment (Quantitative) 2+	274	N/A[1]	Mobile health	N/A[1]
Hsieh et al. (2015)	Older adults with chronic diseases	Post-assessment (Quantitative) 2+	336	N/A[1]	Telehealth	N/A[1]
Jaana et al. (2017)	Older adults with chronic diseases	Post-assessment (Quantitative) 2+	23	75.2	Telemonitoring/E-health	Six months
Keränen et al. (2017)	Older adults with and without frailty	Post-assessment (Quantitative) 2+	794	81.5	ICT	Three months
Kohnke et al. (2014)	Older adults	Post-assessment (Quantitative) 2-	126	N/A[1]	Telehealth	Three months
Loh et al. (2009)	Older adults	Post-assessment (Mix) 2+	53 + Six focus group	N/A[1]	ICT	N/A[1]
Lu et al. (2014)	Older adults with chronic diseases	Post-assessment (Qualitative) 3	20	67	Telehealth	Three months
Mann et al. (2002)	Older adults with chronic diseases	Pre-assessment (Quantitative) 2-	71	73.5	Health monitoring devices	N/A[1]
McCreadie & Tinker (2005)	Older adults	Post-assessment (Qualitative) 2-	67	83.5	Assistive technology	N/A[1]
Middlemass et al. (2017)	Older adults with long-term conditions	Post-assessment (Qualitative) 1-	53	79.5	Telemonitoring	Four years
Mitzner et al. (2010)	Older adults	Post-assessment (Quantitative) 2++	113	N/A[1]	N/A[1]	N/A[1]
Peek et al. (2017)	Older adults	Pre/post-assessment (Qualitative) 1-	33	76.1	N/A[1]	Three years
Peeters et al. (2012)	Older adults with chronic diseases	Pre-assessment (Quantitative) 2+	254	77.8	Telecare	N/A[1]
Russell et al. (2015)	Older adults	Pre-assessment (Quantitative) 2+	306	59	Telehealth	N/A[1]
Steele et al. (2009)	Older adults	Pre-assessment (Qualitative) 3	13	N/A[1]	Wireless sensor networks	N/A[1]
Tsai (2014)	Older adults with chronic diseases	Pre-assessment (Quantitative) 2+	365	N/A[1]	Telehealth	N/A[1]
Tseng et al. (2013)	Older adults	Post-assessment (Quantitative) 2-	32	N/A[1]	Health monitoring system	N/A[1]
van Hoof et al. (2011)	Older adults	Pre/Post-assessment (Qualitative) 2-	18	N/A[1]	Ambient intelligence technology	23 months

Reference	Population/specific health condition	Study design/ level of evidence	Sample size	Mean age	Technology	Study duration
Van Houwelingen et al. (2018)	Older adults	Pre/Post-assessment (Mix) 1-	256 & 15	70 & 73	Telehealth	N/A[1]
Vroman et al. (2015)	Older adults	Post-assessment (Quantitative) 2+	198	76	ICT	N/A[1]
Wong et al. (2012)	Older adults	Post-assessment (Quantitative) 2++	121	70.5	Telehealth	One year
Zacharopoulou et al. 2019	Older adults with chronic diseases	Post-assessment (Mix) 2+	779	78	ICT	15 Month
Zettel-Watson & Tsukerman (2016)	Older adults with chronic diseases	Post-assessment (Quantitative) 2-	169	70.8	Online health management tools	N/A[1]
Zhang et al. (2013)	Older adults with dementia	Pre-assessment (Quantitative) 2-	40	N/A[1]	Assistive technology	Five weeks
Zhou et al. (2019)	Older adults with chronic diseases	Pre-assessment (Quantitative) 2+	436	N/A[1]	Telehealth	N/A

N/A: Not Applicable

3.3.2. Technology Types and Adoption Models/Frameworks

Multiple studies used and tested existing models, several of which were adapted from the information systems literature. Several articles used the Technology Adoption Model/Technology Acceptance Model (TAM) to analyze technology adoption. It is grounded on two fundamental constructs: perceived usefulness, which refers to the individual perceiving that the system/technology is helpful to them and improves their performance, and perceived ease-of-use, which refers to a person believing that the system/technology does not require a lot of effort and is easy to use (Davis, 1989).

The Unified Theory of Acceptance and Use of Technology (UTAUT) was introduced in 2003 (Venkatesh, Morris, Davis, & Davis, 2003) to combine the contributions of different adoption models in the information systems literature. It includes four constructs hypothesized to be predictors of behavioural intention to use technology: 1) performance expectancy, which

is an individual's belief of the extent to which the system helps in attaining performance benefits (similar to perceived usefulness in TAM); 2) effort expectancy, which is the extent of ease-of-use of the system (similar to perceived ease-of-use in TAM); 3) social influence, which is an individual's perception of whether people important to them think that the system should be used; and 4) facilitating conditions, which is an individual's belief of whether conditions exist to support system use. In 2012, and light of the proliferation of technologies outside the boundaries of organizations, the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model — an extension of UTAUT — was proposed in the context of consumer applications (Venkatesh, Thong, & Xu, 2012). It focuses on the adoption factors on a user-level outside of an organizational context (i.e., consumers). In addition to the original UTAUT constructs, it incorporates three additional ones: hedonic motivation, price/cost value, and habit (Venkatesh, Thong, & Xu, 2012). Since some studies included in this SR used a combination of UTAUT and UTAUT2, I am referring to these two models in this paper as UTAUT(2).

Table 7 presents an overview of the technologies and adoption models investigated in the empirical studies included in this SR. Given the variety of terminology used by the authors of the original studies concerning the technology names/labels, and to simplify this information, I combined the terms referring to the same technology under one of the respective eight categories of HIT presented in Table 7. The UTAUT(2) and TAM were the most frequently used models across different technologies. The Health Information Technology Acceptance Model (HITAM) and Theory of Planned Behavior (TPB) were explicitly used in studies investigating Telemonitoring and ICT adoption, respectively. Other models (e.g., IS success model, Diffusion

of Innovation (DoI)) were each used in only one study, and the Cycle of Technology Acquirement by Independent-Living older adults (C-TAILS) model was the only model developed specifically for a survey of technology acquirement by older adults. Interestingly, 21 of 41 studies included in this review did not consider or use any HIT adoption model.

Table 7: Distribution of studies that focused on different HIT and adoption models

Adoption model / HIT Types	C-TAILS	HITAM	UTAUT(2)	TAM	TPB	Diffusion of innovation	Obtrusiveness Model	IS success model	No model	Number of studies that referred to the technology
ICT			✓		✓				✓ (4)*	6
Telemonitoring		✓	✓						✓ (3)*	5
Telecare				✓		✓	✓		✓	4
E-health			✓							1
Assistive technology			✓						✓ (4)*	5
Mobile health			✓						✓ (2)*	3
Home telehealth			✓ (3)*	✓ (4)*				✓	✓ (4)*	12
Others	✓		✓						✓ (3)*	5
Total Number of Studies	1	1	9	5	1	1	1	1	21	41
Number of studies referring to adoption models: Developed (D), Used (U), Modified (M)	D:1	U:1	U:3, M:6	M:5	U:1	U:1	M:1	U:1	0	D:1 U:7 M:12

*** The number of studies (when > 1) is included in the brackets**

3.3.3. Major Factors Affecting the Adoption of HIT by the Elderly in the Community

Table 8 presents details on the adoption factors/constructs examined in the studies included in this review and provides an overview of those that reported significant results based on the various models tested and technologies investigated. The two constructs mainly examined in the literature were performance expectancy and effort expectancy, with a considerable number of studies reporting significant positive impacts of the former and significant negative impacts of the latter on the adoption of technologies by older adults.

Table 8: Adoption factors and constructs investigated in empirical studies on HIT adoption by older adults

Factors & constructs reported in empirical studies	TP[1]	SP[2]	TN[3]	SN[4]	NN[5]	Adoption models considered in the studies	Technology type
Performance Expectancy/ Perceived Usefulness	29	16	-	-	-	C-TAILS, HITAM, UTAUT(2), TAM, No-model, IS success model, TPB, DoI	ICT, Telemonitoring, E-health, M-health, Home telehealth, telecare, assistive technology
Effort Expectancy/ Perceived Ease-of-Use	-	-	29	14	-	C-TAILS, HITAM, UTAUT(2), TAM, No-model, IS success model, TPB, DoI, Obtrusiveness model	ICT, Telemonitoring, E-health, M-health, Home telehealth, telecare, assistive technology
Social Influence	15	3	-	-	2	C-TAILS, UTAUT(2), TAM, No-model, TPB	ICT, Telemonitoring, E-health, M-health, Home Telehealth, Telecare, assistive technology
Facilitating Condition	8	3	-	-	1	UTAUT(2), TAM, No-model	ICT, Telemonitoring, E-health, M-health, Home Telehealth, Telecare, assistive technology
High Price/Cost Value	-	-	15	6	1	C-TAILS, UTAUT(2), DoI, Obtrusiveness model, No-model	ICT, Telemonitoring, E-health, M-health, Home Telehealth, Telecare, assistive technology
Privacy/Security	2	-	9	4	3	UTAUT(2), TAM, TPB, Obtrusiveness model, DoI, No-model	ICT, Telemonitoring, Telecare, E-health, Assistive technology, M-health, Home telehealth
Habit	-	-	1	-	1	UTAUT(2)	Health monitoring
Intrinsic Technology Quality	6	2	-	-	-	TAM, IS success model, No-model, DoI, TPB, UTAUT(2)	ICT, Telemonitoring, Telecare, E-health, Assistive technology, M-health, Home telehealth
Self-Efficacy	8	3	-	-	1	HITAM, UTAUT(2), TAM, No-model	ICT, Telemonitoring, E-health, M-health, Home Telehealth, Telecare, assistive technology
Older adults-centred Product Design	12	-	-	-	-	C-TAILS, UTAUT(2), TAM, Obtrusiveness model, No-model	ICT, telemonitoring, Telecare, E-health, M-health, home telehealth, assistive technology
Experience/Training	7	-	-	-	2	UTAUT(2), TAM, TPB, No-model	ICT, Telecare, E-health, Home telehealth, Ambient Assisted Living Technologies
Age	4	1	3	1	4	UTAUT(2), TAM, TPB	ICT, Telemonitoring, Telecare, E-health, M-health, Home telehealth
Higher Education	5	1	-	-	7	UTAUT(2), TAM, TPB	ICT, Telemonitoring, Telecare, E-health, M-health, Home telehealth
Gender	2	-	-	-	9	TAM, UTAUT(2), No-model	ICT, Telemonitoring, Telecare, M-health, Home telehealth
Health Conditions	2	-	1	1	4	UTAUT(2), No-model	ICT, Telemonitoring, Telecare, E-health, Assistive technology, M-health, Home telehealth
Technology Anxiety	-	-	7	1	2	UTAUT(2), TAM, No-model	ICT, Telemonitoring, Telecare, E-health, Assistive technology, M-health, Home telehealth

[1]TP: Total # Studies Showing *Positive Effects*, [2]SP: Total # Studies Showing *Significant Positive Effects (a subset of TP)*,
[3]TN: Total# Studies Showing *Negative Effects*, [4]SN: Total # Studies Showing *Significant Negative Effects (a subset of TN)*
[5]NN: Total # Studies Showing *no evidence of Effects*

3.3.3.1. Performance Expectancy/Perceived Usefulness

Performance expectancy (also referred to as perceived usefulness) was included in a variety of adoption models (C-TAILS, HITAM, IS success model) investigating the adoption of different types of technologies (e.g., ICT, telemonitoring) by older adults. This construct was

assessed concerning service usefulness in daily life, increase in productivity/quality of life, and quicker and more convenient accomplishment of older adults' daily requirements (Kohnke, Cole, & Bush, 2014; Cimperman et al., 2016; Hoque & Sorwar, 2017). Performance expectancy was found to be positively related to HIT adoption by the elderly in 29 studies (70% of total articles), 16 of which reported significant positive impacts on older adults' adoption of the respective technologies investigated (e.g., Heart & Kalderon, 2013; de Veer, Peeters, Brabers, Schellevis, Rademakers, & Francke, 2015; Hoque & Sorwar, 2017). For instance, in a survey of 274 older adults (60 years and older), Hoque and Sorwar (2017) demonstrated that performance expectancy had a significantly positive impact on older adults' behavioural intention to adopt Mobile Health (m-Health). Heart and Kalderon (2013) also reported that ICTs were adopted by older adults strongly motivated by performance expectancy (Heart & Kalderon, 2013). Van Houwelingen et al. used a mixed-method approach and reported that performance expectancy affects older adults' intention to use telehealth/video conferencing (van Houwelingen, Ettema, Antonietti, & Kort, 2018).

3.3.3.2. Effort Expectancy/Perceived Ease-of-use

Effort expectancy, or perceived ease of use, has been found to have a negative impact on the adoption of HIT by older adults in 29 studies (70%). Out of these studies, 14 reported significant negative effects of adopting various types of technology such as ICT, E-health, and health monitoring systems. It is important to note that while a high perceived ease of use may make the technology more appealing, other factors such as compatibility with the user's needs, training and support, and perceived usefulness also play a significant role in determining the adoption of HIT by older adults. Effort expectancy was assessed in a variety of approaches,

including how simple the technology is easy to use, the learning and convenience of using it, and the simplicity of operating it (e.g., Tseng et al., 2013; Kohnke et al., 2014; de Veer et al., 2015; Cimperman et al., 2016). For example, de Veer et al. found that performance expectancy and effort expectancy are highly related to the intention to use e-Health technologies, with around 63% of participants indicating they would "definitely or probably use it if offered (de Veer et al. 2015). Tsai (2014) used a self-administered questionnaire among 365 participants in Central Taiwan and found that perceived ease of use and perceived usefulness influence the intention to use telehealth technology (Tsai, 2014).

3.3.3.3. Social Influence

Social influence was investigated in 15 studies that considered various models (i.e., C-TAILS, UTAUT(2), TAM, and TPB) to explain the adoption of different technologies (e.g., ICT, telemonitoring, e-health, m-health) by older adults. It was generally assessed concerning the influence people who are important to older adults (e.g., family members or doctors) have on their adoption decisions (Tseng et al., 2013; Kohnke et al., 2014; Hoque & Sorwar, 2017). Despite the generally positive reported impacts of social influence on users' behavioural intention to adopt HIT, only three studies found significant positive effects (Tseng et al., 2013; Kohnke et al., 2014; Hoque & Sorwar, 2017), and two studies with a higher level of evidence (de Veer et al., 2015; Cimperman et al., 2016) reported no effect on HIT acceptance behaviour. For instance, de Veer et al. found no causal relationship between social influence and the intention to use E-health technologies among persons 57 to 77 years old (de Veer et al., 2015). Another study by Cimperman et al. 2016 involving 400 participants aged 50 years and older found that social influence was not related to older adults' acceptance behaviour, although doctors'

recommendations strongly impacted performance expectancy (Cimperman et al., 2016). Interestingly, Zettel-Watson and Tsukerman (2016) also reported that doctors' recommendations have a significant effect in the early stages of online management tools use; this effect, however, appeared to decrease over time (Zettel-Watson & Tsukerman, 2016).

3.3.3.4. Facilitating Conditions

Facilitating conditions were examined in the UTAUT (2) and TAM models across studies investigating different technologies (telehealth, telemonitoring, E-Health). One study used the necessary mental ability, knowledge-to-use technology, available support and assistance in difficulties as indicators of facilitating conditions (Kohnke et al., 2014). Another study by Jaana et al. assessed facilitating conditions with available technical support and training the elderly received when using telemonitoring (Jaana et al., 2017). In eight studies, facilitating conditions were reported to positively impact older adults' behavioural intention to use HIT, with three demonstrating significant positive effects. However, the impact of facilitating conditions was less commonly reported compared to performance expectancy, effort expectancy, and social influence, although significant in a few studies. Cimperman et al. said that facilitating conditions (e.g., technical support) had a "direct impact" on the acceptance behaviour of older users of home telehealth services; they improved older adults' behavioural intention to use this technology (Cimperman et al., 2016). Kohnke et al. indicated that facilitating conditions along with performance expectancy, effort expectancy, and social influence as predictors for older adults' acceptance of telemedicine equipment, with a significant impact on behavioural intention to use them (Kohnke et al., 2014). Only one study reported that facilitating conditions do not significantly impact older adults' behavioural intention to adopt m-Health technology

(Hoque & Sorwar, 2017).

3.3.3.5. Price/Cost value

The price/cost value was referred to as the effect of cost and its value in studies that considered almost all types of technologies and appeared in various adoption models, including UTAUT(2), C-TAILS, and DoI. The cost of HIT relates to the installation, service, repairs, and maintenance of the technology (Steele, Lo, Secombe, & Wong, 2009; Lu, Chi, & Chen, 2014; Alsulami & Atkins, 2016). Overall, 15 studies reported a negative impact of price/cost value on HIT adoption by older adults, of which six indicated significant negative effects. Alsulami and Atkins (2016) found that the cost of assistive technology created a big challenge for older adults' behavioural intention to use it and argued that such technology should be affordable or free to use (Alsulami & Atkins, 2016). Likewise, Lu et al. (2014) described the cost as the most important factor affecting the intention to use home telehealth care among older adults with chronic conditions; they indicated concerns over reimbursement policy changes that preclude HIT coverage (Lu et al., 2014). In addition, Claes et al. (2015) discussed the potential of low technology cost, the usefulness and availability of collected information, and functional requirements in improving older adults' perceptions and attitudes toward contactless sensors (Claes et al., 2015). Their survey of 245 older adults (≥60 years) found that almost 70% considered price/cost value in their decision to accept this technology and indicated unwillingness to bear the costs of the system's maintenance or to ask for co-financing or family assistance (Claes et al., 2015). Hence, the evidence shows higher costs negatively affect older adults' HIT adoption.

3.3.3.6. Privacy/Security

Last, based on the studies included in this review, the evidence on the impacts of privacy/ security concerns on HIT adoption by older adults remains inconclusive. Privacy/security concerns were assessed in various approaches, including older adults' need for privacy in sharing health information with others through ICT (Cimperman et al., 2016) and worries about data security and home security in using ambient assisted living technology (Alsulami & Atkins, 2016). Concerns over privacy/security were found to be barriers to HIT adoption in nine studies (Loh, Flicker, & Horner, 2009; Mitzner et al., 2010; Beer & Takayama, 2011; Cimperman, Brenčič, Trkman, & Stanonik, 2013; Claes et al., 2015; Alsulami & Atkins, 2016; Cimperman et al., 2016; Zettel-Watson & Tsukerman, 2016; van Houwelingen et al., 2018), out of which four studies reported significant negative effects. Specifically, 15% of participants in one study reported privacy concerns over accepting mobile remote presence systems (Beer & Takayama, 2011). In another study, perceived privacy concerns had a negative impact on older adults' desire to share health information with family members (Cimperman et al., 2016), and a third study found that safety/security represent important concerns limiting older adults' adoption of assistive technology (Alsulami & Atkins, 2016). Nevertheless, two other studies postulated that HIT might increase privacy/security and improve older adults' attitudes towards HIT adoption (van Hoof, Kort, Rutten, & Duijnstee, 2011; Lu et al., 2014); these studies, however, had a relatively low level of evidence. For instance, Lu et al. indicated home telehealth might enhance the sense of support and security (i.e. safety from negative health consequences) and improve the attitude of older adults with chronic conditions toward HIT adoption (Lu et al., 2014). It is particularly relevant given the support older adults feel when their health condition is continuously monitored (Lu et al., 2014). Moreover, van Hoof et al.

found that privacy is not perceived as a barrier, explaining that the sense of safety and security for older users may be improved with the use of ambient intelligence technology and that privacy concerns did not present an issue for actual users in relation to ambient intelligence technologies adoption (van Hoof et al., 2011). On the other hand, three studies found that privacy did not affect older adults' HIT adoption, although they emphasized that this issue should not be overlooked (Steele et al., 2009; Charness, Best, & Evans, 2016; Hamblin, 2017). Therefore, given the variation in the empirical studies' evidence levels and the divergence in the direction of the results, the impacts of privacy/security in relation to HIT adoption among older adults remain inconclusive.

3.3.4. Factors Presenting both Direct and Moderating Effects on HIT Adoption by the Elderly

A moderating variable typically affects the relationship between an independent and a dependent variable by reducing or strengthening this relationship (MacKinnon, 2011). Several moderator factors/variables were reported in the literature examining the relationship between the above adoption factors and older adults' behavioural intention to use or use the various technologies. These factors/variables presented in this section were reported as having a direct effect on the behavioural intention to use the technology and a moderating influence that increases/decreases the impacts of other adoption factors on technology use.

3.3.4.1. Habit

Habit, also described as individuals acting based on prior behaviour-future behaviour relationship (Kim & Malhotra, 2005), was included in the UTAUT(2) adoption model tested in the literature in the context of older adults. Russell et al. found that traditional healthcare

habits, dissatisfaction with current services, and online behaviour predict telehealth adoption (Russell, Gillespie, Hartley, Theodoros, Hill, & Gray, 2015). Nevertheless, the number of studies reporting habit impacts on HIT adoption was small, and their level of evidence was generally low; hence, the evidence in this area remains inconclusive.

3.3.4.2. Intrinsic Qualities of the Technology

Six studies examined the intrinsic qualities of the technology in relation to its adoption by the elderly. The intrinsic quality of the technology was investigated in relation to system quality, information quality, and service quality (e.g., Hsieh, Tsai, Chih, & Lin, 2015), as well as the quality of healthcare (e.g., Peeters, de Veer, van der Hoek, & Francke, 2012). Only one study involving 336 participants in a rural community in Taiwan found that among three intrinsic qualities considered (i.e. system, information, and service quality), system quality had the strongest overall positive effect on the intention to use telehealth (Hsieh et al., 2015). Zhou et al. (2019) applied an extended TAM model. They reported that service satisfaction, effort expectancy and information quality significantly impacted telehealth adoption by older adults with chronic conditions (Zhou et al., 2019). No similar evidence, however, was reported in other studies.

3.3.4.3. Self-Efficacy

Self-efficacy refers to a person's capacity to perform a specific behaviour or their ability to achieve objectives (Compeau & Higgins, 1995). Self-efficacy was investigated based on task completion by older adults without assistance or using available resources, such as instructions or others' help (Kohnke et al., 2014). Eight studies reported positive direct and moderating

effects of self-efficacy on behavioural intention to use HIT among the elderly (Steele et al., 2009; Mitzner et al., 2010; Kohnke et al., 2014; Lu et al., 2014; Tsai, 2014; de Veer et al., 2015; Middlemass, Vos, & Siriwardena, 2017; van Houwelingen et al., 2018). For instance, de Veer et al. (2015) found that self-efficacy was related to community-dwelling older people's intention to use e-Health technology (de Veer et al., 2015). Two other studies also reported self-efficacy strongly moderating behavioural intention to use telemedicine and telehealth (Kohnke et al., 2014; Tsai, 2014). Tsai (2014) indicated that self-efficacy has a significant impact on the perceived ease of use (Tsai, 2014), and Kohnke et al. (2014) reported a strong relationship between the constructs examined in the UTAUT model, self-efficacy, and behavioural intention to use the telemedicine equipment (Kohnke et al., 2014). Only one study found no effects of self-efficacy on HIT adoption (Cimperman et al., 2013).

3.3.4.4. Product Design

Product design, which refers to designing products or services according to older adults' needs and capabilities, was included in a variety of models (e.g., C-TAILS, UTAUT(2), and TAM) used in studies involving different types of technology (e.g., ICT, telemonitoring, telecare). Product design was assessed in relation to adaptability with existing systems (Blanson Henkemans, Rogers, Fisk, Neerincx, Lindenberg, & Van der Mast, 2014) and user-centred requirements design (Czaja, Lee, Arana, Nair, & Sharit, 2014). It was reported as a moderating variable in 12 studies that found an impact of customized design on older adults' HIT adoption factors; however, none of these studies said significant effects (Mann et al., 2002; McCreadie & Tinker, 2005; Loh et al., 2009; Steele et al., 2009; van Hoof et al., 2011; Tseng et al., 2013; Blanson Henkemans et al., 2014; Czaja et al., 2014; Lu et al., 2014; Claes et al., 2015;

Middlemass et al., 2017; Cabrita, Tabak, & Vollenbroek-Hutten, 2019). For example, Steele et al. (2009) found that design simplicity had a positive effect on the relationship between effort expectancy and behavioural intention to use and indicated that investigating users' needs and requirements are vital for a variety of health technologies such as wireless sensor networks (Steele et al., 2009). Similarly, Tseng et al. mentioned a user-friendly design of intelligent health monitoring systems had an impact on the acceptance of these systems by the elderly (Tseng et al., 2013). Likewise, Czaja et al. discussed the importance of incorporating a user-centred design for older adults in manufacturing telemedicine systems to accommodate their diverse needs (Czaja et al. 2014).

3.3.4.5. Experience and Training

Experience and training also play an essential role in HIT adoption by older adults; these were assessed to older adults' previous experience with similar ICT (Heart & Kalderon, 2013; Czaja et al., 2014), the adequate training to ICT use or otherwise previous inadequate training (Loh et al., 2009). As with product design, seven studies reported a positive effect of older adults' experience and training on their adoption of HIT, but no studies showed significant findings at this level (Loh et al., 2009; Heart & Kalderon, 2013; Czaja et al., 2014; de Veer et al., 2015; Alsulami & Atkins, 2016; van Houwelingen et al., 2018; Etemad-Sajadi & Dos Santos, 2019). For instance, one study found that training and ease of experience improve users' HIT perception of ambient assisted living and online health management, respectively (Alsulami & Atkins, 2016).

3.3.5. Factors Presenting only Moderating Effects on HIT Adoption by the Elderly

In addition to habit, intrinsic technology quality, privacy, older adult-centred product design, and experience/training, previously discussed as having both direct and moderating effects, I present in the following sections the factors/variables that were found to only have moderating effects on older adults' behavioural intention to use or actual use of various HIT.

3.3.5.1. Socio-Demographic Variables (Age, Higher education, Gender)

Based on the existing literature, there is inconsistent and weak evidence on the impacts of socio-demographic variables (age, higher education, gender) and health conditions on HIT adoption, with both positive and negative effects reported in the empirical studies examined in this review (e.g., Wong et al., 2012; de Veer et al., 2015; Zacharopoulou, Zacharopoulou, Leontiou, Voudouri, Tsampalas, & Lazakidou, 2019). The findings in relation to the impacts of socio-demographic characteristics on the relationship between adoption factors and the use of HIT varied. Heart and Kalderon (2013) reported that older people showed a lower intention to use health-related ICTs (Heart & Kalderon, 2013), while Keränen et al. found that the use of ICT by older adults with and without frailty varied widely. Age, education, and health condition partly explain this variation (Keränen et al., 2017). Etemad-Sajadi and Dos Santos (2019) used the modified TAM. The study reported that gender significantly impacted the "perceived intrusiveness" of HIT innovations, with men generally considering technologies such as assistive alarms, telecare, and sensors to be more invasive than women. This finding is essential in understanding the gender-related differences in accepting and adopting HIT among older adults and their healthcare providers. Such differences should be considered when designing and implementing HIT systems to ensure they are acceptable and appropriate for all potential users.

In addition, older adults who live alone tend to be more likely to accept HIT than those

living with a partner (Etemad-Sajadi & Dos Santos, 2019). On the other hand, the study by Bertera et al. showed no significant impact of these characteristics on HIT use by older adults (Bertera, Tran, Wuertz, & Bonner, 2007). In addition, Blanson Henkemans et al. reported that personal characteristics (i.e. age, gender, health condition) influence users' success with ICT (Blanson Henkemans et al., 2014; de Veer et al., 2015). They found that men tended to use E-health, more than women and discussed the importance of focusing on gender and educational level to improve HIT acceptance (de Veer et al., 2015). Along the same line, two other studies reported that higher education generally increased the use of ICTs (Vroman, Arthanat, & Lysack, 2015; Zacharopoulou et al., 2019). In summary, the evidence on the moderating effect of socio-demographic characteristics is inconsistent and remains unclear with HIT adoption and older adults.

3.3.5.2. Technology Anxiety

Last, technology anxiety was assessed in the original studies included in this review as older adults feeling "nervous," "worried," "uncomfortable," "uneasy," or "confused" (e.g., Kohnke et al., 2014; Russell et al., 2015; Hoque & Sorwar, 2017). Technology anxiety was found to have a negative moderating effect on effort expectancy and behavioural willingness to use technology; only one study, however, reported significant impacts (Houque & Sorwar, 2017). For instance, Steele et al. discussed participants' concerns about technology anxiety in relation to a wireless sensor network (Steele et al., 2009), and Cimperman et al. reported that computer anxiety negatively moderated the impact of effort expectancy for older adults using telehealth services (Cimperman et al., 2016). Nevertheless, the number of studies reporting the negative impacts of technology anxiety on HIT adoption was low, and two studies (Heerink, Kröse, Evers,

& Wielinga, 2010; Russell et al., 2015) indicated no evidence at this level.

3.3.6. Summary of Evidence: A guide for Future Research

To summarize the main findings in this SR and guide future research on HIT adoption and older adults, I present a synthesis/synopsis of the evidence in this area (Table 9). To simplify the process, I categorized the level of evidence (high/moderate/low), considering the number of studies that examined each construct/factor, the rigour of the respective investigations, and the consistency of the findings (Table 9). In addition to the constructs/factors adapted from the information systems literature and applied in the context of health care to better explain HIT adoption by older adults (e.g., performance expectancy, effort expectancy, social influence, facilitating conditions, experience/training, self-efficacy, technology anxiety, habit, intrinsic technology quality, and price/cost value), this review highlights the importance of considering privacy/security and product design when evaluating HIT adoption by older adults. This summary table constitutes a unifying starting point for researchers interested in investigating HIT adoption by older adults and can guide future studies in this area.

Table 9: Summary of existing literature evidence on HIT adoption factors

	Constructs/Factors	Description of Empirical Studies	Predominantly Positive Impacts	Predominantly Negative Impacts	Inconclusive Evidence/No Impacts
Direct effect	Performance Expectancy	Factor	SE		
	Effort Expectancy	Factor		SE	
	Social Influence	Factor	ME		
	Facilitating Conditions	Factor	ME		
	High Price/Cost Value	Factor		SE	
	Privacy/Security	Factor			X
Direct and moderating effect	Habit	Factor/moderator			X
	Intrinsic Technology Quality	Factor/moderator	LE		
	Self-Efficacy	Moderator/factor	ME		
	Older adults-centred Product Design	Moderator/factor	ME		
	Experience/Training	Moderator/factor	LE		
Moderating effect	Age	Moderator			X
	Higher Education	Moderator			X
	Gender	Moderator			X
	Health Condition	Moderator			X
	Technology Anxiety	Moderator		LE	

SE = Strong Evidence; ME = Moderate Evidence; LE = Low Evidence

SE, ME, LE are based on the number of studies, their rigour and respective level of evidence

X: Inconclusive Evidence/No Evidence may be attributed to a low number of studies reporting either positive or negative impacts or a large number of studies reporting no impacts.

Table 9 presents various constructs and factors that impact the adoption of HIT among older adults. Empirical studies have been conducted to investigate the effects of each construct or factor on HIT adoption. Their findings have been categorized into predominantly positive, predominantly negative, or inconclusive evidence/no impacts. The direct effect of HIT adoption factors includes performance expectancy, effort expectancy, social influence, facilitating conditions, high price/cost value, and privacy/security. These factors have been shown to have predominantly positive impacts on HIT adoption, except for privacy/security, which has inconclusive evidence. Habit, intrinsic technology quality, self-efficacy, older adults-centred product design and experience/training directly and moderately affect HIT adoption. Habit has inconclusive evidence, while other factors have either low or moderated impacts. Self-efficacy, older adults-centred product design, and experience/training have direct and moderating effects on HIT adoption and have predominantly positive impacts. Age, higher education, gender, health condition, and technology anxiety are factors that have moderating impacts on

HIT adoption. Their implications on HIT adoption have been inconclusive, with some studies showing positive impacts and others showing negative results.

Age, higher education, gender, and health condition moderate HIT adoption. Their results are inconclusive, with some studies showing positive impacts and others showing negative impacts. Furthermore, habit, intrinsic technology quality, and technology anxiety have direct and moderated effects on HIT adoption, and their impacts are either inconclusive or low. The findings of various studies have consistently demonstrated that adopting health information technology (HIT) among older adults is a multifaceted process influenced by several factors. These factors may include factors related to the individual, the technology, the environment, and the social context. Therefore, it is crucial to consider these factors when designing and implementing HIT interventions for older adults to ensure their successful adoption and use. Additionally, it is essential to consider the unique needs and preferences of older adults when designing HIT interfaces, as these individuals may have specific requirements and limitations that must be addressed to maximize their engagement and use of the technology. Overall, a comprehensive understanding of the factors that influence HIT adoption among older adults is necessary to ensure that these interventions are effective, and sustainable, and improve the quality of care for this population.

The identified factors were merged into a model based on the UTAUT(2). As you can see in the model, there are factors aligned with UTAUT(2), such as Performance expectancy, Effort expectancy, Facilitating condition, Social influence, Price/cost value, Habit, Experience/training, Age and Gender. There are additional factors to UTAUT(2) model, such as Privacy/security,

Intrinsic technology quality, Self-efficacy, Design as per requirements, Education, Health condition and Technology anxiety. Since this model introduces some additional factors, this model should be tested and verified in the context of older adult care in future studies.

3.4. Discussion

HIT represents a broad range of technologies that aim to support the care and management of various health conditions among older adults. To date, the results from empirical studies that investigated the factors affecting the adoption of HIT by older adults have been scattered, with limited knowledge about the level of evidence in the existing literature. No prior review has specifically examined the different adoption models studied in the literature to HIT that support older adults, nor has it synthesized the evidence on the significant factors affecting the adoption of these technologies.

This SR contributes to this area and critically appraises and synthesizes existing evidence on HIT adoption by older adults, which may inform future research and guide policies and efforts targeting this group of users. Specifically, I examined and presented the results of empirical studies investigating the factors that affect the adoption of different HIT, including ICT, telemonitoring, telecare, e-health, assistive technology, m-health, and home telehealth. I also provide a comprehensive overview of the various adoption models tested and/or proposed in HIT studies involving older adults, including C-TAILS, HITAM, UTAUT(2), TAM, TPB, DoI, and IS success models.

Interestingly, this SR did not identify particular patterns or significant differences in the factors that affect the adoption of various types of HIT or the age groups of older adults. The findings of this SR reveal that around 51% of the studies on older adults' HIT adoption did not

consider a technology adoption model/framework. Among the studies that otherwise used a conceptual model/framework, only one developed a model specifically for the context of older adults (Peek et al., 2017). The authors often justified the choice of the adoption model considered in the empirical study in the context of their respective research. However, some technologies (e.g., home telehealth) and IT adoption models (e.g., UTAUT(2)) were more frequently studied than others.

To address this review's research questions, I synthesized the empirical evidence that investigated 16 adoption constructs/factors and moderators in the literature. The findings reveal that *performance expectancy* (perceived usefulness), *effort expectancy* (perceived ease of use), and *price/cost value* were the most investigated, with evidence of their significant impacts on HIT adoption. S*ocial influence* and *product design* were also commonly studied, with fewer studies reporting significant effects of these factors. Other factors, including *facilitating conditions*, *self-efficacy*, *intrinsic qualities*, *experience/training*, and *technology anxiety,* were also considered, but the evidence on their impacts remains either weak or limited. Interestingly, no consistent and strong evidence exists on the effects of socio-demographic variables (e.g., *age*, *gender*, *higher education)*, *health condition*, *habit* and *privacy/security concerns* on HIT adoption among older adults. Given the importance and relevance of frailty among older adults, its relation to physical capacity and the ability to live at home, and the potential to reverse it if early detected (e.g., Xue, 2011; Sørbye, Sverdrup, & Pay, 2018), I propose that future research examine the impacts of frailty on HIT adoption.

Despite increased efforts in recent years to investigate the adoption of HIT by older adults, evidence in this area remains scattered, with a constant focus on using existing models

and common rationalistic approaches in exploring this topic. To date, we seem unable to explain the low level of HIT adoption by older adults and the variation in technology use among this group, which is critical for fully leveraging the potential of these tools to support elderly care in the community better. Although existing IT adoption models have contributed to a better understanding of HIT adoption by older adults, we have reached a minimal yield about our ability to explain the relatively low level of HIT adoption by this particular group of users in the context of diverse healthcare systems. This is further emphasized by the inconsistent and inconclusive evidence in relation to the majority of the factors considered in the literature. The question then that presents itself is whether research in this area, within the existing paradigm, is sufficient to understand older adults' behaviour vis-à-vis HIT better and adequately address their care needs using these tools. I posit that research on older adults' adoption of HIT should extend beyond the traditional IT adoption paradigm to provide a complete explanation for the low level of HIT adoption among older adults in today's environment and the variation in elderly HIT adoption across countries and regions within the same country. IS research on IT innovations in organizations has challenged existing paradigms in the past to expand the perspective and investigation lens and contribute to a more comprehensive understanding of the diffusion of innovations in these settings. For example, Ramiller and Swanson (2003) argued that IT innovation carries organizational visions that involve the collective understanding of the application of an IT innovation through public discourse. Along the same line, Kaganer, Pawlowski, & Wiley-Patton (2010) built on the organizational vision concept and discussed the role of legitimation strategies in increasing awareness and interest in an IT innovation, hence increasing the likelihood of its adoption. In the context of consumer HIT applications and older

adults, would a paradigm shift contribute to a collective understanding of HIT's role in supporting older adults' care in the community and the conditions that would enable adoption and optimal benefits from these technologies?

Limited work has been done to investigate older adults' IT adoption, considering their collective environment, which may be shaped by the web/network of interactions between them and their surroundings. In a complex environment like healthcare, where the elderly interact with numerous persons contributing to their care, it is important to study the discourse between them, their family/caregivers, their peers, their healthcare providers, and the technology suppliers. I concur with Schulz et al. that research on technology adoption and the elderly should extend beyond describing the facilitators and barriers. Instead, we need to understand better the environment surrounding the elderly and their interaction with it (Schulz, Wahl, Matthews, De Vito Dabbs, Beach, & Czaja, 2015). Thus, I call for future research to explore the nature, and weight of the dyads of interactions i.e. older adult-family/caregiver, older adult-older adult, older adult-provider, older adult-vendor, which may shape a older adults' decisions to use or not use a technology and hence would inform efforts and strategies in this area. I believe that uncovering the role of communication and interaction between the elderly and their environment would support an "older adult-centred" digital health research plan that contributes to the care of older adults in the community.

It is important to note that, given the scope of this review, I focused on older adults' HIT adoption and limited our results to the constructs/factors investigated in the healthcare literature with older adults as target participants. Future studies should also explore caregivers' perspectives in this area, given their close interaction with and knowledge of older adults and

their needs. In addition, healthcare systems are very different across disparate regions and countries. For example, the HIT cost is not a concern for older adults residing in areas with state-provided healthcare, but it can be an enormous barrier in other regions. Hence, system-level variables may be essential in determining HIT adoption by older adults, especially at the community level. Variations in policies and HIT cost coverage should be carefully examined and discussed when conducting studies in this area.

Last, my review was based on published studies in this area of research, thus potentially presenting limitations inherent to the original biases and variation in the rigour of the empirical studies. In addition, although the impact of different adoption factors did not change significantly across technologies, the number of studies varied considerably based on technology types; this may also affect the generalizability of the findings. For example, the number of studies focusing on m-health and e-health was minimal compared to other technologies like telehealth, thus highlighting the need for more research in these areas.

I consulted five major academic databases in this study, using a variety of keyword combinations. However, the articles included in this review were limited to studies published in English, excluding potentially relevant studies that may have been published in other languages. The level of evidence in the original articles was relatively low-moderate, which may limit the confidence in the conclusions presented in this review. Hence, I recommend future empirical studies consider more rigorous designs/approaches and longitudinal evaluations to assess the factors that significantly affect the adoption of different types of HIT by older adults in the community and the differential impacts that may exist among various groups of the elderly.

The number of older adults and the prevalence of chronic conditions is increasing

worldwide, resulting in more pressure on health systems. Although prior studies have investigated HIT and older adults, it remains unclear what factors significantly affect the adoption of other HIT by the elderly in the community. This SR was conducted between December 2017 and February 2018 (with a search update in 2018-2019) to critically appraise and synthesize existing evidence on HIT adoption factors among older adults. Following the PRISMA guidelines, five major databases were consulted (PubMed, Medline, CINAHL, Scopus, and Web of Science). The inclusion criteria consisted of empirical studies published in English reporting the impacts of specific factors on HIT adoption among older adults in the community. A total of 41 studies were included in this review, mainly published between 2014 and 2017 in Europe and the US, with a low to moderate level of evidence. The factors affecting HIT adoption did not differ across technologies or age groups. The findings reveal that older adults adopt HIT *perceived as useful* and require *low effort* commitment; *price/cost* value were reported as adoption barriers. S*ocial influence*, *facilitating conditions*, *older adults-friendly product design*, *self-efficacy*, *Intrinsic Technology Quality*, *experience/training*, and *technology anxiety* may affect HIT adoption by older adults. However, the evidence of these impacts remains weak and limited. Mixed and inconclusive evidence was observed on socio-demographic variables, health conditions, habits, and privacy/security impacts. Given the reported low level of HIT adoption among older adults, I call for more rigorous research in this area using a "older adult-centred" perspective, which takes into account the discourse/interaction between older adults and their collective environment to better understand the factors that affect their technology adoption and address their needs.

In addition to examining the factors that affect older adults' adoption of technology, it is

also important to investigate the factors that affect healthcare professionals' use of health information technology to support older adults' care. Nurses represent a major group of healthcare professionals who care for older adults in LTC homes. Therefore, their attitude toward use is essential and should be considered in future studies.

The systematic review (SR) conducted in this study has uncovered a potential issue regarding the interchangeability of the terms "adoption" and "use" within the collected studies. Adoption refers to the process of accepting and implementing an innovation or technology, whereas use refers to the actual utilization of technology after it has been adopted. As the collected studies use these terms interchangeably, it is unclear how they defined adoption and whether the terms were used consistently across all studies. This lack of consistency can create confusion and undermine the ability to draw meaningful conclusions about adopting and using health technologies in the LTC. It is essential to differentiate between adoption and use as they represent distinct stages in the implementation process of new practices. Adoption involves the decision to adopt an innovation, while use pertains to the practical implementation of the innovation. To promote successful implementation in LTC settings, it is crucial to understand the factors that influence adoption and use. Therefore, when researching the adoption and use of health technologies in LTC, it is crucial to utilize clear and consistent definitions of these terms to ensure that the findings are reliable and accurate. This approach can assist in identifying the most significant factors for successful adoption and use, which can be used to develop strategies for promoting the implementation of new practices in the LTC industry.

This article discusses older adults' adoption of HIT. It highlights the scattered results from empirical studies regarding the factors affecting the adoption of HIT and the limited

knowledge in the existing literature. The article reviews the different adoption models studied in the literature to HIT that support older adults and synthesizes the evidence on the significant factors affecting the adoption of these technologies. The article reveals that around 51% of the studies on older adults' HIT adoption did not consider a technology adoption model or framework, and only one developed a model specifically for the context of older adults. The article proposes that future research should examine the impacts of frailty on HIT adoption. This study suggests that research on older adults' adoption of HIT should extend beyond the traditional IT adoption paradigm to provide a complete explanation for the low level of HIT adoption among older adults in today's environment and the variation in elderly HIT adoption across countries and regions within the same country.

4. Delphi Study

The LTC context is unique to the adoption of HIT by healthcare professionals. The factors that affect the adoption of HIT by LTC nurses may not be fully captured in traditional adoption models presented in the literature. To date, limited research has explored the perspective of critical stakeholders caring for older adults in LTC, the nurses, on the factors that affect their adoption of technology, and evidence is lacking in the Canadian context.

4.1. Long-Term Care Nurses HIT Adoption in a Canadian Setting

Studies among LTC nurses regarding HIT adoption are minimal and have mainly been conducted among diverse groups, such as a combination of nurses, older adults, patients, and physicians. For example, Thoma-Lürken et al. conducted a mixed-method study on a usable decision-support application among nurses and case managers in community-based dementia care. They mentioned that looking aside from more technological development, putting the technology into real-world needs, and proving its efficacy and effectiveness are driving factors toward decision-support application use (Thoma-Lürken et al., 2018). LTC nurses' studies have been conducted outside the Canadian healthcare system. Alaiad and Zhou conducted an empirical study of home healthcare robot adoption among older adults and healthcare professionals in the US healthcare system. They reported social influence, performance expectancy, trust, privacy, ethical concerns, and facilitating conditions as the main adoption factors (Alaiad & Zhou, 2014). Since these studies have mainly been conducted outside Canada and among varied participants, it is unclear if the identified factors apply to the Canadian healthcare system.

On the other hand, studies in Canadian healthcare settings have been mainly related to

home care (Ibrahim et al., 2019; Seto et al., 2019) and limited to well-known adoption models (e.g., UTAUT, TAM). For example, Ibrahim et al. surveyed 217 nurses currently practicing within the home care sector in Ontario. They used the UTAUT model and mentioned that performance expectancy, social influence, and facilitating conditions had a significant, positive, and direct impact on nurses' behavioural intention (Ibrahim et al., 2019). However, effort expectancy and nurses' demographics (e.g., age, level of education, and technology experience) were not found to have a direct and/or moderating impact on nurses' intention to use HIT (Ibrahim et al., 2019). In terms of nurses' perspectives regarding HIT adoption, the medical informatics literature has trailed behind, and a comprehensive study to capture LTC nurses' perspectives was suggested by previous papers (Shoolin, 2010; Takian, Sheikh, & Barber, 2014). Despite the paucity of research in this area, no earlier study has investigated LTC nurses' HIT adoption in depth or assessed their attitude toward HIT adoption in the Canadian healthcare system. A comprehensive list of identified adoption factors with solid predictive power among LTC nurses is missing. This study aims to fill this gap in prior studies and presents findings of a Delphi survey conducted by nurses at a long-term care facility in Canada. The results provide a preliminary list of factors to consider when developing a HIT adoption framework for LTC nurses.

4.2. Methodology

4.2.1. Delphi Study Design and Approach

The Delphi method is a sequence of surveys interspersed with controlled reviews. It has been commonly used in several settings to elicit previously unheard opinions from individuals. The central concept is that the group's or panel's common view is more reliable than individual

opinions (Schmidt et al., 1997; Jaana et al., 2011; Stanyon, Goldberg, Astle, Griffiths, & Lee Gordon, 2017; Ameel, van Achterbrg, Kinnunen, Kontio, & Junttila, 2021).

The Delphi study approach is used in exploratory studies when limited information is available on particular research areas. It is a useful data-driven approach to developing new concepts and determining the direction of future-oriented research (Fletcher & Marchildon, 2014). The Delphi approach has been used to investigate a wide range of scientific questions in academic domains (e.g., information technologies and healthcare) (e.g., McPherson & Candela, 2019; Soobiah et al., 2019; Vogel, Zwolinsky, Griffiths, Hobbs, Henderson, & Wilkins, 2019; Woodcock, Loveland, Herold, & Bauer, 2020). The Delphi technique has been adapted in many ways throughout its history. The primary methodologies of Delphi studies consist of Ranking, Classical, Decision, and Policy (Paré, Cameron, Poba-Nzaou, & Templier, 2013) (Table 10). Although these methods have several fundamental similarities (for example, feedback and an iterative process), they also differ in their specific goals and how they accomplish them (Paré et al., 2013).

Table 10: Comparison of Delphi types*

	Classical Delphi	Policy Delphi	Decision Delphi	Ranking-type Delphi
Focus	Facts	Ideas	Decisions that influence future	Rankings
Goal	Create consensus	Define and differentiate views	Prepare and support decisions	Identify and rank critical issues
Panellists	Unbiased experts	Lobbyists	Decision makers	Experts
Participation	Need many panellists (concerning the complexity of the questions being asked)	Consider all relevant groups	Cover a high percentage of the relevant decision-makers	The number of panellists should not be too large (to facilitate consensus)
Common uses	In the natural sciences and engineering, where underlying physical "laws of nature" guide experts' answers	In social and political contexts, to analyze policy issues	In contexts where a small, well-defined group has decision-making power	In business, to guide future management action or research agendas

* **Paré et al., 2013**

The ranking-type Delphi technique is the most extensively used in information systems and consists of a set of linked surveys intended to elicit expert opinions through iterative

controlled feedback (Jaam, Awaisu, El-Awaisi, Stewart, & El Hajj, 2022). The ranking type of the Delphi study is suited for this investigation since the study aims to identify and rank in order of importance the factors influencing LTC nurses' adoption of health information technology.

The ranking Delphi study mainly conducts three phases, each resulting in the next phase. The first phase is usually brainstorming to identify the most critical items among panellists. Then, collected responses are consolidated by removing duplicates and merging close items. Two researchers usually extract information from collected responses to reduce bias in the research. Narrowing down is the next phase of the Delphi study, with validation, selection, and paring down the identified items. In the narrowing-down phase, specified items in the brainstorming phase get validated, and items with the highest rating scores are retained for the next phase. Each panellist ranks the list of factors and computes the degree to which they agree, and factors are sorted in order of priority. The draft of the first-round survey in this study was created by consulting previous studies (e.g., Schmidt, 1997; Paré et al., 2008; Jaana et al., 2011; Gill, Leslie, Grech, & Latour, 2013).

4.2.2. Study Location

The Perley and Rideau Veterans' Health Centre (PRVHC) is one of Ontario's most extensive LTC facilities. This facility comprises seven buildings serving diverse groups of older adults and veterans, including LTC residents and older adult-unit clients needing convalescent care and sub-acute care with various services (Perley and Rideau Veterans' Health Centre, Centre of Excellence in Frailty-Informed Care). The PRVHC has three buildings where residents live (Gatineau (G), Rideau (R), and Ottawa (O)) and Perley Centre, where most of the administration offices are located:

- Gatineau building: Gatineau1North (G1N), Gatineau2North (G2N), Gatineau1South (G1S), Gatineau2South (G2S)
- Ottawa building: Ottawa1East (O1E), Ottawa2East (O2E), Ottawa1West (O1W), Ottawa2West (O2W)
- Rideau building: Rideau1North (R1N), Rideau2North (R2N), Rideau1South (R1S), Rideau2South (R2S)

Each unit has 40 beds except for R1N and R2N, which have 20 beds. Veterans are located in the Rideau buildings, including G2N and G1N. Secured units and locations include G1S, G1N, and the Specialized Behavioural Support Unit (SBSU). Convalescent Care/Sub-Acute care for Frail Elderly (SAFE) has 20 beds for each unit for isolation. Long-term care, convalescent care, respite care, on-site independent living, and on-site assisted living are different types of care provided to older adults. These services are provided in a variety of other locations, including the Ottawa, Rideau, and Gatineau Buildings; Guest House; Apartment Building; Commissionaires Ottawa Place (COP); Perley Building; Apartment Building B; COP Perley Building; and distributed in the nearby long-term care facilities outside of the PR location. There are three different lengths of stay for 621 patients: "indefinite," "up to 90 days," and "up to 90 days per year" (Perley and Rideau Veterans' Health Centre, Centre of Excellence in Frailty-Informed Care).

The residents of the PRVHC facilities, older adults, were divided based on their level of cognitive performance. The Cognitive Performance Scale (CPS) measures long-term center residents' mental cognitive levels. The CPS combines consciousness and executive functions with scores ranging from zero to six, where zero is the lowest level of impairment and six is the

highest. There are intact older adults with 68 residents (17%), borderline intact older adults with 48 (12%), mild impairment older adults with 65 (16%), moderate impairment older adults with 126 (31%), moderately severe impairment older adults with 44 (11%), severe impairment older adults with 50 (12%) and very severe impairment older adults with 6 (1%). The demographic information of the older adult residents was collected and listed as LTC (non-veteran) with 204 (48%) residents, the veteran group with 224 (52%), female with 154 (36%), and male with 274 (64%). The older adults who are living in LTC include those less than 65 years old, 15 (4%); between 65 years old and 74 years old, 31 (7%); between 75 years old and 84 years old, 70 (16%); between 85 years old and 94 years old, 175 (41%); and older than 95 years old, 137 (32%).

A total of 218 nurses work in different occupations at the PRVHC. These include 164 registered practical nurses, 53 staff nurses, and only one psychogeriatric nurse. Of these, 39 are casual, 96 full-time, and 83 are part-time nurses. These nurses work in occupations such as psychogeriatric RNs (registered nurses), registered practical nurses, and staff nurses. The PRVHC identifies these occupations as per the below list:

- Psychogeriatric Registered Nurse (PRN): A registered nurse whose practice is focused on older adults (usually 65 years of age or older) with mental illness and/or cognitive impairment.
- Registered Practical Nurse (RPN): Since 2005, all RPNs in Ontario must earn a diploma in Practical Nursing by taking four semesters over two years in a college program. Because an RPN's education is less comprehensive and more focused, RPNs' careers are most appropriately suited to patients with less complex needs and stable and predictable

conditions.

- Staff Nurse RN is the same as Registered Nurse (RN): Since 2005, all Ontario RNs must have a baccalaureate degree. RNs either take a collaborative college-university nursing program or a four-year university nursing program, leading to a Bachelor of Science in Nursing degree (BScN) or a Bachelor of Nursing degree (BN). Because RN education is more comprehensive, they have a deeper knowledge base in clinical practice, critical thinking, and research utilization. RNs can care for patients with more complex needs in unpredictable situations.

4.2.3. Ethics Certificate

Before I started the Delphi study, I submitted an ethics application to the University of Ottawa Ethics board in March 2021. The University of Ottawa Human Research Ethics Committee (REB) granted an ethics approval certificate (Certificate #: S-04-21-6727). Upon approval of the University of Ottawa ethics board, an application to the PRVHC was submitted. PRVHC was informed about the ethics approval, and their rules and regulations were followed.

The consent was implied by panel members' willingness to participate in the study (Appendix 3). Participants were told that the information they shared would remain confidential and be used solely for this research, and research results would only be reported at the aggregate level.

When data were imported into Excel, participants' names, e-mail addresses, and IP addresses were segregated from the ID numbers to ensure that only the researchers could connect participants' answers to their identifying information. As a token of appreciation for the participants' time, I offered all participants of this project a Starbucks gift card.

4.2.4. Sample Selection

The number of participants varies in studies, and there is no commonly recognized criterion for panel sample size. It is crucial to understand how many different classes are required to cover all possible points of view. It is widely accepted that the more participants, the more reliable group judgements are. The previous studies mentioned various acceptable numbers of panellists as being required. Ogbeifun, Agwa-Ejon, Mbohwa, & Pretorius (2016) suggested any number between 3 to 80. Okoli and Pawlowski (2004) proposed a range from 10 to 18 panellists as a feasible and adequate number of panel members. Another study by Hallowell and Gambatese (2010) recommended eight panellists for a Delphi study.

The participants in this study are mainly homogenous groups (either registered practical nurses or staff nurses). Given the intricacy of the criteria and the likelihood of several areas of competence among health professionals, I aimed for a minimum sample size of 15–20 participants. It covers enough critical viewpoints and limits bias in the modelled adoption factors among the nurses. A panel of nurses at PRVHC was solicited to participate in the Delphi study that involved three rounds of data collection: brainstorming, narrowing down, and ranking. In each round, the survey questions were sent through SurveyMonkey to panellists. The center of excellence in frailty-informed care at PRVHC sent an invitation e-mail and informed the nurses about this study. They mentioned study initiatives and the purpose of this study. In addition, I developed a recruitment banner to encourage more nurses to participate in this project. The required identification logo was uploaded for each survey page to serve as a header. The first page was an outline and included material about the ethics approval process and consent form. The participants were required to acknowledge their review of the consent

form and accept it; otherwise, they would not be allowed to participate in the study.

4.2.5. Data Collection

Some studies used telephone, e-mail, or fax for their surveys (Beattie and Mackway-Jones, 2004; McGinn, 2012), but recently there have been studies using electronic survey platforms (Wagner, Grames, Forister, Berenbaum, & Stopak, 2021; Perveen et al., 2022). The web-based survey software, SurveyMonkey (SM), is commercially available with a range of benefits over designing applications manually. SurveyMonkey was chosen to manage the Delphi method. The output from SM was imported into Excel using high-level data security protocols that followed industry best practices. With the SurveyMonkey approach, over 300 commercial web-survey app products are currently available (Allen & Roberts, 2010; Fan & Yan, 2010). Each survey phase lasted two weeks, as recommended by the literature (Fan & Yan, 2010).

Attrition can occur in any research study. It has been determined that most attrition occurs in the first phase, with numbers rising as the Delphi survey continues (van Zolingen & Klaassen, 2003). Since the Delphi method consists of multiple rounds, there is a greater chance that experts will leave the study owing to exhaustion, diversions between phases, or disillusionment with the procedure (Donohoe & Needham, 2008). However, few studies have investigated the likelihood of participation or dropout among particular expert groups. I used every chance to remind participants that each round is based on their prior phases' replies to encourage ownership and active involvement and to encourage participants to stay in the study (Keeney et al., 2011a) (Appendix 4; list of questions in all three phases).

4.2.6. Data Analysis

4.2.6.1. Brainstorming

In the first phase of the Delphi study, brainstorming, participants were asked to identify 5–10 most important factors that affect their adoption of HIT in the context of long-term and elderly care. A high-level question was sent to the panellists to collect possible ideas, concerns, and factors regarding technology adoption. Each panellist provided a list of factors with brief explanations. The research assistant and I independently coded and extracted information from the collected responses. Factor names and descriptions helped the research assistant and me organize a cohesive list of responses, including factors with a short description in their selection. After removing repetitive factors, the items with close contents were merged.

4.2.6.2. Narrowing down

At the end of phase one, a list of common factors among panellists was established within their specified descriptions. In the second phase of the Delphi study, I asked participants to perform the following tasks: First, participants validated each key adoption factor name/label and its associated description. If participants agreed with the label and description of the factor, they checked the box. Otherwise, they suggested a change to the name/label or description. Second, a seven-point Likert scale (1=least important and 7=most important). Seven rather than five data points were chosen for greater data granularity and to support response interpretation using continuous data analytics (Dawes, 2008; Watson et al., 2008).

The nurses' panel should eliminate everything graded low (Paré et al., 2008; Jaana et al., 2011). However, what level should be chosen without a scientific basis for selection? Paré et al. mentioned that only factors with a mean of 3.5 and higher (on a 7-level scale) should be

included in the third round (Paré et al., 2008). Jaana et al. used factors selected by at least one-third of participants from the second to the third rounds (Jaana et al., 2011). In the Delphi study, Schmidt used the top 10 factors among 20 factors from the second to the third rounds (Schmidt, 1997). McKenna (1994a), in his study of the Delphi technique, advises a 51 percent threshold, Mitchell (1991) and Keeney et al. (2006) consider a 75 percent level acceptable, while Ulschak (1983) wants 80 percent. McKenna et al. (2002) proposed that 70 percent is a solid cut-off point for the items to be included in the third round.

Hasson, Harel, Levy, & Malach (2003) mentioned that only those opinions that received over 50 percent average score in round two were fed back to respondents in round three; this may bias the range of the views from successive phases. Loughlin and Moore (1979) suggested 51 percent, Boyce, Stubbs, & Todd (1993) set the consensus at 66 percent. Mubarak, Alturaiki, & Hemida (2019) used a purposive sample of 29 experts, and the consensus was pre-defined to be the point where >85 percent of the experts agree or strongly agree on the category for each statement. Alternatively, Crisp, R., & Slote (1997) questioned the value of using percentage measures, suggesting that the stability of the response through a series of rounds is a more reliable indicator of consensus.

Homberg, Klafke, Loukanova, & Glassen (2020) mentioned, “According to the ’experts’ assessments, the topics and therapy methods were assigned to four relevant groups. Group 1: very relevant (at least 80% of respondents evaluated the issues as 6 or 7 on a Likert scale), Group 2: relevant (at least 80% of the remaining subjects received a 5), Group 3: partly relevant (at least 80% of the remaining issues were ranked as four or above), and Group 4: inapplicable (for the remaining topics)”. Santaguida et al. (2018) stated that the “Standard Delphi

methodology will be employed with an expectation of at least three rounds to achieve consensus (75% average score)". Schmalz mentioned, "the IQR (Q3–Q1) is a common consensus measurement widely used in applied Delphi studies. It depicts 50% of assessments between the lower quartile (Q1) and upper quartile (Q3)" (Schmalz, 2021). Vogel et al., 2019 defined consensus as >70 percent average score. There seems to be no general agreement on what degree of consensus should be used in Delphi research or how this level of consensus should be determined. Consensus on each item was equivalent to at least 70 percent for this study. I combined the participants' responses. Analyzing the responses allows me to have a consolidated final list of factors that affect the adoption of health information technology by nurses in long-term and elderly care. The consolidated list was distributed for confirmation to all panellists, and each panellist individually pared down the list of the factors. A definition list for each factor was established to provide a similar understanding of the proposed factors. The panellists choose factors (rather than ranking them) that could impact health information technology adoption. The HIT adoption factors with a median equal to or above five (70%) were retained in the following study round.

4.2.6.3. Ranking

The HIT adoption factors preserved from phase two were given in random order to the panellists for their ranking. The panellists ranked the selected factors by priority. The top-rated items were factors with close attention among the panellists. The factor rate was calculated based on the Kendall (W) coefficient rank correlation. Cohen (1960) provided that the kappa result be interpreted as follows: values ≤ 0 as indicating no agreement, 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as

almost perfect agreement (McHugh, 2012). Despite the consensus level being “fair” on the first attempt, two rounds of the ranking were performed to improve the level of agreement among panellists. This is the conventional approach used and suggested by scholars to improve the Delphi study agreement level in different phases (Paré, Sicotte, Jaana, & Girouard, 2008; Heiko, 2012).

4.3. Results

4.3.1. Characteristics of Participants

The first phase drew 24 nurses among the 25 volunteer nurses. In the second phase of the Delphi, there was very little attrition, with only two participants failing to complete the survey. The failure rate in the third round was the same, and only two participants in the second round did not complete the third round. Twenty nurses participated in all three phases of the Delphi survey. The participants were mostly female (85%), between the ages of 30 and 50 years (60%), and had a wide range of job experience (from five to more than 25 years). They were either familiar or very familiar with HIT and had primarily utilized HIT in the past (67 percent). Half of the participants had 10 or fewer years of experience, whereas they mainly (75 percent) had this amount (10 or fewer years) of work experience with PRVHC. The majority of participants came from a similar job position (e.g., Registered Nurse (RN), Registered Practical Nurse (RPN), Nursing Administration, Practice Leader). PCC (point-and-click care), handheld/bladder scanners, electronic health records, iPads, and POC (point-of-care) were used among the nurses (Table 11).

Table 11: Demographic information among nurses

Gender	***Number (%)***
Female	17 (85%)
Male	2 (10%)
Prefer not to answer	1 (5%)
Age group	
18-29	5 (25%)
30-39	6 (30%)
40-49	6 (30%)
50-59	3 (15%)
Job position	
Registered Nurse (RN)	6 (30%)
Registered Practical Nurse (RPN)	12 (60%)
Nursing Administration	1 (5%)
Practice Leader (RN)	1 (5%)
Number of years of experience	
Less than 5	6 (30%)
5:10	4 (20%)
11:15	3 (15%)
16:20	3 (15%)
21:25	1 (5%)
More than 25	3 (15%)
Number of years of experience (PRVHC)	
Less than 5	9 (45%)
5:10	6 (30%)
11:15	3 (15%)
16:20	2 (10%)
Familiar with Health information technology	
Familiar	10 (50%)
Very familiar	10 (50%)
Used HIT in the past	
Yes	14 (70%)
No	6 (30%)
Most used technology	
PCC	5 (25%)
Handheld/bladder scanners	4 (20%)
Electronic health records	2 (10%)
Ipad	2 (10%)
POC	2 (10%)

4.3.2. Brainstorming (phase 1)

Given the exploratory nature of the Delphi study and the scarcity of data in this field, this phase aimed to create a list of HIT adoption factors among LTC nurses. The Delphi research assessed nurses' perspectives vis-à-vis the role of various HIT in supporting older adults' care in HIT adoption. In the first phase of the Delphi study, brainstorming, the panel participants responded to the research question using multiple text boxes that provided names and brief descriptions for each factor affecting HIT technology adoption. Each panellist identified

between four and ten different HIT adoption factors. A total of 25 nurses contacted the authors directly and volunteered to participate in this study, and 24 participants completed the first round. Combined responses from the 24 panellist nurses who participated in this phase provided a list of 176 factors, including a description of each factor. The first phase of survey panel responses was reviewed, and comments were incorporated for thematic interpretation (Braun & Clarke, 2006). A research assistant and I checked the collected responses, coded the responses, and merged duplicate answers. The two researchers shared and compared the list of factors and descriptions, and the average score level was 89%. The factors within disagreement were discussed in different meetings and resolved by consensus.

A total of 21 adoption factors were collected in the first round of the Delphi study. These are samples from the collected responses: “Access for all groups,” "Access to a device,” “internet,” and “Wi-Fi” (Please see Appendix 5 for more details about collected responses in the first phase of the Delphi study). Some of these factors were mentioned by a majority of the panellist respondents. For example, ease of use (e.g., the complexity of the technology, easy to use); training and education (e.g., access to training to use the technology, adequate training should be provided). On the other hand, the other factors were mentioned only by two or three panellists, such as habits and routine (e.g., routine, usual practice/habit) and privacy and security concerns (e.g., fear of breach of confidentiality or misuse of personal health information and privacy/security) (Table 12).

Table 12: The adoption factors with their descriptions

Nurses' health information adoption factors	Brief description
Age of users	Experience using technology varies by age, and learning how to use technology at older ages is challenging. The technology may be too advanced for users (e.g., for residents as well as nurses).
Funding availability	Limited funding is available in long-term care, and new technologies can be costly and not affordable in these organizations (e.g., maintaining updates, fixing damaged devices, and cost of training).
Adequacy of change management	Multiple and fast changes within the organization (e.g., new programs, new policy, new assessments protocols), which sometimes happen at the same time, can overload nurses and cause difficulties in adapting to new technologies. Ensuring the entire health care team is on the same page and ensuring buy-in from physicians would support the use of technology.
Ease of use and technology complexity	Simplicity of the technology, convenience, user-friendliness and ease of use for nurses, and (minimal technical complexity and steps to take and effort to use the technology.
Troubleshooting and technical support	The ease of troubleshooting and access to help screens, and the availability of technical help and support is important for staff to continue using the technology and for nurses to know what to do if something goes wrong and the technology breaks.
Habits and routine	Technology will be an integral part of nurses' habits, usual practice, and routine in providing care to older people.
Communication challenges	A low level of communication among nurses, who prefer to communicate verbally and not through the technology, and a challenge in communication between the technology and interprofessional team.
Privacy and security concerns	Fear of breach of confidentiality or misuse of personal health information.
Experience with technology	Varying level of professional experience and knowledge to use technology across different types of work, generation, age, and countries of origin.
Training and education	Adequate and proper level of training is not always available in health care facilities and sometimes lacking, and IT training is given rarely to healthcare workers. Education sessions and ensuring sufficient time to learn how to use the technology are important.
Quality of healthcare	Technology should be designed to support the ability to easily collect and draw useful data when needed, and improve the quality of care.
Data/information accuracy	Accuracy of data and information produced by technology.
Reliability of technology	Reliability of the technology in relation to system crashes, technology breaking down, and issues with the connections during power disruption and outage.
Technology-related anxiety	Anxiety associated with the use of advanced technologies and their invasiveness, the fear of technology replacing nurses and taking away their jobs, and the worry about making mistakes in environments with punitive cultures impact willingness to try new things.
Compatibility and adaptability of technology	The adaptability of new technologies to the long-term care environment (e.g., alignment with nursing workflow and team approach, consideration for the nature and condition of residents in long-term care, synchronizing with the technology used at residents' homes), their integration with existing records, their compatibility with various devices (e.g., iPad, desktop, phone), and the ability to share information directly and send the order to the pharmacy are important.
Technology design considerations	Technology design should take into consideration the particularities of the long-term care environment: ease of technology cleaning, hearing and vision barriers, cognitively impaired residents and residents with physical disabilities, ability for picture taking (documentation of the healing process), language barriers, long battery life, portability and mobility to the bedside, and light weight and compact technology size.
Technology benefits and usefulness	Ability of the technology to produce easily accessible information, save time, make the work easier and more efficient (e.g., integrating vital signs into documentation, adding value to the role of nurses), and have positive effects on residents that can be seen by the care team.
Workload Impact	Technology can reduce duplication and repeated steps and improve efficiency, thus decreasing the workload. But it can also create more work if the system crashes or when there are difficulty findings the correct information.
Resistance from users	Resistance to change associated within the culture around liking things to stay the same, older nurses' perceptions of change difficulties (from paper use to new technologies), and inability of residents with dementia to understand the reason behind using a technology.
Limited time for learning	Limited time and availability of staff to properly train and orient staff and clients to new technologies. There isn't enough time in the units for nurses to come to in-services or learn on their own.

Accessibility of technology	Availability and accessibility of technology in the facility for all groups (e.g., computer for point click care and program for medication administration/ documentation, cell phone to communicate with staff, call bell system, internet, wifi, iPad) and required time for information to be available for interpretation.

4.3.3. Narrowing down (Phase 2)

The aggregated list of randomly sorted HIT adoption factors was collected in phase one (Table 12) and shared with respondents in the second phase of the Delphi study. Among 24 participants in the first round, a total of 22 participants completed the second phase of the study. The participants were asked to verify and rate each factor's importance on a 1–7 scale (1=least important and 7=most important). Moreover,

Two participants did not provide the required information, resulting in a lack of two ranking inputs from two different adoption factors. To complete the dataset, I filled in the missing data. I filled them with the median amount of the other participants' answers since the most commonly used statistics in Delphi studies to convey information about respondents' collective judgements are measures of central tendency (mean, median, and mode) and degree of dispersion (standard deviation and interquartile range) (Hasson et al., 2003). The median and mode are recommended in most cases. However, in other cases, the average is used (Murray & Jarman, 1987). Using the median, based on a Likert-type scale, is strongly recommended in the literature for providing input to the expert panel (Hill & Fowles, 1975; Belton, MacDonald, Wright, & Hamlin, 2019). The median would immediately look best adapted to reflect the coming convergence of opinion, given the predicted consensus of thinking and the skewed anticipation of replies as they were obtained. The consensus measurement among participants is an essential step in Delphi studies. There is no standard threshold for consensus, whereas a

low consensus shows less agreement with the order of importance. Differences in settings, experience, areas of work, etc., may explain this.

On the other hand, a strong consensus means panellists have higher agreement on the order of importance, as it would even add to the validity of the findings regarding the importance of the factors. HIT adoption factors that got a minimum of 70% average score in the 2nd round were retained in the 3rd round of the Delphi study. These factors are *ease of use and technology complexity, reliability of technology, workload impact, technology benefits and usefulness, funding availability, troubleshooting and technical support, privacy and security concerns, training and education, quality of healthcare, data/information accuracy, limited time for learning and training, accessibility of technology, compatibility and adaptability of technology, adequacy of change management, communication challenges, experience with technology, technology-related anxiety,* and *technology design considerations.*

Interestingly, there are differences between the most identified factors between the first and second phases of the study. The *most mentioned factors in the study's first phase are the ease of use and technology complexity, training and education, technology design considerations, technology benefits and usefulness, and function availability*. *Workload impact*, *ease of use and technology complexity*, *reliability of technology*, *training and education,* and *technology benefits and usefulness* are the most mentioned factors in the second phase. Surprisingly, *technology design considerations* were among the top five factors in the first phase but was rarely considered important in the second phase. Conversely, *workload impact* got greater attention and rank in the Delphi study's second phase than in the first phase (Appendix 6).

4.3.4. Ranking (Phase 3)

Following the second stage of the Delphi survey, I combined the nurses' responses. Analyzing those responses allowed me to have a consolidated final list of factors that affect the adoption of health information technology by nurses in long-term and elderly care. Moreover, characteristic demographic questions were designed with multiple-choice answers. The final page of the survey thanked participants and included some additional information.

The identified factors from phase two, narrowing down, were listed randomly to panellists in the first ranking round. The consensus level was fair on the first attempt (Kendall W; 0.24). I repeated the ranking phase to increase the consensus average score level by putting the adoption factors in order based on their earned average ranking in the first round of ranking (Paré, et al., 2008), resulting in a moderate Kendall W value (Kendall W; 0.41). The identified factors followed almost the same pattern within the second phase (i.e., narrowing down) and two rounds of the third phase (i.e., ranking). *Workload impact*, *ease of use*, *and technology complexity* are these phases' main adoption factors. Interestingly, the *reliability of technology*, which was highly mentioned in the first phase, lost attention among the LTC participants. In contrast, *healthcare quality* came among the five most important factors in the second round of the ranking phase (Appendix 6) (Figure 6; summary of Delphi study's different phases).

Phase 1 – Brainstorming
- Twenty-four participants (out of 25 LTC nurses) completed this phase - 5-10 HIT adoption factors solicited from LTC nurses - LTC nurses identified a total of 178 responses regarding HIT adoption factors - After deleting duplicates and merging comparable concerns, the final combined list of 21 distinct HIT adoption factors was created
Phase 2 – Narrowing Down
- Twenty-two responses were collected in this phase of the study - Panellists assigned 1-7 Likert numbers to each HIT adoption factor - Two missing inputs from panellists were filled by median - HIT adoption factors with a median equal to and above 5 (On a 1-7 Likert scale) (70%) were retained - 18 distinct HIT adoption factors remained to the next phase of the study
Phase 3 – Ranking
- Each panellist generated a prioritized ranked list of HIT adoption factors that were retained in their ideas - The results were presented to panellists, who were then asked to rank the HIT adoption factors again until they reached a consensus - Kendall's coefficient of concordance was used to calculate (W) Kendall's coefficient agreement level in the first round of ranking was 0.24, and in the second round was 0.41

Figure 6: Different phases of the Delphi study

4.3.4.1. Consensus Level Between Different Rounds of the Delphi study in the Ranking Phase

The prior studies used various techniques to measure consensus among different Delphi rounds. The chi-square test for independence, McNemar change test, and Wilcoxon matched-pairs signed-ranks test are among these tests (Table 13).

Table 13: Consensus measurement by inferential statistics

Measure of consensus	Criteria
Chi-square test for independence	Ludlow analyzed disagreement between subgroups of homogenous individuals using Chi-square testing (Ludlow, 1975).
McNemar change test	Weir et al., as well as Rayens and Hahn, quantified the degree of response change across Delphi rounds using the McNemar test (Rayens & Hahn, 2000; Weir, Hicken, Rappaport, & Nebeker, 2006).
Wilcoxon matched-pairs signed-ranks test	Wilcoxon signed-rank tests were used to determine the change in consensus between the second and third rounds (De Vet, Brug, Nooijer, Dijkstra, & De Vries, 2005).
Intra-class Correlation coefficient, kappa statistics	The intraclass correlation coefficient was used to determine the degree of consensus between participants in the first and second rounds (Ferri et al., 2005). Interclass correlation coefficients were used to determine general agreement on importance (5-point Likert scale) among panellists, while Cohen's kappa was used to determine within-question consensus (Weir, Hicken, Rappaport, & Nebeker, 2006). Brender et al. evaluated the consistency of replies (5-point rating scale) using the intraclass correlation coefficient (Brender, Ammenwerth, Nykänen, & Talmon, 2006). Molnar et al. employed the kappa statistic to determine the degree of agreement among experts graded on three-point scales. In the subsequent phase, questions with a kappa value of 0.74 or less were evaluated (Molnar et al., 1999).
Spearman's rank-order correlation coefficient	A Spearman rank correlation coefficient was used to determine the degree of agreement between Round 2 and Round 3 evaluations. A high correlation coefficient indicated a high degree of agreement (DeLeo, 2004). The correlation coefficient between the aggregated scores was somewhat negative. This indicated that an agreement was reached between rounds two and three (Clark & Wenig, 1999).
Kendall's W coefficient of concordance	Large and statistically significant W suggests that participants are judging the significance of issues using almost the same standards. Last round, a statistically significant W (W= 0.618) was calculated, and it was found to be statistically significant (Brancheau and Wetherbe, 1987). Concordance (W) in ranking-type Delphi surveys is measured using Kendall's coefficient of concordance (W): W= 0.1 (extremely little agreement) to W= 0.7 (very strong agreement) (Schmidt, Lyytinen, Keil, Cule, & 2001). According to Cooper et al., there were W= 0.65 and W= 0.34 in two subgroups of the sample (Cooper, Gallegos, & Granof, 1995). The study's final rankings produced a W of 0.54 at a p-value of 0.001 (Doke & Swanson, 1995).
t-statistics, F-tests	T-statistics were used by Hakim and Weinblatt (Hakim & Weinblatt, 1993) to see if there were significant differences in the means for each round. They decided to stop after round 2 because there were only small changes. They also used F-statistics to see if the variance or lack of consensus in one group was different from the variance or lack of consensus in another group. There were no significant differences in mean weights after the second Delphi round, which means there was a high level of consistency. Buck et al. used t-statistics to check for consistency between rounds of the Delphi (Buck, Gross, Hakim, & Weinblatt, 1993). F-tests were used by Ludlow to look at the disagreement between groups of people who were all the same (Ludlow, 1975). Weir et al. used paired-sample t-tests to look for changes in preferences between Delphi rounds 2 and 3. This way, they could see if there were any changes in preferences (Weir, Hicken, Rappaport, & Nebeker, 2006).

* **Gracht, 2012**

After completing both rounds of the ranking phase, to authenticate the decision of consensus, the Wilcoxon signed-rank test was executed on all survey items to compute the stability of experts' responses between the two rounds. After both rounds of the survey in the ranking phase, Wilcoxon's signed-rank test was measured on all factors to see how stable nurses' answers were between rounds. The null hypothesis (H0) was that there was a difference in participants' responses between the two rounds of the ranking phase, while the alternative

hypothesis (HA) was that there was no difference in respondents' responses between the two rounds of the ranking phase. Hence, when $p < 0.05$, the null hypothesis would be rejected, and there would be no difference between the Delphi in the ranking phase.

4.3.5. Correlation Analysis Among Adoption Factors

Pearson correlation analysis was used to evaluate data to determine the link between different adoption factors. The technology benefits and usefulness show a significant correlation within the workload. Nurses' who see the benefits and usefulness of technology also reported workload impact from technology usage. The technology can provide conveniently available information, save time, make work more straightforward and more efficient (e.g., integrating vital signs into documentation, enhancing the value of nurses' roles), and have good visual impacts on residents. By reducing duplication and repetitive tasks and increasing efficiency, technology helps to decrease effort.

On the other hand, technology-related anxiety and workload are negatively correlated. Technology-related anxiety, examples of concerns that people may have included the fear of being replaced by technology and worries about making mistakes in cultures with punitive consequences., influences LTC nurses' desire to try new things and impacts LTC nurses' technology adoption. Technology anxiety affects the nurses' workload, where nurses believe that using technology increases their workload. Privacy and security concerns negatively correlate with ease of use and technology complexity. Confidentiality or misuse of health information is a concern. Using the technology should be as simple as possible for nurses, with few steps and little effort required on their part, as well as being convenient and user-friendly.

Interestingly, the accessibility of technology, training, and education move against each

other. Technology should facilitate the collection and analysis of essential data when required and enhance the overall quality of care. Accessibility and availability of technology in the facility for all groups (e.g., computer for point-and-click care and program for medication administration/ documentation, cell phone to communicate with staff, call bell system, internet, Wi-Fi, iPad) and the required time for information to be available for interpretation are important considerations to bear in mind. Healthcare institutions often lack practical training in providing healthcare technologies, and HIT training is seldom offered to healthcare staff. Technology education classes and enough time to understand how to utilize the technology are critical when healthcare providers provide the system for nurses. Unfortunately, the quality of provided healthcare services gets impacted if the equipped technology is not compatible and adaptable. The adaptability of new technologies to the LTC environment (e.g., alignment with nursing workflow and team approach, consideration for the nature and condition of residents in LTC, and synchronization with the technology used at residents' homes), their integration with existing records, their compatibility with various devices (e.g., iPad, desktop, and phone), and the ability to share information directly and send orders to the pharmacy are all crucial factors to consider.

The technology design, as per nurses' requirements, increases the benefits and usefulness of technology. Long-term care technologies should consider the following factors: ease of technology cleaning, hearing and vision barriers, cognitively impaired residents and residents with physical disabilities, ability to take pictures (to document the healing process), language barriers, long battery life, portability and mobility to the bedside, and lightweight and compact technology size. In addition, the technology design considers nurses' communication

requirements and challenges. Despite nurses finding technology helpful, technology results in decreased communication among them: a lack of oral communication among nurses who like to talk orally rather than through technology, as well as communication barriers between the technology and the interprofessional team.

Interestingly, nurses' experience with technology and technology-related anxiety are significantly and positively correlated. Nurses who mentioned that experience with technology is a crucial adoption factor also said that technology-related anxiety is a vital adoption factor. Experience with technology reduces technology-related anxiety (Table 14) (Appendix 7).

Table 14: Correlation between different adoption factors

Technology benefits and, usefulness & workload impact	.451*
Technology-related anxiety & workload impact	-.459*
Privacy and security concerns & ease of use, and technology complexity	-.472*
Accessibility to technology & training, and education	-.665**
Compatibility and adaptability of technology & quality of healthcare	-.482*
Communication challenges & Technology benefits and usefulness	-.481*
Technology design considerations & Technology benefits and usefulness	.539*
Technology design considerations & Communication challenges	-.444*
Accessibility to technology & Limited time for learning	-.518*
Technology-related anxiety & compatibility and adaptability of technology	-.473*
Adequacy of change management & Compatibility and adaptability of technology	.490*
Experience with technology & Technology-related anxiety	.609**

*** Correlation is significant at the 0.05 level (2-tailed)**
**** Correlation is significant at the 0.01 level (2-tailed)**

4.3.6. Technology Adoption Factors into Different Dimensions

Previous studies categorized the identified factors into groups, layers, or dimensions. Paré et al. studied prioritizing risk factors that influence the success of clinical information system projects. They classified risk factors into different dimensions (Paré, Sicotte, Jaana, & Girouard, 2008). For example, the risk factors of poorly perceived system ease of use, poorly perceived system usefulness, and misalignment of system with local practices and processes are included under the usability dimension, and lack of support from upper management,

organizational instability, and lack of local personnel knowledgeable in HIT go under the organizational dimension (Paré et al., 2008). Huijg et al. studied factors influencing the adoption, implementation, and continuation of physical activity interventions in primary healthcare. They identified various factors related to innovation, socio-political context, organization, patient, individual adoption, and innovation strategy (Huijg, Crone, Verheijden, van der Zouwe, Middelkoop, & Gebhardt, 2013). Likewise, Han et al. conducted a study and identified factors influencing the adoption of health information standards in healthcare organizations. They searched and synthesized comprehensive frameworks and identified four main factors: technology, organization, environment, and inter-organizational relationships (Han et al., 2020). Relative advantage, complexity, compatibility, trialability, observability, switching cost, standards uncertainty, and common business process qualities were all considered in the technology dimension (Han et al., 2020). Organizational size, organizational culture, resistance to change, staff training, top management support, and organization preparedness were all part of the organizational dimension (Han et al., 2020). External pressure, external support, network externality, installed base, and information communication were all part of the environmental dimension (Han et al., 2020). Finally, inter-organizational connections include partner trust, dependency, relationship commitment, and partner power (Han et al., 2020). An interesting systematic review of patients' acceptance of consumer health information technology was conducted by Or and Karsh (2009). I used the same approach as that of Han et al. (2020) and Or and Karsh (2009). I categorized the identified adoption factors into *Technological*, *Organizational,* and *Individual* dimensions with human-technology interaction, process, task, benefits, functionality, and design layers (Table 15).

Table 15: The rank of HIT adoption factors among nurses

Dimension	Layer	Factors	Rank	Median/SD
Individual (Ave, 9.2)	*Human-technology interaction* ***(Ave, 9.2)***	Ease of use and technology complexity	2	3 (4.09)
		Training and Education	3	5 (4.52)
		Troubleshooting and technical support	7	9 (4.15)
		Privacy and security concerns	11	10 (4.92)
		Technology-related anxiety	15	15 (4.36)
		Experience with technology	17	15.5 (4.54)
Organizational (Ave, 8.5)	*Process* ***(Ave, 11)***	Quality of healthcare	4	6.5 (3.70)
		Communication challenges	8	9 (3.52)
		Funding availability	14	13 (5.74)
		Adequacy of change management	18	16 (2.31)
	Task ***(Ave, 5.5)***	Workload impact	1	2 (2.74)
		Limited time for learning	10	10 (4.89)
	Benefits ***(Ave, 5)***	Technology benefits and usefulness	5	6.5 (3.50)
Technology (Ave, 11.2)	*Functionality* ***(Ave, 10)***	Reliability of technology	6	7 (3.75)
		Data/information accuracy	9	9 (3.18)
		Accessibility of technology	12	10.5 (4.60)
		Compatibility and adaptability of technology	13	12.5 (4.04)
	Design ***(Ave, 16)***	Technology design considerations	16	15 (3.91)

4.3.6.1. Individual Dimension

Individuals are at the core of the adoption of any technology. In this study, the factors of ease of use and technology complexity (simplicity of the technology, convenience, user-friendliness, and ease of use for nurses, and minimal technical complexity, required steps, and effort to use the technology), troubleshooting and technical support, privacy and security concerns, technology-related anxiety, and experience with technology are included under the human-technology interaction adoption layer, which is part of the Individual dimension, since these items are mostly related to human and technology interaction as well as individuals' criteria and conditions. The individual factors mostly include variables related to image or emotion (Huang, Ullah, Zhou, Yi, & Zhao, 2019). Interestingly, the average ranking in the Individual dimension is lower than that of the Organizational dimension. This means that

Organizational dimension factors, on average, got a higher rank among the participants in terms of importance than individual factors, followed by technological factors.

4.3.6.2. Organizational Dimension

The decision to adopt or not adopt HIT among nurses is made at the organizational level. The adoption factors of quality of healthcare, communication challenges, and funding availability are part of the process layer. In contrast, workload impact, limited time for learning, and adequacy of change management are included in the task layer, and benefits are part of the Organizational dimension.

4.3.6.3. Technological Dimension

In studies on technology adoption, the design and functionality of technologies have been extensively investigated. In this study, the factors of reliability of technology, data/information accuracy, accessibility of technology, compatibility and adaptability of technology, and technology design considerations are under the functionality and design layers in the Technological dimension (Figure 7).

Future analytical studies can examine the magnitude and direction of the relationship between these factors and the adoption/use of different technologies in LTC.

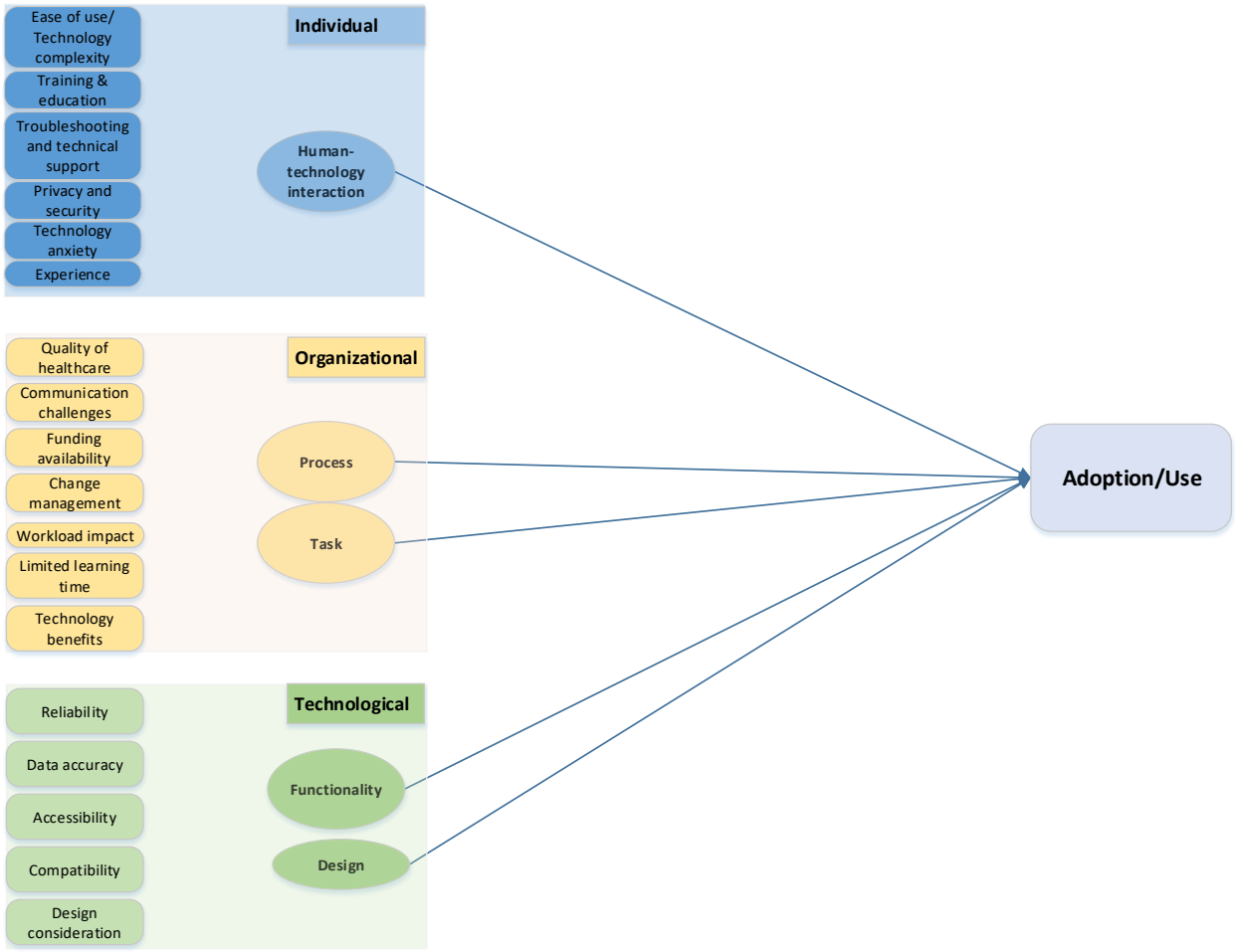

Figure 7: The adoption factors regarding LTC nurses' HIT adoption (Delphi)

4.4. Study Limitation

Each study has some limitations. Since this study was conducted online (SurveyMonkey), LTC nurses needed internet access to participate. So, nurses with limited internet access may not have been able to participate. Moreover, LTC participant nurses needed the knowledge and computer skills to participate in the survey. The Centre of Excellence in Frailty-Informed Care in the Perley and Rideau Veterans' Health Centre provided computer and internet facilities for nurses in case they were interested in participating in the study. Moreover, survey questions were designed based on basic computer use skills, and all

nurses familiar with computers should have been able to participate in the survey.

Although generalizability is not expected in this type of study, the fact that all nurses came from one LTC may have presented some bias in their perspectives, which may not necessarily represent other settings. However, the diverse characteristics of the panellists, such as different genders, age groups, years of experience, and used technologies, indicate variability among participants, who may have also had prior or current work experience in other LTC homes.

Participant attrition is a concern in any study, especially in the Delphi study, in which different phases are interconnected, and participants should participate in the different phases. In this study, four participants did not finish the study in all phases. Yet, the number of participants remained within the recommended range for Delphi panels, as a minimum of 12 respondents is generally considered sufficient to achieve consensus (Vogel et al., 2019). The consensus in the final phase of the study is moderate. Although consensus does not necessarily imply that the correct response, viewpoint, or judgment has been reached (it only identifies areas one set of participants or specialists deems crucial concerning that topic), further studies may conduct similar research and compare the level of consensus.

4.5. Study implications

4.5.1. Implication for theory

The identified factors are additional factors beyond the traditional UTAUT and TAM adoption models. These factors include *workload impact*, *training and education*, *quality of healthcare*, *reliability of technology*, *data/information accuracy*, *communication challenges*, *limited time for learning and training*, *privacy and security concerns*, *accessibility of technology*,

compatibility and adaptability of technology, *technology design considerations*, *adequacy of change management,* and *resistance from users* are additional factors which should be taken into consideration in future studies regarding LTC nurses HIT adoption. Moreover, technology adoption should be seen and investigated beyond individual or organizational factors. Other adoption factors within the *Organizational* and *Technological* dimensions should also be considered. This study collected and investigated these factors for future research on management of the LTC home care process and the work of nurses, managers' decisions to adopt and implement new technologies, resources allocated and assisting policymakers to see the adoption within different dimensions.

4.5.2. Implications for Practice

The adoption factors within the *Organizational* dimension are essential for LTC nurses. Among them, *workload impacts*, *quality of healthcare,* and *technology benefits* and *usefulness* are primary factors in this dimension. Policymakers and leadership teams should put further effort into the organization's readiness to deal with necessary changes concerning these factors. Moreover, adoption factors within individual dimensions, such as *ease of use and technology complexity* and *training and education*, are among the Individual dimension factors with the highest rank. Organizations should provide training and education and ensure that the technologies are easy to use and avoid too many complications.

The workload demonstrates a high association between the benefits of technology and usefulness. Nurses aware of the merits and applications of technology have noted an influence on their workload as a direct result of technology use. Health information technology has significantly transformed healthcare by making information accessible, reducing time, and

increasing efficiency. It has visible positive effects on patients and residents and helps reduce the required effort by eliminating repetitive work and boosting productivity. Technology has become an essential tool for modern healthcare organizations, allowing them to streamline processes and improve patient outcomes. It is crucial for healthcare organizations to stay up to date with the latest technological advancements and to integrate them into their operations.

Technology can make information easily accessible, reduce time, make work easy to use and more effective (e.g., integrating vital signs into paperwork and increasing the value of nurses' tasks), and have positive visible visual effects on patients and residents. Technology helps to reduce the amount of effort required since it eliminates redundant and repetitive work while simultaneously boosting productivity. Technology can be utilized in many ways to reduce the time spent on repetitive tasks, increase productivity, and lower the required work. LTC nurses’ propensity to attempt new things is influenced by many factors, including anxiety associated with technology, the fear of being replaced by technology, and the concern about making errors in environments with punishing cultures. The organization should provide facilities for LTC nurses to try new technologies and ideas without fearing consequences in case of failure. In addition, the organization should work closely with LTC nurses to show the benefits of Health information technology in their setting and ensure that technology should and will not replace them. Since nurses' workloads are affected by technology anxiety, the organization should provide some extra time for them with adequate training to ensure they will learn and use technology.

Technology usage should be made as easy as possible for the nurses, with as few steps and as little work necessary on their side as possible. Additionally, the technology should be

user-friendly and convenient. On the other hand, there is a concern about the abuse or breach of confidentiality of health information. It is interesting to note that the availability of technology, training and education advance in directions counter to one another. Important factors to keep in mind include the accessibility and availability of technology in the facility for all groups (for example, a computer for point-and-click care and a program for medication administration/documentation, a cell phone to communicate with staff, a call bell system, internet, Wi-Fi, and an iPad), as well as the required amount of time for information to be available for interpretation. The provision of practical training in healthcare technology is frequently lacking in healthcare institutions, and IT training is rarely made available to healthcare professionals. When the healthcare providers supply the system for the nurses to use, the nurses need to have access to technology education sessions and sufficient time to comprehend technology entirely.

This research shows that adopting HIT in the LTC industry has demonstrated that organizational factors play a crucial role in determining whether LTC nurses are willing and able to adopt them. These factors can range from the organization's culture and leadership style to the resources available and support for HIT adoption. The finding that organizational factors are the most influential in determining adoption is important because it highlights the relevance of the environment in which nurses work when implementing new practices and the role that LTC homes may play in facilitating the successful adoption of new technologies. Given the unique challenges and complexities of the LTC industry, nurses may struggle to adopt HIT independently. Therefore, organizations must take a proactive approach to support their nurses in the adoption process by providing additional training and support, creating a culture that

values innovation and continuous improvement, and investing in resources that make it easier for nurses to adopt new practices, among others. By doing so, organizations can improve the quality of care provided to patients and ensure that their nurses remain up to date with the latest developments in the field. In conclusion, HIT adoption in LTC requires collaboration between nurses and organizations. By recognizing and addressing the organizational factors that impact adoption, organizations can help their nurses succeed in implementing new practices that lead to better outcomes for both older adults and healthcare providers.

Unfortunately, the quality of healthcare services can suffer if the technology is incompatible with and not adaptive to new systems. The ability of new technologies to be adapted to the environment of LTC (for example, alignment with the nursing workflow and team approach, consideration for the nature and condition of residents in LTC, and synchronization with the technology used at residents' homes), their integration with existing records, their compatibility with various devices (for example, iPad, desktop, and phone), and their capacity to share information directly and send orders to the pharmacy are all crucial aspects. Technology should be designed to make the gathering and analysis of vital data easier whenever necessary, and it should also be used to improve the overall quality of medical care. Technology can make information easily accessible, reduce time, make work more straightforward and more effective (for example, by integrating vital signs into paperwork and adding value to the position of nurses), and positively influence residents that the care team can observe. Even though nurses believe technology to be helpful, it makes communication among them more difficult. Technology design that considers nurses' needs enhances the technology's benefits and usefulness. Long-term care technologies should take into account the

following factors: the simplicity of cleaning the technology, the presence of hearing and vision barriers, the presence of residents with cognitive impairments and residents with physical disabilities, the ability to take pictures (to document the healing process), the presence of language barriers, a lengthy battery life, portability and mobility to the bedside, and lightweight and compact size for the technology. In addition, the technology design should consider the requirements and difficulties of communication nurses face. The findings from the Delphi study indicate a high level of alignment with the development of the literature review. The results demonstrate an overlap between the identified factors in both studies, as presented in Table 16. For example, performance expectancy, quality improvement, and design considerations were reported as relevant factors affecting the adoption of HIT by both LTC nurses and older adults in the community.

Moreover, the Delphi study uncovered two additional factors, "technology-related anxiety" and "workload impact," not identified in the literature review. These novel factors highlight the importance of considering broader perspectives and including input from subject matter experts to ensure comprehensive coverage of the research domain. Identifying two additional factors in the Delphi study highlights the value of considering multiple sources and perspectives in research and underscores the need to consider broader implications of technology adoption beyond its technical aspects. Identifying "technology-related anxiety" in the Delphi study aligns with recent developments in technology adoption and usage, which have emphasized the need to consider technology's psychological and emotional impact on individuals. This factor underscores the importance of understanding how technology can induce user anxiety and how that technology can be managed to improve technology

acceptance and adoption. Similarly, identifying "workload impact" as an additional factor highlights the importance of considering the practical implications of technology adoption, such as changes in job roles, responsibilities, and workload. This factor is particularly relevant for organizations implementing new technologies, as it can impact employees' productivity and job satisfaction. In conclusion, aligning the Delphi study's findings with the literature review's development supports the research's validity and reliability. Technology's workload, benefits, and usefulness are primary factors in the organizational dimension, while ease of use, technology complexity, and training and education are among the highest-ranked factors in the individual dimension. Factors like workload, training and education, quality of healthcare, reliability of technology, data/information accuracy, communication challenges, limited time for learning and training, privacy and security concerns, accessibility of technology, compatibility and adaptability of technology, technology design considerations, adequacy of change management, and resistance from users should be considered. Technology adoption should also be investigated beyond technological factors. Organizations should provide training and education and ensure that technologies are easy to use. The abuse or breach of confidentiality of health information, incompatibility with new systems, and communication challenges among nurses are also factors to consider. Designing HIT to assess nurses' needs enhances the technology's benefits and usefulness. Long-term care technologies should consider factors like simplicity of cleaning the technology, hearing and vision barriers, cognitive and physical impairments, language barriers, battery life, portability, and compact size.

Table 16: A comparison between adoption factors within LR and Delphi study

Dimensions	Layer	Factors (LR)	Factors (Delphi)
Individual	Human-technology interaction	Self-confidence	
		Ease of use (system Complexity)	Ease of use and technology complexity
		Usefulness	Technology benefits and usefulness
		Knowledge and experience with technology	Experience with technology
		Privacy & security	Privacy and security concerns
		Learning and training	Training and Education
			Technology-related anxiety
	Social influence	Culture	
		Developing competence	
		Ethical concerns	
		Motivation	
		Project champions	
		Environmental influence	
		Leadership support	
	Burnout	Burnout	
Organizational	Process	Cost and price value	Funding availability
		Policy and regulation	
		Facilitating condition	Troubleshooting and technical support
		Quality improvement	Quality of healthcare
		Organizational perspective	
			Communication challenges
			Adequacy of change management
	Task	Practice change	
		Time constraints	Limited time for learning
		Users' engagement	
			Workload impact
	Benefits	Improved communication	
Technological	Functionality	Technology compatibility	Compatibility and adaptability of technology
		Technology accessibilities	Accessibility of technology
		Technology reliability	Reliability of technology
			Data/information accuracy
	Design	System design as per user requirements	Technology design considerations

5. Long-term Care Nurses and Digital Health Technologies Adoption/Use

In this chapter, I will first present an overview of the literature on the impacts of HIT adoption and use by LTC nurses. Next, I will provide an overview of the unique challenges that LTC nurses face in using HIT, including issues related to documentation, data access, healthcare system notifications, supporting tools, communication, policy and regulations, consultation, training, and design requirements. Then, I will discuss the impacts of these challenges on LTC nurses regarding patient care outcomes and organizational performance. Finally, I will propose different ways to address these challenges and facilitate the adoption and use of HIT in LTC settings. The chapter concludes with recommendations for policymakers and LTC organizations' leadership to facilitate HIT adoption and usage and reduce barriers to its impact on LTC nurses.

5.1. Older Adults and Long-term Care Nurses

The age distribution of people in industrialized nations is shifting toward older adult groups due to rising longevity and falling fertility rates (Anderson & Hussey, 2000). This demographic shift affects more industrial countries such as Australia, Canada, France, Germany, Japan, New Zealand, the United Kingdom, and the United States (Anderson & Hussey, 2000). The demographics of Canada are undergoing a significant change. The proportion of older adults in Canada will increase from one in seven in 2012 to one in four by 2030 (Government of Canada, 2022). Chronic illnesses and disorders may hinder older adults' everyday activities, diminish their quality of life, and raise the risk of death (Government of Canada, 2022). Long-term care facilities are appropriate for older adults' healthcare services (Kaye, Harrington, & LaPlante, 2010). Healthcare professionals, especially nurses, are crucial in providing older adults with health services in LTC (Fisher, 1998; Grundberg, Hansson, Hillerås, & Religa, 2016). Nurses

are key healthcare professionals who provide healthcare services to older adults in long-term communities (Davis, Marino, & Davis, 2007). “Nurses have knowledge and experience; they know what decision-making is about. If nurses mobilize—change could happen overnight” (Marion Dewar, CM; former mayor of Ottawa and former public health nurse). As nurses make up a significant workforce and are at the forefront of patient care delivery, they are ideally positioned to profit from incorporating digital health technologies into clinical practice (Beauséjour & Hagens, 2022). Nurses relate to improvements in numerous metrics of older individuals' health conditions and behaviours in LTC facilities and family satisfaction (Donald et al., 2013).

LTC nurses' technology adoption/use is critical to healthcare system transformation. The adoption and use terms have been used interchangeably in studies. Moreover, scholars have used the number of uses as an indicator for adoption. For example, Chen et al. relied on telehealth adoption and the number of times a telehealth technology was used (Chen, Amaize, & Barath, 2021). In this research, the adoption and use of the term were used interchangeably to refer to the same concept, so I use the term adoption/use in this study.

5.1.1. Healthcare technologies in older adults’ care

Health information technology is a broad category of healthcare technologies, including EMR and virtual care (Bergier, Duron, Sordet, Kawka, Schlencker, Chasset, & Arnaud, 2021). HIT improve patient care by storing, managing, and exchanging data electronically. Many Health information technology, such as EMR and virtual care, have been used to meet older adults' healthcare needs (Ludwick & Doucette, 2009). Health information technology assist nurses in providing care to older adults (Samal, Dykes, Greenberg, Hasan, Venkatesh, Volk, & Bates,

2016). Despite these technologies helping nurses provide healthcare services to older adults, they are underused in their care and LTC (Gallant et al., 2022). Some jurisdictions in Canada have already started to evaluate and utilize digital health technology in LTC. For example, telehomecare services used in New Brunswick, EMPcare@home, have guided and assessed patients with congestive heart failure and chronic obstructive pulmonary illness.

More than 40% of nursing care facility residents in Canada were in Ontario (StatCanada, 2019). Health information technology' adoption/use has benefits, such as easing communication between healthcare professionals, enhancing medication safety, monitoring, and reporting (Willems, Rao, Bhambere, Patel, Biggins, & Guite, 2021; Sonoda, Takedai, & Salter, 2022). In Canada, the prior studies are minimal and mainly focused on in-patient settings such as clinicians and hospitals (Robinson, 2007) or public healthcare facilities (Ifinedo, 2018). Many scholars suggested additional research into this area (Bezboruah, Paulson, & Smith, 2014; Vest, Jung, Wiley, Kooreman, Pettit, & Unruh, 2019).

5.2. Theoretical Model and Hypothesis

Grounded in the information system (IS) success model, the intention to use a design or technology affects user satisfaction and net system benefits (DeLone & McLean, 2003). DeLone and McLean (2003) developed a model to evaluate the impacts of technology adoption and use on user satisfaction and net system benefits. Among the outcomes they proposed, benefits (e.g., efficiency improvements) and additional factors, including burnout and quality improvement, were investigated in this research.

I included burnout as part of the Individual dimension, net benefits (e.g., efficiency improvements), and quality improvement under the Organizational dimension. Prior studies

mentioned the impact of digital health technologies adoption/use, burnout, and quality of healthcare service (Gardner, Cooper, Haskell, Harris, Poplau, Kroth, & Linzer, & 2019; Tsai, Eghdam, Davoody, Wright, Flowerday, & Koch, 2020; Baxter, Apathy, Cross, Sinsky, & Hribar, 2021) and nursing practice (Jedwab, Manias, Hutchinson, Dobroff, & Redley, 2022). Gardner et al. tried to quantify the impact of health information technology adoption/use on burnout. Overall, 26% of participating physicians mentioned a sign of burnout; among this group, 70% reported health information technology-related stress (Gardner et al., 2019). Similarly, Melnick et al., 2021 investigated the association between perceived electronic health record usability and professional burnout among US nurses. Using a defined criterion for evaluating the usability of technology, nurses ranked the usability of their present EHR in the low marginal range of acceptable levels. The ease of using EMR was shown to have a significant association with the risk of burnout, and this association was found to have a dose-response connection (Melnick et al., 2021).

The focus of global efforts to improve healthcare quality and safety is centred around deploying and expanding HIT. As a significant percentage of the healthcare workforce, nurses' views toward health information technology may affect EHR deployment (Huryk, 2010). Bowles et al., 2012 mentioned that nurses who used HIT improved their provided healthcare quality and efficiency (Bowles, Parker, & Scott, 2012). The use of information technology (IT) is a critical component of nursing practice. Nurses' experiences and views on the advantages of integrating and using IT in healthcare settings are driving this adoption/use. Therefore, the experiences and perspectives of nurses about incorporating technology into healthcare help improve nurses' acceptance of technology. There are various benefits reported regarding HIT implementation.

For example, the enhancement of the quality and effectiveness of medical services and care; the facilitation of management of communication in a technological environment; the improvement of information documentation, management, and monitoring; the enhancement of resource management; the enhancement of management performance and policymaking; and the facilitation of organizational and professional growth pathways are all goals of this initiative (Farokhzadian, Khajouei, Hasman, & Ahmadian, 2020; Kernebeck et al., 2022).

The adoption/use of technologies in the context of LTC is hypothesized to influence the *Individual* (e.g., burnout) and *Organizational* (quality improvement and benefits) dimensions.

5.2.1. Individual Dimension

5.2.1.1. Burnout

The *Individual* dimension consists of the outcome of the LTC nurses' characteristics, such as *burnout* (mental, emotional, and physical exhaustion from intense stress). Although digital health technology offers numerous advantages, there is rising worry about its negative impact on nurses' burnout (Shah et al., 2021). Nursing is a profession connected with employee burnout, characterized by increased emotional tiredness, depersonalization, and declines in personal achievement (Rachel & Francesco, 2018). LTC nursing staff face tremendous professional stress and report high burnout levels. However, little is known about this population's association between HIT adoption/use and burnout (Rachel & Francesco, 2018). Rachel and Francesco, (2018) studied factors associated with and the impact of burnout in nursing and residential home-care workers for the elderly. They mentioned a correlation between working in nursing and experiencing burnout, characterized by increased mental and emotional exhaustion, depersonalization, and a diminished sense of accomplishment (Rachel &

Francesco, 2018). In a study of 1800 physicians using EHR in the US, 70% reported HIT-related stress, with the highest prevalence in primary care-oriented specialties (Gardner et al., 2019). Likewise, a recent study showed that electronic health records are associated with lower professional satisfaction, increased burnout, and raised the risk that a physician may curtail or abandon the clinical practice (Ehrenfeld & Wanderer, 2018). In contrast, one study reported that electronic health records improved quality and decreased burnout (Thomas Craig, Willis, Gruen, Rhee, & Jackson, 2021). Thus, I posit this hypothesis:

H1*: There is a negative relationship between adoption/use and burnout among LTC nurses*

5.2.2. Organizational Dimension

The *Organizational* dimension includes benefits perceived at the organizational level due to technology use (e.g., expedited robust clinical research processes) and healthcare quality improvements (e.g., quality of treatment and patient records).

5.2.2.1. Benefits

HIT presents an opportunity to address the challenges facing healthcare systems worldwide by optimizing healthcare efficiency, reducing costs, increasing productivity, and improving the quality of care (Bardhan & Thouin, 2013; Nguyen, Bellucci, & Nguyen, 2014; Khosravi & Ghapanchi, 2016; Shrank et al., 2019). HIT implementation in LTC settings has been extensively researched, but little is known about the benefits of HIT implementation in LTC settings (Hillestad et al., 2005; Yu et al., 2013). A "benefit" is defined as a "quantifiable and measurable improvement resulting from completion of deliverables that is perceived as positive by a stakeholder" (Association for Project Management, 2012). Canada Health Infoway established a

Benefits Evaluation Framework for digital health technology and recommended specific indicators for evaluating the benefits associated with new technologies (Canada Health Infoway, 2012), based on DeLone and McLean's information systems success model (Delone & McLean, 2003). The framework included dimensions related to service quality (system, information, and services), system usage (use and user satisfaction), and net benefits (care quality, access, and productivity) (Canada Health Infoway, 2012). Several potential benefits of digital health technology provided by a home care nursing agency have been noted, such as enhanced patient education, nurses having a better grasp on the patient's current state of health, and fewer home visits (Seto et al., 2019). Thus, I posit a hypothesis in the *benefits* layer:

H2*: There is a positive relationship between adoption/use and benefits, such as efficiency improvement among LTC nurses*

5.2.2.2. Quality Improvement

It has been argued that the prospect of improved quality and performance is the primary motivator for organizations to embrace HIT. For example, digital health technology systems have been found to enhance the quality of healthcare by boosting time efficiency (Bardhan & Thouin, 2013; Campanella et al., 2016), increasing adherence to best-practices guidelines (Chaudhry et al., 2006; Bardhan & Thouin, 2013; Campanella et al., 2016), facilitating patient monitoring (Chaudhry et al., 2006), and minimizing medication errors (Chaudhry et al., 2006; Campanella et al., 2016), the burden of redundant data capture, nursing documentation, and care quality and patient data.

It is only possible to get the benefits of healthcare technologies if nurses embrace and

aim to adopt/use them (Strudwick, 2015). Research investigating the benefits associated with technology use in LTC settings remains limited, and few studies likely reflect the impact of digital health technology interventions on healthcare quality. It has been suggested that digital health technology that combines computerized physician/provider order entry (CPOE) with clinical decision support (CDS) is an essential systems-based method for minimizing pharmaceutical mistakes and preventing drug-related injuries (Subramanian, Hoover, Gilman, Field, Mutter, & Gurwitz, 2007). On the other hand, Wang and Biedermann mentioned that the lack of proven benefits of EHR use is a barrier to EHR adoption and utilization (Wang & Biedermann, 2012). Menachemi, Chukmaitov, Saunders and Brooks conducted a digital health technology adoption/use study. They mentioned that by adopting more digital health technology applications, hospitals were significantly more likely to have favourable quality outcomes (Menachemi, Chukmaitov, Saunders, & Brooks, 2008). An exciting study by Plantier et al. on the adoption impact of the EMR on healthcare equality in France mentioned a significant positive impact of EHR use on healthcare quality (Plantier et al., 2017). Thus, I posit this hypothesis in the *Organizational* dimension:

H3: *There is a positive relationship between adoption/use and healthcare quality*

5.2.3. Demographic Factors

The literature on the role of demographic characteristics concerning the adoption/use of technology and the observed impacts is inconsistent (e.g., Kavandi & Jaana, 2020). Demographic factors have either a direct effect on HIT adoption by LTC nurses or a moderating effect on the relationship between HIT adoption and the impacts observed. Demographic factors (e.g., Age, Hours of work, Years of experience, Population and Gender) moderate the

relationship between adoption/use and Burnout, Benefits and quality of healthcare. Demographic factors such as age, gender, knowledge, and years of experience affect the relationship between digital health technology adoption/use and its impact on the Individual and Organizational dimensions. Some studies showed no effect of individual characteristics. For example, Dowding et al. mentioned neither age nor experience impacts HIT adoption among LTC nurses (Im & Chee, 2006; Dowding et al., 2014). Ibrahim et al. said that individual characteristics (i.e., age, level of education, and technology experience) were not found to have a direct and/or moderating influence on nurses' intention to use EDS in home-care practice (Ibrahim et al., 2019). On the other hand, Im and Chee mentioned that gender has an impact on the nurses' attitude toward HIT, where females adopt/use HIT more than males (Im & Chee, 2006).

5.2.4. Barriers

Several scholars have focused on the barriers preventing the adoption/use of digital health technologies among LTC nurses. Seto et al. (2019) found several challenges in adopting telemonitoring systems in home-care nursing and impediments to implementing HIT systems (Seto et al., 2019). These impediments included issues in nurses' communication, such as contacting patients and physicians, retention concerns, and difficulty integrating the telemonitoring system into a sophisticated home care nursing workflow. Similarly, Huryk (2010) noted that prior expertise with computers is the most critical factor in determining whether or not an individual would embrace digital health technology (Huryk, 2010). On the other hand, the most common obstacles in realizing the impact of the adoption/use of digital health technology in adopting and using HIT include unsuitable system design, sluggish system

performance, and system outages (Huryk, 2010). Moreover, incomplete hardware and software features, time-consuming ICT adoption, demanding or increasing workloads, the perception that ICT is not beneficial, cost or budget limits, concerns over security and privacy, and a lack of interaction are challenges which influence the relationship between adoption/use and the technologies' impacts (Perez, Neubauer, Marshall, Philip, Miguel-Cruz, & Liu, 2022). This survey includes access to electronic record/clinical information systems in the main care setting, available budget/costs associated with implementing electronic procedures, internal policies that do not support accessing electronic record/clinical information systems, and use of both paper charts and electronic records as identified barriers. Figure 8 presents the relationships between technology adoption/use and the outcomes measured from the perspective of LTC nurses, which will be investigated in this research. In the following sections, I will present the methodology used to assess the relationships shown in this framework to test the connection between adoption and its impact.

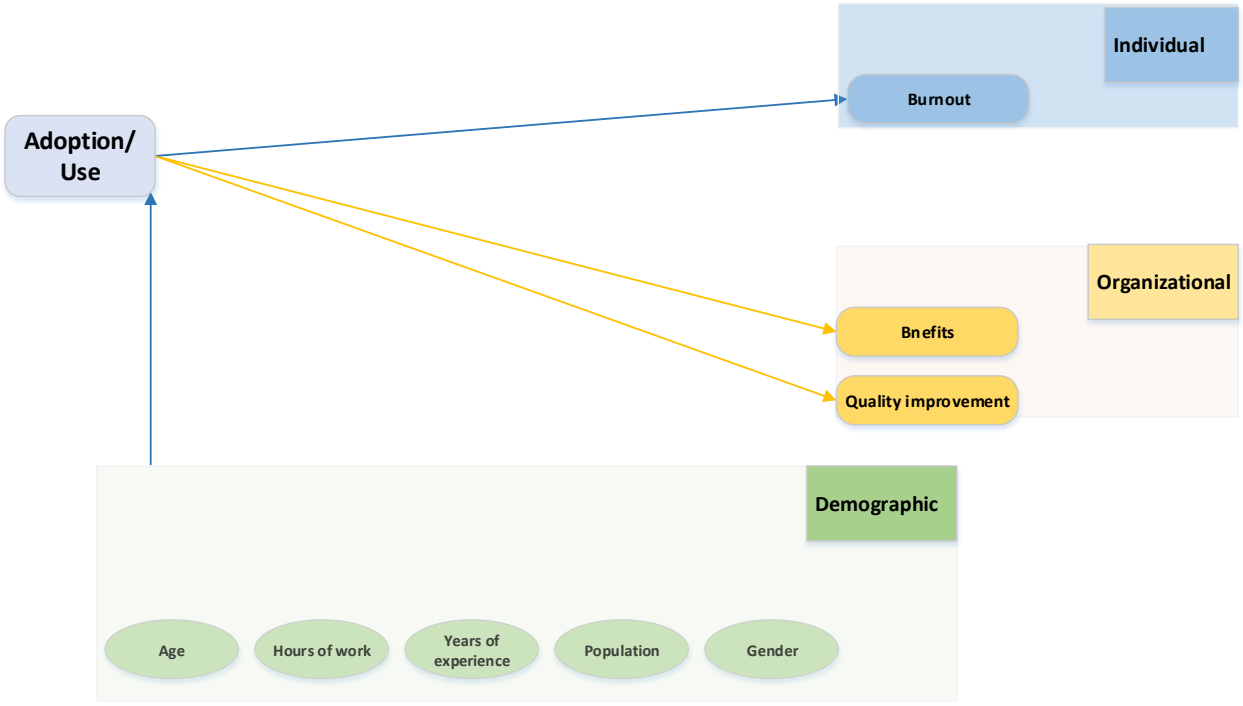

Figure 8: The impact of adoption

5.3. Methodology

5.3.1. Survey Overview and Data Management

A recent series of surveys were commissioned by Canada Health Infoway (CHI) in conjunction with the Canadian Nurses Association (CNA) and the Canadian Nursing Informatics Association (CNIA) on the use and effect of digital health technologies (electronic medical records and virtual care) on nursing practice. This research used secondary data from the CHI nurses survey (2020) to examine the relationships between digital health technology adoption/use and the outcomes described earlier. These surveys were implemented starting in 2014 and repeated every three years.

The recent 2020 CHI nurses' national survey on digital health technology used collected data from a sample of 1,642 Canadian nurses between January 20 and March 29, 2020, using an

online questionnaire. The national survey aimed to assess the professional characteristics of Canadian nurses who access virtual care, understand how these characteristics vary across different types of technologies and determine whether nurses who access virtual care possess the necessary skills and knowledge to use these technologies. The 2020 national survey also explored the impact of EMR systems on the quality of care and the use of EMR and virtual care in nursing practice.

5.3.2. Survey Design and Data Collection

5.3.2.1. Survey Design and Pilot Test

The survey data were collected from the CHI (Canadian health Infoway, 2020) website. The survey included 233 nominal, ordinal, and scale-type questions. These questions covered demographics, LTC nurses' work settings, quality improvements, burnout, the reason for use, privacy and security, satisfaction, technology accessibility, confidence, learning and training, technology design as per nurses' requirements, and barriers. The demographic questions were related to nurses' primary domain of practice, age, gender, and area of work. Barriers were mostly related to accessing electronic record/clinical information systems, available budget/costs associated with implementing electronic procedures, and not receiving applied training on electronic record/clinical information systems.

5.3.2.2. Data Collection

This study used secondary data analysis. Between January 20 and March 29, 2020, an online survey in French and English was sent to a national sample of Canadian nurses who are regulated nursing practitioners in various healthcare settings and practice areas by Infoway. A

week before the start of the study fieldwork, a pilot test of the online survey in both French and English was undertaken (Canada Health Infoway, 2020). This online pilot study was conducted using a convenience sample of nurses (less than twenty) recruited through the AQIISTI (’Association québécoise des infirmières et infirmiers en systèmes et technologies de l’information) and CNIA (Canadian Nursing Information Association) networks.

The nurses were contacted and recruited via four primary channels: the AQIISTI Infolettre, the CNA newsletter, the CNIA Newsblast, and Leger's online panel (CHI, 2020). In Quebec, the AQIISTI network and recruiting channels contained a contact list of 206 members, nursing directors, nursing education institutions (colleges and universities), and nursing organizations (CHI, 2020). Additionally, the invitation was extended by the national director of nursing to 36 directors of nursing (CHI, 2020). The CNA distributed the survey to its member jurisdictions and nursing specialty networks through e-newsletters and social media platforms (CHI, 2020). CNA distributed the 2020 poll through the following networks and channels: a) Canadian Nursing Specialty Network—a sizable network of 40,000 nurses; b) CNA nurses distributed the survey to their networks, which resulted in the survey reaching over 131 nurses; and c) the CNA newsletter, which was released in early February 2020, and the CNA CEO newsletter, which was disseminated via e-mail in February 2020 to all provincial and territorial nursing regulatory bodies and the national network (CHI, 2020). On February 7th, 2020, CNIA disseminated a request to take the survey through its monthly Newsblast to its CNIA distribution list (N=718) across Canada. On February 11th, an e-mail was sent to the same distribution list, requesting that respondents take the survey and share the request and information with their networks. CNIA asked that board members share the survey request with their networks during its

February 13th, 2020, executive board meeting (CHI, 2020). They selected 73 nurses from an online healthcare professional panel to boost regional representation, with the majority coming from Ontario, British Columbia, and Alberta.

Additionally, the association utilized Twitter to communicate identical survey requests to CNIA followers. Moreover, Leger used their internal resources, including direct e-mail invitations in English and French with a URL link to the live survey sent to members of the OIIQ (Ordre des infirmières et des infirmiers du Québec), 377 of whom responded. Using the e-mail approach, Leger reached out to nurses who had already completed the survey, which resulted in the recruitment of six more participants through the snowball technique (CHI, 2020).

Representatives of the Advarra Institutional Review Board (IRB), an independent ethics commission, assessed the survey's ethical issues to protect the rights and welfare of survey participants (CHI, 2020). The IRB approved the protocol and methods for the 2020 National survey of Canadian nurses in January 2020 (CHI, 2020).

5.3.2.3. Nurses within Different Regions

Nurses from different regions participated in this survey. The participant nurses were divided into direct and non-direct patient care within other regions (Table 17) (this information was collected from the Canada Infoway website and a report released by the 2020 national dataset).

Table 17: Number of participants in different regions

	ATL	QC	ON	MB/SK	AB	BC	Territories	Total
Direct Patient care	72	653	149	111	43	85	19	1,132
Non-Direct Patient care	53	224	74	33	35	80	11	510
Total	125	877	223	144	78	165	30	1,642

Note: An online survey was conducted among Canadian nurses, with 1,642 responses among French (n=839) and English (n=802) participants

5.3.2.4. Subset of Nurses in the LTC Setting

There is a lack of systematic planning and decision-making regarding health IT deployment among LTC nurses (McGlade, Daly, McCarthy, Cornally, Weathers, O'Caoimh, & Molloy, 2017) as well as a lack of knowledge about or consideration for the actual costs and advantages of adopting health IT (Bezboruah et al., 2014). Adoption/use is not evidence-based but rather driven mainly by actual and perceived legal obligations. In the same vein, Vest et al. mentioned that, compared to nurses in other settings, LTC nurses are slow to implement interoperable digital health technologies (i.e., technologies that allow the sharing and use of electronic patient information between different information systems) (Vest et al., 2019).

The adoption/use of digital health technologies varied between LTC nurses and nurses in other settings. These nurses are from different settings, including primary care/family medicine offices/clinics, specialists' offices/clinics located in the community, and community clinics/community health centres. Despite some similarities between nurses in different settings, prior studies mentioned differences in the level of digital health technology adoption by nursing home nurses compared to nurses in other settings (Bezboruah et al., 2014; Vest et al., 2020). Bezboruah et al. investigated the perspectives of nursing home administrators and key management personnel on digital health technologies (Bezboruah et al., 2014). They discovered some inconsistencies in the extent of health IT implementation by nursing facilities. While some administrators are aware of health IT and are gradually but haphazardly integrating or upgrading their IT systems, others have shown a lack of enthusiasm for implementing change (Bezboruah et al., 2014). This research aims to a) compare LTC nurses to those working in other settings regarding technology adoption/use and impacts and b) Examine the relationships

between technology adoption/use and specific outcomes (earlier mentioned hypotheses).

This study selected a subset of 166 long-term care nurses related to my thesis research scope for secondary data analysis (Table 18).

Table 18: Number of nurses who participated in the study within different work settings

Assigned numbers to items in the Dataset	Nurses work settings	Frequency (%)
1	Primary Care/Family Medicine office/clinic (including free-standing walk-in clinics)	110 (6.7%)
3	Specialists' office/clinic located in the community (not hospital-affiliated)	34 (2.1%)
4	Community clinic/Community health centre	82 (5%)
5	Nursing home/ Long term care facility / Older adults' residence/Homecare	166 (10.1%)
6	Public Health Clinic	49 (3%)
8	Free-standing lab/diagnostic clinic	12 (0.7%)
9	Hospice care	16 (1%)
10	Community Hospital	421 (25.6%)
11	Academic health sciences centre (AHSC)	287 (17.5%)
12	Non-AHSC teaching hospital	116 (7.1%)
13	Complex Continuing Care/Rehabilitation Hospital	41 (2.5%)
14	Government – Provincial/Territorial or Regional (e.g., Ministry of Health, Health Region/LHIN, Health governance agency	76 (4.6%)
15	Government – Federal (e.g., Correctional Services, Federal ministries, First Nations/Aboriginal Health)/Canadian Military|	14 (0.9%)
17	University or College	62 (3.8%)
18	Private Industry	33 (2%)
95	Other (Please specify):	60 (3.6%)
96	Other (Please specify):	63 (3.8%)
	Total	1,642 (100%)

5.3.2.5. Survey Characteristics

This survey collected data that cover different categories: a) the current state of Health information technology (e.g., EMR and virtual care) adoption/use, b) the state of virtual care technologies adoption/use by nurses in Canada across clinical practice settings, c) attitudes and perceptions related to access and the impact of the use of digital health technologies in practice and the impact of digital health technologies on the quality of care, d) benefits and impacts of digital health technology adoption/use and, e) barriers preventing nurses from getting total value from digital health technologies.

Before further analysis, I managed data to ensure that the data were ready for research,

as explained in the Data Preparation section below.

5.3.2.6. Survey Sections and Constructs/Variables

There are 232 variables/questions included in this dataset. These variables were grouped within their different factors (e.g., demographics, burnout, security concerns, and quality of healthcare) and layers (e.g., satisfaction, burnout, confidence, knowledge, skills, benefits, quality improvements, and security concerns) within the *Individual*, *Organizational* and *Technological* dimensions.

The *Individual* dimension includes demographics, satisfaction (e.g., desires, expectations, or needs met), and burnout (e.g., results from unmanaged persistent working stress). The *Organizational* dimension includes healthcare quality (e.g., healthcare quality and patient data), training and education (e.g., sufficient training is not always accessible), communication challenges (e.g., low communication among nurses), funding availabilities (e.g., long-term care has limited resources), and workload (e.g., technology should reduce duplication, increase efficiency, and reduce labour).

Lastly, the *Technological* dimension includes technology design and functionality. Technology design (e.g., current system and equipment are sufficient for their needs) and functionality includes *technology accessibility* (e.g., technology availability and accessibility at the institution for all groups (e.g., computer for point-and-click care and cell phone to communicate with staff) and *compatibility and adaptability* (e.g., new technologies' flexibility to the LTC setting, integration with current records, and compatibility with various equipment are vital).

5.4. Challenges of working with secondary data and Data Preparation

The research methodology in this section relies on secondary data already collected by Canada Infoway. Although there are many upsides to working with secondary data (e.g., saving money, time, and effort), there are also some challenges. Managing data quality is one of the most difficult aspects of working with secondary data. Evaluating secondary data's accuracy, dependability, and completeness is critical. Before secondary data can be analyzed, it must undergo extensive cleaning, processing, and manipulation.

Conversely, secondary data is frequently collected for a different purpose and may not have undergone the same stringent quality control measures as primary data. As a result, researchers must exercise caution when interpreting and applying data to ensure that it serves the intended purpose. Moreover, secondary data may not always be tailored to the specific research question or context and may not provide the depth of information needed for the research. It may also be outdated or incomplete, mainly if not updated or maintained. Several difficulties in working with the 2020 national survey must be resolved. First, the dataset contains a sizable number of missing values, which can significantly impact the data quality and affect the validity of any inferences made from the analysis. Secondly, the survey contained various concepts and questions rather than focusing on a single subject. It can be challenging to pinpoint precisely the information gathered from participants using this method. Furthermore, the survey's few questions on each topic could make it hard to perform sophisticated statistical analysis. To avoid compromising the data's quality and reliability, it is imperative to carefully consider these issues when working with the 2020 national survey. Considering these problems can enable more thorough and insightful analysis, producing more accurate results and insights.

Following the guidance of experts in the field (Cowan, 1998; Cobb, 1999; Meloun & Militký, 2011; Mihaylova, Briggs, O'Hagan, & Thompson, 2011), I employed a methodology that tackled missing data, disengaged responses, normality, outliers, linearity, homoscedasticity, and multicollinearity. In the upcoming sections, each of these steps will be elucidated in detail.

5.4.1. Outliers Test

The values that differed considerably from the average are identified as outliers using a boxplot. Outliers are values in a dataset that stand out because they are significantly higher or lower than the rest of the values in the dataset (Ben-Gal, 2005; Walfish, 2006; Rousseeuw & Hubert, 2011; Kline, 2015). When the sample size is very large, there is a potential to remove more outliers. However, the selected sample is relatively small, and there should be more stringent deletion records. Again, there is a trade-off since outliers impact small datasets more than big ones. Finally, outliers do not exist in Likert scales. Answering at the extreme (1 or 5) does not represent outlier behaviour. Outliers are divided into two primary categories: univariate and multivariate (Hair, Ortinau, & Harrison, 2010; Kline, 2015). In contrast to univariate outliers, which relate to extreme values on a single variable, multivariate outliers refer to values that are either exceptionally high or exceptionally low on two or more variables (Hair et al., 2010; Kline, 2015). In the current research, both forms of outliers were analyzed and considered. Outliers were investigated for continuous variables, whereas several variables/questions do not have a range of replies in their questions (e.g., Q39r1: on average, how many prescriptions do you generate daily?). Although some data points are beyond and below lower and upper points, there is no reason for me to accept these data points as outliers. The present investigation identified univariate outliers using z-scores and boxplots, as advised

by scholars (Hair et al., 2010; Aguinis, Gottfredson, & Joo, 2013; Kline, 2015). Various rules of thumb were used to determine which z-scores should be labelled outliers. Overall, |Z| more than 3.29 denotes an anomaly. According to Hair et al., sample size determines the cut-off point of standard values (z-scores) (Hair et al., 2010). If the sample size is smaller than 80, the appropriate cut-off value is 2.5 or higher (Hair et al., 2010). For sample sizes greater than 80, the cut-off is 4 (Hair et al., 2010). As the sample size in this research exceeds 80, the threshold of four indicates the existence of an outlier. In addition, the multivariate outliers were calculated based on the Mahalanobis distance. Multiple outliers were identified using the Mahalanobis distance (D2) test, which divides the distance (i.e., the number of variables) by the degree of freedom (D2/df) (Hair et al., 2010; Kline, 2015; Byrne, 2016). Generally, a case is considered an outlier if its significance level is less than or equal to 0.001 (Ghasemi & Zahediasl, 2012; Mishra, Pandey, Singh, Gupta, Sahu, & Keshri, 2019). Three variables (Q9, Q3Mc2, Q3Yc1) are samples for outliers analysis:

Question 9: On average, how many hours do you work per week in your MAIN work setting?

There are three respondents with 75 hours in their main work settings. Although this number seems too high, there is no evidence that these respondents are outliers.

Question Q3Mc2: Months - How many months have you been a nurse?

There are no outliers concerning the number of months within the nursing practice.

Question Q3Yc1: Years - How many years have you been a nurse?

A participant with 75 years of experience in nursing practice identified herself in category 5 of the age group “55–64yrs”. So, it does not make sense that she has 75 years of nursing experience between 55–64yrs. This response was replaced with the mean of the other

respondents (15 years). Please see Figure 9 for the revised boxplot analysis.

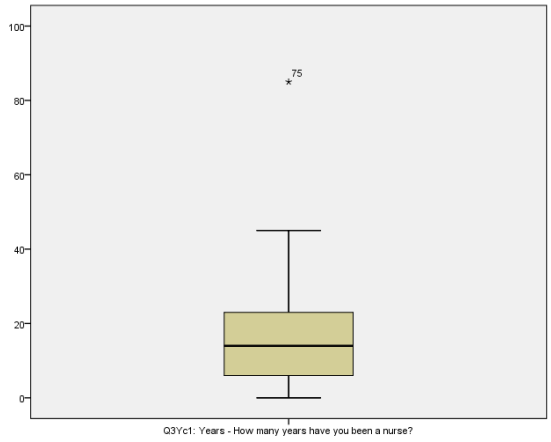

Figure 9: Boxplot for the number of years working as a nurse

5.4.2. Normality Test

The assumption of parametric tests is normality. The normality test applies to a subset of variables, as many others were designed as categorical or ordinal. The parametric tests use average, variance, standard deviation, T-test, variance analysis, Pearson correlation, and covariance. On the other hand, non-parametric tests are used when dealing with data for which there is no assumption on the data distribution (the non-parametric tests are mean, Spearman correlation, Wilcoxon, Mann-Wilcoxon, Kruskal-Wallis, and Friedman).

The residuals are the error terms or the discrepancies between the observed and predicted values of the dependent variable. For appropriate regression results, residuals must be normally distributed. Determining whether the residuals are normally distributed may be done by examining an average predicted probability (P-P) plot. The normality is a test to confirm that data are mainly distributed around the mean. Overall, skewness and kurtosis are acceptable tests for normality.

The Kolmogorov-Smirnov and Shapiro-Wilk tests were conducted to test the normality of the dataset. If the significant value of the Shapiro-Wilk test is more than 0.05, then the data point is normal. If it is below 0.05, the data point significantly deviates from a normal distribution. Normality is one of the critical assumptions of inferential analysis (Hair et al., 2010; Schumacker & Lomax, 2010). Normality includes univariate and multivariate tests (Hair et al., 2010; Byrne, 2016). While univariate normality is concerned with the distribution of each variable, multivariate normality is concerned with the distribution of any two variables' combined influence (Hair et al., 2010; Kline, 2015). The concept of normality is evaluated using a variety of metrics, including skewness and kurtosis (flat/peaked). Skewness is a measure of symmetry, or more accurately, its absence. A distribution or data set is symmetric if the appearance of the left and right sides of the central point is the same. Kurtosis indicates whether the data have heavy or light tails compared to a normal distribution. I implemented a normality test for selected variables within skewness and kurtosis (Table 19).

Table 19: Skewness and kurtosis tests

Questions/ variables	N	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	*Statistic*	*Statistic*	*Statistic*	*Statistic*	*Std. Error*	*Statistic*	*Std. Error*
Q9	162	35.3433	10.14166	102.853	0.915	0.191	3.109	0.379
Q3Mc2	162	4.296	3.5437	12.558	0.174	0.191	-1.365	0.379
Q3Yc1	162	15.568	11.3279	128.321	0.687	0.191	-0.360	0.379

On the other hand, some scholars mentioned that conducting normality (skewness and kurtosis) is not meaningful, and they suggested alternative options for non-parametric variables (Kruskal-Wallis test).

5.4.3. Homoscedasticity Test

They were testing whether the residuals are homoscedastic means identifying whether

they tend to cluster at specific values and spread out widely elsewhere. Equal variance or homogeneity of variances may be used in t-tests and ANOVAs to describe the same notion. The data is homoscedastic if it resembles a shotgun discharge of random data. Heteroscedasticity is the polar opposite of homoscedasticity, characterized by data with a cone or fan form. A scatterplot is the best way to test this assumption. Homoscedasticity implies that various groups or levels of an independent variable explain similar amounts of the variance of a dependent variable (Osborne & Waters, 2002; Hair et al., 2010; Kline, 2015; Meuleman, Loosveldt & Emonds, 2015). The error variance is found by adding the sums of squares inside each group. If the conflicts in the two groups are not the same, then adding them together is unsuitable and will not result in an estimate of the variance shared across different groups. Although Gaskin (2013) advises that researchers should not check for homoscedasticity when models contain moderators as heteroscedasticity is expected, I checked the homoscedasticity within the model. However, since the included variables are mostly nominal, the homoscedasticity test does not show any pattern or helpful information, so they were not included in the homoscedasticity result in this study.

5.4.4. Linearity Test

The term "linearity" refers to a regression model's linear connection between the predictors and the outcomes. There is no concern with linearity if our residuals are normally distributed and homoscedastic. Researchers often undertake linear regression analysis to examine their data's linearity. Two variables, "x" and "y," are linear if they are connected by the equation "y = cx," where "c" is any constant number (Schumacker & Lomax, 2010; Terziev & Petkova-Georgieva, 2019). The significance of testing for linearity stems from the fact that

many statistical approaches assume that data are linear (i.e., the data were sampled from a population that relates the variables of interest in a linear fashion). This necessitates the performance of linearity checks before using conventional techniques such as linear regression (otherwise, the linear regression results cannot be accepted). Any multivariate correlation analysis relies on the assumption of linearity (Hair et al., 2010; Hejazi, Badri, & Yang, 2019; Sauzet, Razum, Widera, & Brzoska, 2019). There are several methods for testing linearity, but the most widely used are scatterplot graphs (Weisberg, 2005; Hair & colleagues, 2010). The linearity test applies correlation and linear regression analysis. The linearity analysis is critical, especially for multiple regression analysis. The linearity is tested to analyze whether the correlation between variables is linear. So, to test this assumption of linearity, I examined the bivariate correlation for each pair of variables to ensure that I did not capture and record any non-linear correlation.

5.4.5. Dealing with Missing Values

Various tools and techniques are available for missing data (series mean, mean of near points, the median of close points, linear interpolation, and linear trend at the moment). Due to the high amount of missing data in this dataset, different techniques listed above were used and applied. The first approach applied the mean and median; however, it reduced the variance of variables and made them useless in the model for further analysis. To ensure that missing data are handled appropriately, there are some steps to be followed: first, take any necessary steps to complete or reduce the amount of missing data whenever possible; second, conduct further investigation to understand the mechanism behind the remaining missing data; third, handle the missing data using an appropriate methodology; and fourth, perform sensitivity

analyses where applicable (Papageorgiou, Grant, Takkenberg, & Mokhles, 2018). Before replacing the missing values with predicted values, I verified that the missing values were randomly distributed in the dataset (Little, 1988; Jamshidian, Jalal, & Jansen, 2014). Commonly, values are characterized as missing entirely at random (MCAR), missing at random (MAR), and missing not at random (MNAR) (Jansen, Hens, Molenberghs, Aerts, Verbeke, & Kenward, 2006; Shrive, Stuart, Quan, & Ghali, 2006; Hazewinkel, Bowden, Wade, Palmer, Wiles, & Tilling, 2022). The prior studies used these approaches (MCAR, MAR, and MNAR) to test the data and identify whether the missing data were distributed randomly or not. The test for differentiating between MAR and MNAR is always dependent on data. Researchers are constantly examining the plausibility of any missing data mechanism in light of the technique used to analyze the data and, more crucially, how the data were acquired, as described above. Three variables were taken out since they had more than 99% of missing values, and these variables included information already captured in other variables. The SPSS “Missing Values Analysis” option within Estimate Maximization (EM) was used in this study. The null hypothesis suggests that missing data is not randomly distributed. However, the "Missing Values Analysis" within the EM test indicates a P-value less than 0.05, which allows us to reject the null hypothesis and accept the alternative hypothesis that missing data were distributed randomly. During the data collection process, some participants failed to provide the required information, resulting in missing data. The null hypothesis suggests that the missing data are not randomly distributed, and therefore, the data are missing, not at random (MNAR). I conducted a "Missing Values Analysis" to test this hypothesis using the Expectation-Maximization (EM) test. The analysis results are less than the predetermined significance level of 0.05. This result indicates that the

null hypothesis can be rejected, and the alternative hypothesis can be accepted. Therefore, it can be concluded that the missing data are distributed randomly and are missing at random (MAR). In addition, the regression option was also used for missing data, and the same results were observed. Moreover, multiple imputation techniques with SPSS were used to identify the numbers and percentage of missing data in the selected samples (see Figure 10 for more details).

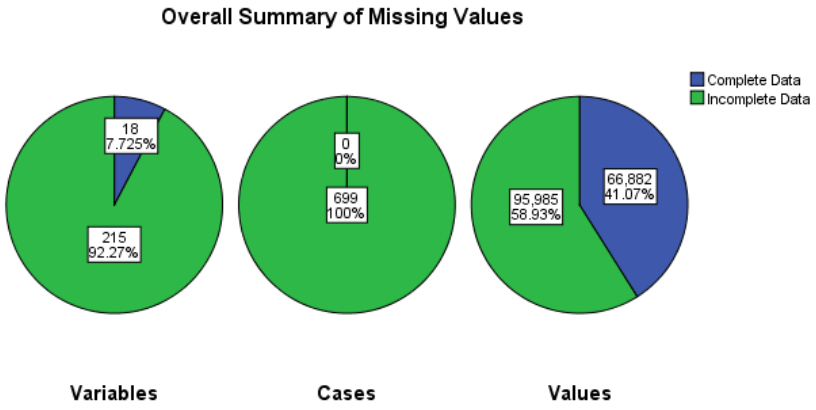

Figure 10: Overall summary of missing values before missing data treatments

As shown in Figure 10, 92.3% of variables have at least one missing value. The values (multiplication of variables within cases) show almost 59% of values are missing, whereas 41% of collected data is complete. When dealing with missing data, a variety of techniques should be utilized. These include listwise deletion, pairwise deletion, mean imputation, regression imputation, pattern-matching imputation, and model-based approaches (Bennett, 2001; Scheffer, 2002; Graham, Cumsille, & Shevock, 2013; Kang, 2013). Choosing an appropriate strategy for handling missing data relies mainly on the quantity of missing data (i.e., the total number of missing values over the whole data collection) (Hair et al., 2010; Byrne, 2016). If the

missing data is less than 5% of the collected data, any method for dealing with missing data is applicable (Bennett, 2001; Dziura, Post, Zhao, & Peduzzi, 2013). Scholars in prior studies suggested expected maximization to fill missing data (Dong & Peng, 2013). However, the amount of missing data in our dataset is more than 5% for many variables. In addition, trimming and removing these variables leads to losing a good amount of information, which may cause bias in the analysis. Resolving this situation using multiple imputations (regression method) was suggested by prior studies (McKnight, McKnight, Sidani, & Figueredo, 2007; Nassiri, Lovik, Molenberghs, & Verbeke, 2018; Hegde, Shimpi, Panny, Glurich, Christie, & Acharya, 2019). Multiple imputations replace each missing item with two or more reasonable values. The selected values should indicate uncertainty about the reasons for non-response and delay regarding which matters to impute if the reasons for non-response are known (Sterne, White, Carlin, Spratt, Royston, Kenward, & Carpenter, 2009). The missing values were filled in using multiple imputations in many rounds. Multiple imputation is a method of handling missing data that involves creating several plausible values for each missing data point. These reasonable values are generated based on statistical models that consider the importance of the other variables in the dataset. The multiple imputation process is usually repeated to create a set of complete datasets, each containing different plausible values for the missing data.

As seen in Figure 11, the overall summary of missing values has significantly improved. The percentage of missing variables went from almost 88% to less than 8.5%, and the percentage of missing cases went from 100% to less than 74%, with more than 99% of the values filled by complete data. There are some variables in which multiple imputations cannot load the missing data (Q16r2, Q36, Q36_2_Coded_1, Q43, Q44A, Q44B, and Q46). These factors

are in correlation with other factors in this dataset. So, removing them from the analysis does not impact the quality of the analysis. These items were removed from the research, improving the variables, cases, and values (see Figure 11 for more info). More than 95% of the variables and more than 99% of cases and values have complete data after applying the multiple imputations.

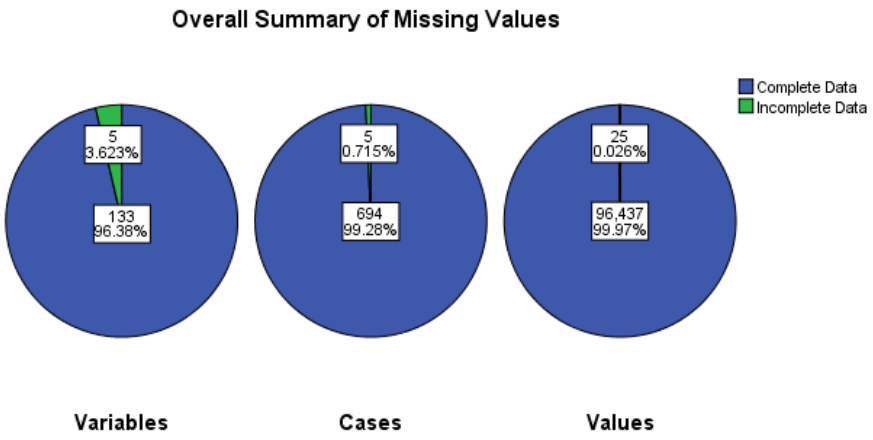

Figure 11: Summary of missing values after different rounds of multiple imputations

5.4.6. Treatment of Unengaged Responses

Bhattacherjee (2012) advises that researchers should look out for unengaged responses in which respondents choose the same response for all questions regardless of their content or answer the questions in the same order (such as 1, 2, 3, 4, 1, 2, 3, 4 or 1, 1, 1, 2, 2, 2, 2, 2, 3, 3). Such instances should be excluded from the analysis (Bhattacherjee, 2012). There is no specific method for evaluating disengaged replies but viewing data during data input is the most effective method (Bhattacherjee, 2012). SD (standard deviation) was utilized for each observation to discover repetitive answers. The SD in different observations showed no zeros. This means the respondents did not follow the same pattern in responding to the questions. In addition, I checked various resources for different approaches regarding the unengaged

respondents. The best process is to review the dataset visually to see if there is any repetitive pattern, and this dataset does not show any repetitive responses.

5.4.7. Data Reliability

Independent variables should ideally be strongly correlated with the dependent variable but have no or only a moderate connection between the independent variables. There are a series of questions referring to a specific factor. For example, Q16r1–Q16r27 relate to healthcare quality within EMR adoption/use. The Cronbach alpha was used for the reliability of this factor (Table 20). The Cronbach alpha was used to measure consistency among different factors (reliability of other items in questions under the same dimension/layer/factor). The reliability/Cronbach alpha is applicable for ordinal and scale objects. A value greater than 0.7 for the Cronbach alpha indicates the reliability among different items under the same factor.

Table 20: Reliability test among questions regarding the quality of care

Cronbach's Alpha	Cronbach's Alpha Based on Standardized items
.761	.764

Before analyzing the questionnaire results, data must be checked for reliability among common factors. The reliability test determines whether each respondent consistently answers the multiple questions on each variable. If they are inconsistent, there may be problems with the measurement items (e.g., the questions may have been misinterpreted). Validity refers to whether variable responses match their actual nature. This should show within- and between-response correlations to those variables. Standard tests were conducted for reliability, and the results showed no problems.

To determine whether favourable or unfavourable perceptions were held by LTC nurses

who adopt/use digital health technologies, one-sample t-tests were performed, which compare the mean of each dimension in the evaluation framework (*Individual*, *Organizational,* and *Technological*) to the midpoint of the Likert scale (i.e., the midpoint on a seven-point Likert scale is 4). When the comparison is insignificant (P_value>0.05), the users appear neutral concerning the dimension. Values above the midpoint, when statistically significant (P_value< 0.05), indicate that respondents hold positive perceptions of the dimension. Values less than the midpoint, when statistically significant, indicate negative perception.

5.5. Data Analysis

This dataset was used for secondary data analysis that involved descriptive and inferential data analysis in providing a comprehensive overview covering the characteristics of the LTC nurses and their adoption/use of digital health technologies (e.g., EMR and virtual care). The researchers should ensure that the measurement model is accurate, implying that the observed variables (indicators) should accurately measure the dependent variable (Hair et al., 2010; Crockett, 2012). The variables in the research questions were identified, each labelled as IVs or DVs and controls. Then, each variable was categorized as a nominal, ordinal, or scale variable, and the purpose of the research question was identified. The statistical analysis in this study includes a) descriptive analysis of selected factors (e.g., age and gender); b) bivariate analyses to check for significant associations among adoption/use and its impact (burnout, benefits, and quality improvement); and c) multivariate analyses (e.g., use/adoption, benefits) to check for regression relationships between adoption/use and outcomes variables (burnout, benefits, and quality improvement) while controlling for moderating factors (e.g., age and years of experience).

First, descriptive analyses provided an overview of the sample characteristics regarding LTC nurses' digital health technologies (e.g., EMR). Second, bivariate analysis (two-sided t-test for continuous variables and chi-square for categorical variables) was used to assess the differences between LTC nurses and nurses in other settings regarding digital health technologies (e.g., virtual care) adoption/use. Then, multivariate analyses were conducted to investigate the potential relationship between adoption/use and its impacts on burnout, benefit (efficiency improvement), and quality improvement results of digital health technologies implementations (e.g., virtual care).

The inferential analysis was conducted regarding virtual care adoption/use among LTC nurses. The adoption/use factor was made by merging four questions, Q43, Q44A, Q44B, and Q46, aligned with the prior study (Beauséjour & Hangens, 2022).

Q43: An e-visit is where a patient initiates a consultation via secure e-mail to their health provider(s) about a specific health question or concern. In the past three months, how many times have you carried out an e-visit using secure e-mail?

Q44A: Consulted directly with a patient via virtual videoconference?

Q44B: Carried out a virtual visit while in-person with a patient with a remote clinical provider (e.g., telehealth)?

Q46: In the past three months, how many patients under your care have been enrolled in remote telemonitoring services (e.g., telehomecare)?

All statistical analyses were conducted using a combination of Excel and IBM SPSS for descriptive and inferential statistical analysis to explore factors associated with use of digital health technologies in the workplace and the use/adoption impact. The inferential analysis,

including Pearson correlation and linear regression, were used to investigate the association between adoption/use and its impacts, such as burnout and benefits (e.g., efficiency improvements). The technical affinity summary measures, including mean (SD), were used for continuous variables, and frequency (%) for categorical variables. The chi-square or Fisher's exact test examined the association between categorical variables.

The inferential analysis is a vast group of approaches beyond just describing and making inferences about a data set. Inferential statistics assist researchers in extrapolating results from a sample to a larger group of people. They investigate group disparities and the connections between variables (Marshall & Jonker, 2011; Bureau, 2012; Tong, 2019). A combination of descriptive and inferential methods were used to analyze the 2020 nurse's data in the present research. This study used the chi-square independence test, correlation, and linear regression as suitable approaches for evaluating the theoretical model. The multivariate statistical method was used to assess theoretical models by concurrently investigating the correlations between observable variables and their associations (Hair et al., 2010; Paulssen, Temme, & Walker, 2014). The chi-square independence test, correlation, and linear regression are suitable for testing and validating hypotheses and conceptual models by examining complicated relationships between variables (Schumacker & Lomax, 2010; Kline, 2015; Byrne, 2016). The chi-square independence test was used to compare LTC nurses with nurses in other settings. Pearson correlation (e.g., Pearson correlation, Spearman rank-order, and point-biserial correlation) was used to test the correlation and association between adoption factors and adoption/use and its impact. Linear regression analysis was used to predict the impact of the adoption with adoption/use and its impact factors (Table 21).

Table 21: Various statistical tests and their application in this study

Statistical test name	Statistical test description	Statistical test application
chi-square independence test	Chi-square is a non-parametric (distribution-free) method for analyzing group differences when the dependent variable is nominal. Chi-square is non-parametric and resilient to data distribution. It doesn't require equal variances or homoscedastic data. It allows both dichotomous and multiple-group experiments. Unlike many other non-parametric and parametric statistics, Chi-square calculations include information on how each group did in the research (McHugh, 2012).	Compare LTC nurses with nurses in other settings
Pearson correlation	The Pearson correlation coefficient, sometimes known as r, is the method most frequently utilized for determining the strength of a linear link. The coefficient of determination is a numeric value that ranges from –1 to 1, representing the degree and direction of the relationship between two variables (Benesty, Chen, Huang, & Cohen, 2009).	Correlation relationship between IV (Scale) & DV (Scale)
Spearman rank-order	A nonparametric measure of the degree and direction of connection between two variables assessed on at least an ordinal scale is referred to as the Spearman rank-order correlation coefficient (Bishara & Hittner, 2012).	Correlation relationship between IV (Scale) & DV (Ordinal)
Point-Biserial Correlation	When one of the variables being analyzed is dichotomous and the other variable being studied is metric, the value of Pearson's product-moment correlation is referred to as the point biserial correlation (Kornbrot, 2014).	Correlation relationship between IV (Scale) & DV (nominal)
Linear regression	The modelling of the dynamic connection between a continuous response and one or more explanatory factors may be done using a linear method called linear regression (also known as dependent and independent variables) (Freedman, 2009).	The regression relations between adoption/use and its impact.

It is crucial to analyze the capacity of observed variables to measure their corresponding variables, followed by examining links between IV and DV variables. The correlation and regression approaches allow researchers to evaluate complicated models, including the direct and control effects (Hair et al., 2010; Schumacker & Lomax, 2010). The inferential analysis contains model estimation. The estimation approach relied on an iterative procedure called the fitting function to minimize the discrepancies between the predicted population covariance matrix and the observed sample covariance matrix. The statistical software that was utilized offers a range of appropriate methods including maximum likelihood (ML), generalized least squares (GLS), unweighted least squares (OLS), scale-free least squares (SLS), and asymptotically distribution-free (ADF) estimates (Schumacker & Lomax, 2010; Blunch, 2012; Crockett, 2012).

5.6. Ethics Approval

Approval from CHI was obtained to use the data for this thesis research. Subsequently, the data and related documentation will be shared with CHI. The Ottawa University REB committee confirmed that there is no need for further ethics application, and I can use this dataset in my thesis.

5.7. Results

5.7.1. Overview Samples and used Technology

LTC nurses are primarily between 35 and 44 years old, with 48 (28.9%), followed by 42 (25.3%), who are 25–34 years old and 45–54 years old. There are 22 (13.3%) nurses between 55 and 64 years old and 6 nurses (3.6%) either less than or equal to 24 years old or 65 years old or older. The participant nurses are mostly female, with 152 (91.6%), followed by 13 (7.8%) males. The LTC nurses have a variety of work experience, ranging from first-year nurses to those with up to 45 years of experience, with an average of 15 years. There are 162 (97.6%) salaried/paid/payroll employees and 4 (2.4%), self-employed nurses, whereas 114 (70.4%) are full-time nurses, followed by part-time nurses, 43 (26.5%), and 5 (3.1%) casual nurses. The participant nurses are mostly from Quebec, with 113 (68.1%), followed by Ontario with 17 (10.2%), Manitoba with 11 (6.6%), both British Columbia and Alberta with 7 (4.8%), New Brunswick with 4 (2.4%) and one or two each from other regions and provinces such as Nova Scotia, the Northwest Territories/Yukon, Newfoundland and Labrador, Nunavut, and Saskatchewan. The LTC nurses are mostly in clinical care with 123 (74.1%), nursing administration 28 (16.9%), nursing education 5 (3.0%), nursing policy 3 (1.8%), and nursing/clinical informatics 7 (4.2%). They are mostly registered nurses (RN) with 64 (38.6%),

nurse practitioners (NP) with 4 (2.4%), clinical nurse specialists (CNS) with 15 (9.0%), licensed practical nurses (LPN) (known as a registered practical nurse (RPN) in Ontario and Quebec) with 8 (4.8%), nurse clinicians with 33 (32.7%), and nurse educators/instructors 2 (2.2%). In addition, LTC nurses are mostly from towns or cities, with 111 (66.9%), and equally from rural areas and urban centers, with 27 (16.3%) and only 1 (0.6%) from First Nations, Métis, or Inuit communities. The major size of the community they serve is 10,001 to 100,000 individuals with 47 (28.3%), followed by 100,001 to 500,000 individuals with 36 (21.7%). The LTC nurses are aware of privacy and security concerns and use their user account, with 90 (93.8%). They do not share their user account with colleagues, with 80 (88.9%), whereas their electronic systems mainly need multiple logins, with 51 (72.9%) (Table 22).

Table 22: LTC nurses' characteristics

Factor	Factor value	N (%)
Gender	Male	13 (7.8%)
	Female	152 (91.6%)
	Others	1 (0.6%)
Age	Less than or equal to 24 yrs	6 (3.6%)
	25 - 34 yrs	42 (25.3%)
	35 - 44 yrs	48 (28.9%)
	45 - 54 yrs	42 (25.3%)
	55 - 64 yrs	22 (13.3%)
	65 yrs and older	6 (3.6%)
Occupation	Salaried/paid/payroll employment	162 (97.6%)
	Self-employed	4 (2.4%0
Province/territory	Alberta	7 (4.2%)
	British Columbia	7 (4.2%)
	Manitoba	11 (6.6%)
	New Brunswick	4 (2.4%)
	Newfoundland and Labrador	1 (0.6%)
	Nova Scotia	2 (1.2%)
	Nunavut	1 (0.6%)
	Northwest Territories/ Yukon	2 (1.2%)
	Ontario	17 (10.2%)
	Quebec	113 (68.1%)
	Saskatchewan	1 (0.6%)
Work setting	Rural area	27 (16.3%)
	Town or City	111 (66.9%)
	Urban centre	27 (16.3%)
	First Nations, Métis or Inuit communities	1 (0.6%)
Population size	5,000 people or less	24 (14.5%)
	5,001 to 10,000 people	20 (12.0%)
	10,001 to 100,000 people	47 (28.3%)
	100,001 to 500,000 people	36 (21.7%)
	500,001 or more people	19 (11.4%)
	500,001 or more people	20 (12.0%)
Length of EMR use	Less than a year	15 (15.6%)
	1-2 years	24 (25.0%)
	3-4 years	20 (20.8%)
	5-6 years	11 (11.5%)
	Over six years	23 (24.0%)
	Prefer not to answer	3 (3.1%)

The majority of the nurses, 126 (75.9%), provide direct care to patients, and they described the quality of nursing care as fair with 46 (36.5%), good with 38 (30.2%), and 20 (15.9%) as excellent service. Forty-six (36.5%) nurses identified themselves as “under stress, and don’t always have as much energy as I did, but I don’t feel burned out,” followed by “I enjoy my work, I have no symptoms of burnout” with 34 (27.0%). In addition, “I’m definitely burning out and have one or more symptoms of burnout, e.g., emotional exhaustion,” was reported by 30 (23.8%), and 16 (12.7%) reported higher stages of burnout, such as "burnout

symptoms and felt completely burned out."

5.7.1.1. Differences in Electronic Medical Record Use Among Long-Term Care Nurses

The LTC nurses used HIT to enter, review, or retrieve patient information in nurses' main care settings, including Meditech, Ariane, and MedAccess (Table 23). Despite these technologies being slightly different in their definitions, they provide various services, including reminders for recommended patient care clinical documentation, electronic ordering/order entry of laboratory tests, and access to provincial/territorial patient electronic and clinical dashboarding.

Table 23: Nurses used EMR technologies in LTC setting

Technology name	Technology description
Meditech	On-premise EMR system that provides clinical charting for healthcare professionals at midsized and community hospitals
Ariane	A reliable and robust solution to optimize patient records management. Ariane Healthcare adapts to the organization and classification method. It creates patient files in the system, simplifies search and tracking, and monitors patients' requests to consult their records.
DSQ	Dossier Santé Quebec (DSQ) is a secure provincial tool used to collect, conserve and release health information. The aim is to improve the quality of care and efficiency of Québec's health system.
RSIPA	RSIPA(Réseau de services intégrés pour les personnes adults): The RSIPA solution covers the field of planning interventions with meters in place to respond to users' needs and thorough evaluation. Ease of communication and concerting between interveners of a particular location implicated in those available for use. Reports containing data from the global planning services to the adult client within autonomy. Finally, a data set is available to supply RSIPA client installations with full access to all data generated by the solution or systems in the cell
Chartmaxx	Enterprise Content Management (ECM) solution provides 24/7 concurrent access to the complete medical record, including structured and unstructured data across different enterprises, organized to reflect targeted and proactive data
Oacis / Oasis	OACIS is the system that the MUHC uses as an electronic medical record. Users will receive a username and password from the clinical coordinator at the beginning of their rotation. Nurses will need to use this to obtain information about their patients throughout work placement
Purkinje	A healthcare ERP (Enterprise Resource Planning)
Soft lab	SoftLab is a LIS solution built on the latest modem multi-tier client/server architecture. It includes CORBA (Common Object Request Broker Architecture) and Web Services, which promote enterprise-wide connectivity and allow the incorporation of new technologies
ICLSC	Système d'information sur la clientèle et les services des CSSS - mission CLSC: Minister's database containing personal information and providing data on service requests, users and interventions concerning services offered in CSSSs (CLSC mission). The database describes the services provided on the front line to ensure the quality and efficiency of the health and social services offered
Omnimed	A 100% Web EMR includes only one file per patient, and it is the only shareable EMR
Kinlogix	KinLogix is a simple and robust cloud-based EMR
Medesync	Designed by a physician for physicians and specialists, Medesync is a web-based, modern EMR solution
Clinibase / e-clinibase	Logic eClinibase is an integrated solution combining a series of modules supported by a robust electronic document manager
QHR Accuro	A high-performance EMR is designed to give healthcare providers more control over their information, workflow, and, most importantly, time
eChart	eCharts' EMR cloud-based platform, with built-in Telehealth and EMDR Light Bar, offers a complete package, ideal for solo

Practice Solutions (PS Suite)	Developed by physicians for physicians and specialists, PS Suite (formerly Practice Solutions) is an easy-to-use, customizable EMR that captures, organizes and displays patient information in a user-friendly way. Get information at your fingertips to spend more time with patients and less on administration
Myle	This unique integrated platform offers MYLE easy access to patients' medical records, minimizes administrative tasks, and facilitates complex medical decisions.

5.7.2. Comparing Technology Use and Impacts Among Long-Term Care Nurses to Other Healthcare Settings

A comparison of technology adoption/use between LTC nurses and nurses working in other settings was conducted to explore the pattern and purpose of digital health technology (e.g., EMR). Bivariate analyses (two-sided t-test for continuous variables and chi-square for categorical variables) were used to assess the differences between these two groups. Significant differences were observed between LTC nurses and nurses in other settings regarding digital health technology adoption/use and its impact (Table 24). Significant differences were observed in technology adoption/use between nurses in LTC and those working in other settings, which further emphasizes the low level of technology adoption among LTC nurses.

5.7.2.1. Purpose of Adoption and Use: Understanding the Factors that Influence Technology Acceptance and Integration in Healthcare

Overall, EMR use for documentation and communication is more common among LTC nurses than nurses in other settings. LTC nurses (74%) are more likely than nurses in different settings (60.7%) to utilize EMR for electronic clinical documentation. Similarly, electronic communication with other healthcare professionals outside the organization (such as secure e-mail or messaging) is more common among LTC nurses (56.3%) than nurses in different settings (42.6%). On the other hand, the use of digital health technology for *laboratory order entry*,

decision support tools, *medications list, lab results/diagnostic imaging*, *discharge summaries, medication reconciliation, electronic order entry/prescribing, drug interactions, drug interactions communication outside the organization (e.g., secure e-mail or messaging)* is *less* available and gets *used less* among LTC nurses than other nurses.

5.7.2.2. Exploring Barriers to Technology Adoption Among Long-Term Care Nurses: A Comparative Analysis with Other Healthcare Settings

The burden of administrative work is significantly higher among LTC nurses in comparison to nurses in other settings (with 65.7% of LTC nurses compared to 41.2% of nurses in different settings), with a redundant data capture (with 62.5% of LTC nurses versus to 36.8% of nurses in other settings), and nursing documentation (with 67.7% of LTC nurses compared to 44% of nurses in other settings) significantly increased or increased among LTC nurses in comparison to nurses in other settings. A higher percentage of LTC nurses (41.7%) use two or more electronic systems and a paper chart than nurses in other settings (25.2%) in accessing and *documenting patient* information, which is time-consuming. LTC nurses have been less adequately consulted about digital health technology (e.g., EMR) adoption/use and decisions to introduce electronic records/clinical information systems compared to nurses in other settings, and most LTC nurses did not provide input on workflow redesign leveraging systems to support continuous improvement. LTC nurses struggle more with data documentation and report *more unreliable network connections* than other nurses. More LTC nurses have to deliver *too many different work demands* than other nurses and require more *"workarounds*" to use the system than other nurses.

5.7.2.3. EMR and Mobile Device Accessibility

Access to a mobile device to provide documentation and communicate with other care team members is highly or moderately essential among LTC nurses compared to other nurses, with 55.2% and 63.5% compared to 30.5% and 28.7% among nurses in other settings, respectively.

5.7.2.4. The Impact of EMR Use Among LTC Nurses: Identifying Potential Barrier

The LTC nurses believe that clinical decision-making and communication with other clinicians have not been changed due to HIT implementation. In addition, the turnaround time for lab/diagnostic results, needed lab tests, providing quality patient care, and medication errors did not change the outcome of HIT implementation.

5.7.2.5. Exploring Barriers to Electronic Medical Record Use Among Long-Term Care Nurses

Many LTC nurses mentioned barriers to accessing electronic record/clinical information systems (91.3%). In addition, LTC nurses said that the existing equipment does not meet their nursing requirements (23%), and more LTC nurses said it takes too long to sign in to use the system than other nurses (30.2%).

Table 24: A comparison of LTC nurses' characteristics with nurses in other settings

Characteristics	LTC Nurses, n=166, n(%)	Nurses in other settings, n=1476, n(%)	P_Value	Comments
Electronic clinical documentation			0.03	Electronic clinical documentation use is **more** common among LTC nurses than among other nurses
I currently use this functionality in my setting	71 (74.0%)	489 (60.7%)		
This is available electronically - but I do not have access	4 (4.2%)	107 (13.3%)		
Not available in my setting	19 (19.8%)	194 (24.1%)		
Don't Know/ Unsure	2 (2.1%)	16 (2.0%)		
Electronic ordering/order entry of laboratory tests			0.00	Electronic ordering/order entry of laboratory tests is **less** available and gets used among LTC nurses than other nurses
I currently use this functionality in my setting	31 (32.3%)	472 (58.6%)		
This is available electronically - but I do not have access	21 (21.9%)	109 (13.5%)		
Not available in my setting	34 (35.4%)	182 (22.6%)		
Don't Know/ Unsure	10 (10.4%)	43 (5.3%)		
Electronic access to provincial/territorial patient electronic health record systems			0.00	Electronic access to provincial/territorial patient electronic health record systems is **less** available and gets used among the LTC nurses than other nurses
I currently use this functionality in my setting	52 (41.3%)	469 (46.6%)		
This is available electronically - but I do not have access	15 (11.9%)	195 (19.4%)		
Not available in my setting	51 (40.5%)	242 (24.1%)		
Don't Know/ Unsure	8 (6.3%)	100 (9.9%)		
Electronic notification of hospital visit			0.02	Electronic notification of hospital visits is **less** available and get used among LTC nurses than other nurses
I currently use this functionality in my setting	32 (33.3%)	300 (37.2%)		
This is available electronically - but I do not have access	8 (8.3%)	107 (13.3%)		
Not available in my setting	48 (50.0%)	280 (34.7%)		
Don't Know/ Unsure	8 (8.3%)	119 (14.8%)		
Electronic clinical decision support tool			0.00	The electronic clinical decision support tool is **less** available and gets used among LTC nurses more than other nurses
I currently use this functionality in my setting	22 (22.9%)	330 (40.9%)		
This is available electronically - but I do not have access	9 (9.4%)	93 (11.5%)		
Not available in my setting	54 (56.3%)	263 (32.6%)		
Don't Know/ Unsure	11 (11.5%)	120 (14.9%)		
Electronic list of all medications taken by an individual patient			0.00	An electronic list of all medications taken by an individual patient is **less** available and gets used among LTC nurses than other nurses
I currently use this functionality in my setting	51 (40.5%)	533 (53.0%)		
This is available electronically - but I do not have access	17 (13.5%)	193 (19.2%)		
Not available in my setting	55 (43.7%)	234 (23.3%)		
Don't Know/ Unsure	3 (2.4%)	46 (4.6%)		
Electronic list of all lab results/diagnostic imaging for a patient			0.00	An electronic list of all lab results/diagnostic imaging for a patient is **less** available and get used among the LTC nurses than other nurses
I currently use this functionality in my setting	59 (46.8%)	639 (63.5%)		
This is available electronically - but I do not have access	14 (11.1%)	150 (14.9%)		
Not available in my setting	49 (38.9%)	160 (15.9%)		
Don't Know/ Unsure	4 (3.2%)	57 (5.7%)		
Electronic list of all discharge summaries and discharge instructions for a patient			0.00	An electronic list of all discharge summaries and discharge instructions for a patient is **less** available and gets used among the LTC nurses than other nurses
I currently use this functionality in my setting	25 (19.8%)	299 (29.7%)		
This is available electronically - but I do not have access	13 (10.3%)	144 (14.3%)		
Not available in my setting	78 (61.9%)	438 (43.5%)		
Don't Know/ Unsure	10 (7.9%)	125 (12.4%)		
Electronic medication reconciliation			0.00	Electronic medication reconciliation is **less** available and gets used among LTC nurses than other nurses
I currently use this functionality in my setting	29 (30.2%)	354 (43.9%)		
This is available electronically - but I do not have access	17 (17.7%)	134 (16.6%)		
Not available in my setting	44 (45.8%)	234 (29.0%)		
Don't Know/ Unsure	6 (6.3%)	84 (10.4%)		
Electronic order entry/prescribing of patient medications			0.01	Electronic order entry/ prescribing of patient medications is **less** available and gets used among the LTC nurses than other nurses
I currently use this functionality in my setting	24 (25.0%)	305 (37.8%)		
This is available electronically - but I do not have access	11 (11.5%)	140 (17.4%)		
Not available in my setting	50 (52.1%)	307 (38.1%)		
Don't Know/ Unsure	11 (11.5%)	54 (6.7%)		
Electronic warning for adverse prescribing and/or drug interactions			0.00	Electronic warning for adverse prescribing and/or drug

I currently use this functionality in my setting	9 (9.4%)	254 (31.5%)		interactions is **less** available and get used among LTC nurses than other nurses
This is available electronically - but I do not have access	7 (7.3%)	93 (11.5%)		
Not available in my setting	65 (67.7%)	351 (43.5%)		
Don't Know/ Unsure	15 (15.6%)	108 (13.4%)		
Electronic receipt of laboratory test results from external laboratory/diagnostic imaging			0.00	Electronic receipt of laboratory test results from external laboratory/ diagnostic imaging is **less** available and used among LTC nurses than among other nurses
I currently use this functionality in my setting	51 (40.5%)	525 (52.2%)		
This is available electronically - but I do not have access	18 (14.3%)	160 (15.9%)		
Not available in my setting	51 (40.5%)	227 (22.6%)		
Don't Know/ Unsure	6 (4.8%)	94 (9.3%)		
Electronic referral to other healthcare provider(s)			0.01	Electronic referral to other healthcare provider(s) is **less** available and used among the LTC nurses than among other nurses
I currently use this functionality in my setting	32 (33.3%)	315 (39.1%)		
This is available electronically - but I do not have access	12 (12.5%)	131 (16.3%)		
Not available in my setting	51 (53.1%)	308 (38.2%)		
Don't Know/ Unsure	1 (1.0%)	52 (6.5%)		
Electronic transfer of patients' clinical health information securely to other health professionals			0.00	Electronic transfer of patients' clinical health information securely to other health professionals is **less** available and used among LTC nurses than among other nurses
I currently use this functionality in my setting	26 (27.1%)	264 (32.8%)		
This is available electronically - but I do not have access	6 (6.3%)	131 (16.3%)		
Not available in my setting	50 (52.1%)	272 (33.7%)		
Don't Know/ Unsure	14 (14.6%)	139 (17.2%)		
Electronic communication with other health professionals outside my organization: secure e-mail or messaging			0.01	Usage of Electronic communication with other health professionals outside the organization is **more** common among LTC nurses than among other nurses
I currently use this functionality in my setting	54 (56.3%)	343 (42.6%)		
This is available electronically - but I do not have access	7 (7.3%)	133 (16.5%)		
Not available in my setting	31 (32.3%)	236 (29.3%)		
Don't Know/ Unsure	4 (4.2%)	94 (11.7%)		
Electronic communication with other health professionals outside my organization: virtual face-to-face e-consultation such as telehealth consultation			0.01	Electronic communication with other health professionals outside the organization is **less** available and used among the LTC nurses than among other nurses
I currently use this functionality in my setting	20 (15.9%)	218 (21.7%)		
This is available electronically - but I do not have access	19 (15.1%)	213 (21.2%)		
Not available in my setting	76 (60.3%)	437 (43.4%)		
Don't Know/ Unsure	11 (8.7%)	138 (13.7%)		
Electronic patient care plans			0.00	Usage of Electronic patient care plans is **more** common among LTC nurses than among other nurses
I currently use this functionality in my setting	69 (71.9%)	279 (34.6%)		
This is available electronically - but I do not have access	9 (9.4%)	100 (12.4%)		
Not available in my setting	18 (18.8%)	353 (43.8%)		
Don't Know/ Unsure	0	74 (9.2%)		
Quality of patient care you provide			0.05	LTC nurses believe that providing quality patient care did not change Vs. other nurses reported the **increased** result of electronic record/clinical information systems
Greatly Increased	8 (8.3%)	122 (15.1%)		
Increased	33 (34.4%)	315 (39.1%)		
Did not change	37 (38.5%)	252 (31.3%)		
Decreased	6 (6.3%)	42 (5.2%)		
Greatly decreased	2 (2.1%)	26 (3.2%)		
Not applicable	3 (3.1%)	30 (3.7%)		
Not sure	7 (7.3%)	19 (2.4%)		
Medication errors			0.03	More LTC nurses believe that medication errors did not change Vs. other nurses reported a **decrease** in medication errors.
Greatly Increased	2 (2.1%)	30 (3.7%)		
Increased	9 (9.4%)	66 (8.2%)		
Did not change	34 (35.4%)	236 (29.3%)		
Decreased	13 (13.5%)	114 (14.1%)		
Greatly decreased	2 (2.1%)	113 (14.0%)		
Not applicable	26 (27.1%)	153 (19.0%)		
Not sure	10 (10.4%)	94 (11.7%)		
Identification of needed lab tests			0.00	More LTC nurses believe that the identification of needed lab tests did not change, whereas other nurses reported an **increase** in the identification of required lab tests
Greatly Increased	8 (8.3%)	127 (15.8%)		
Increased	17 (17.7%)	244 (30.3%)		
Did not change	30 (31.3%)	221 (27.4%)		
Decreased	3 (3.1%)	50 (6.2%)		
Greatly decreased	1 (1.0%)	21 (2.6%)		

Not applicable	34 (35.4%)	113 (14.0%)		
Not sure	3 (3.1%)	30 (3.7%)		
Turnaround time for lab/diagnostic results			0.01	More LTC nurses believe that Turnaround time for lab/diagnostic results did not change Vs. other nurses reported mainly **increased** or **significantly increased**.
Greatly Increased	15 (15.6%)	138 (17.1%)		
Increased	20 (20.8%)	229 (28.4%)		
Did not change	24 (25.0%)	182 (22.6%)		
Decreased	10 (10.4%)	103 (12.8%)		
Greatly decreased	5 (5.2%)	52 (6.5%)		
Not applicable	21 (21.9%)	73 (9.1%)		
Not sure	1 (1.0%)	29 (3.6%)		
The burden of administrative work			0.00	The burden of administrative work is either **significantly increased or increased** among the LTC nurses Vs. other nurses mentioned more "Did not change" in their responses.
Greatly Increased	33 (34.4%)	124 (15.4%)		
Increased	30 (31.3%)	208 (25.8%)		
Did not change	17 (17.7%)	201 (24.9%)		
Decreased	8 (8.3%)	140 (17.4%)		
Greatly decreased	3 (3.1%)	62 (7.7%)		
Not applicable	3 (3.1%)	37 (4.6%)		
Not sure	2 (2.1%)	34 (4.2%)		
Redundant data capture			0.00	The redundant data capture is mainly **significantly increased** or **increased** among the LTC nurses. other nurses
Greatly Increased	22 (22.9%)	97 (12.0%)		
Increased	38 (39.6%)	200 (24.8%)		
Did not change	18 (18.8%)	206 (25.6%)		
Decreased	6 (6.3%)	138 (17.1%)		
Greatly decreased	3 (3.1%)	49 (6.1%)		
Not applicable	4 (4.2%)	44 (5.5%)		
Not sure	5 (5.2%)	72 (8.9%)		
Nursing documentation			0.00	The Nursing documentation is **significantly increased** or **increased** among the LTC nurses. other nurses
Greatly Increased	22 (22.9%)	114 (14.1%)		
Increased	43 (44.8%)	241 (29.9%)		
Did not change	19 (19.8%)	228 (28.3%)		
Decreased	5 (5.2%)	105 (13.0%)		
Greatly decreased	0 (0.0%)	32 (4.0%)		
Not applicable	5 (5.2%)	57 (7.1%)		
Not sure	2 (2.1%)	29 (3.6%)		
Communication with other clinicians outside of your organization			0.01	LTC nurses believe that communication with other clinicians outside of the organization did not change Vs. other nurses reported a higher **increas**e due to digital health technology.
Greatly Increased	10 (10.4%)	78 (9.7%)		
Increased	20 (20.8%)	222 (27.5%)		
Did not change	43 (44.8%)	272 (33.7%)		
Decreased	1 (1.0%)	28 (3.5%)		
Greatly decreased	3 (3.1%)	16 (2.0%)		
Not applicable	18 (18.8%)	109 (13.5%)		
Not sure	1 (1.0%)	81 (10.0%)		
Clinical decision making			0.05	LTC nurses believe that Clinical decision-making did not change Vs. other nurses reported a higher **increase**.
Greatly Increased	9 (9.4%)	74 (9.2%)		
Increased	27 (28.1%)	292 (36.2%)		
Did not change	45 (46.9%)	303 (37.6%)		
Decreased	5 (5.2%)	19 (2.4%)		
Greatly decreased	0 (0%)	9 (1.1%)		
Not applicable	9 (9.4%)	55 (6.8%)		
Not sure	1 (1.0%)	54 (6.7%)		
Accessing patient information: do you typically use to support a patient encounter			0.00	LTC nurses must **use two or more electronic systems** as well as a paper chart than other nurses in accessing patient information
All patient information is accessed from one electronic system	17 (17.7%)	206 (25.6%)		
I access patient information across two or more electronic systems	23 (24.0%)	254 (31.5%)		
I access patient information from one electronic system as well as from a paper chart	9 (9.4%)	116 (14.4%)		
I access patient information from two or more electronic systems as well as from a paper chart	40 (41.7%)	203 (25.2%)		
Don't know	7 (7.3%)	27 (3.3%)		
Documenting patient information: do you typically			0.00	LTC nurses must **use two or**

use it to support a patient encounter				**more electronic systems as well as a paper chart** than other nurses in accessing and documenting patient information
All patient encounter information is electronically documented in one system	15 (15.6%)	275 (34.1%)		
I document patient encounter information across two or more electronic systems	20 (20.8%)	123 (15.3%)		
I document patient encounter information electronically in one system as well as on a paper chart	27 (28.1%)	264 (32.8%)		
I document patient information in two or more electronic systems as well as on a paper chart	27 (28.1%)	97 (12.0%)		
Don't know	7 (7.3%)	47 (5.8%)		
Access to a mobile device to provide and document			0.00	Access to a mobile device to provide documentation is highly **or moderately essential** among LTC nurses Vs. other nurses
Highly essential	53 (55.2%)	246 (30.5%)		
Moderately essential	31 (32.3%)	216 (26.8%)		
Neither essential nor not essential	3 (3.1%)	155 (19.2%)		
Moderately not essential	4 (4.2%)	37 (4.6%)		
Not essential at all	5 (5.2%)	140 (17.4%)		
Prefer not to answer	0(0%)	12 (1.5%)		
Access to a mobile device to communicate with other care team members			0.00	Access to a mobile device to communicate with other care team members is either **highly essential or moderately essential** among the LTC nurses than other nurses
Highly essential	61 (63.5%)	231 (28.7%)		
Moderately essential	21 (21.9%)	229 (28.4%)		
Neither essential nor not essential	7 (7.3%)	138 (17.1%)		
Moderately not essential	3 (3.1%)	57 (7.1%)		
Not essential at all	3 (3.1%)	139 (17.2%)		
Prefer not to answer	1 (1.0%)	12 (1.5%)		
Nursing peers adequately consulted about decisions to introduce electronic records/clinical information systems			0.02	LTC nursing peers have **less adequately consulted** about decisions to introduce electronic records/clinical information systems than other nurses
Yes	13 (13.5%)	188 (23.3%)		
No	62 (64.6%)	401 (49.8%)		
Don't know	21 (21.9%)	217 (26.9%)		
Have input on the use of electronic records/ clinical information systems			0.04	LTC had either "**none at all**" or "**a little**" input on the use of electronic records/clinical information systems in comparison to other nurses
A great deal	5 (5.2%)	88 (10.9%)		
Quite a lot	10 (10.4%)	139 (17.2%)		
A little	25 (26.0%)	212 (26.3%)		
None at all	56 (58.3%)	367 (45.5%)		
Design and use of clinical order sets applicable to your practice - input on aspects of the design			0.02	Most LTC nurses did not provide input on aspects of the design and use of clinical order set applications in their practice, whereas nurses in other settings provided "**Quite a lot**" or "**A little**."
A great deal	4 (10.0%)	40 (9.1%)		
Quite a lot	3 (7.5%)	82 (18.7%)		
A little	4 (10.0%)	112 (25.5%)		
None at all	21 (52.5%)	162 (36.9%)		
Not Applicable	8 (20.0%)	43 (9.8%)		
Workflow redesign leveraging systems to support continuous improvement - input on aspects of the design			0.01	Most LTC nurses did not provide input on Workflow redesign leveraging systems to support continuous improvement, whereas nurses in other settings provided **"Quite a lot"** or **"A little."**
|1 |A great deal	5 (12.5%)	37 (8.4%)		
|2 |Quite a lot	0 (0.0%)	80 (18.2%)		
|3 |A little	7 (17.5%)	109 (24.8%)		
|4 |None at all	24 (60.0%)	168 (38.3%)		
Not Applicable	4 (10.0%)	45 (10.3%)		
No barriers to accessing electronic record/clinical information systems in my main care setting			0.02	A **higher** percentage of LTC nurses mentioned barriers in accessing electronic record/ clinical information systems in their main care setting
NO TO: No barriers to accessing electronic record/clinical information systems in my main care setting	115 (91.3%)	839 (83.4%)		
No barriers to accessing electronic record/clinical information systems in my main care setting	11 (8.7%)	167 (16.6%)		
Didn't receive applied training on electronic record/clinical information systems in my undergraduate nursing program			0.03	A **higher** percentage of LTC nurses mentioned not receiving applied training on

NO TO: Didn't receive applied training on electronic record/clinical information systems in my undergraduate nursing p	105 (83.3%)	904 (89.9%)		electronic record/ clinical information systems in their undergraduate nursing program
Didn't receive applied training on electronic record/clinical information systems in my undergraduate nursing program	21 (16.7%)	102 (10.1%)		
Equipment does not meet nursing needs -			0.01	A **higher** percentage of LTC nurses mentioned that equipment **does not meet** their nursing needs
NO TO: Equipment does not meet nursing needs	97 (77.0%)	860 (85.5%)		
Equipment does not meet nursing needs	29 (23.0%)	146 (14.5%)		
It takes too long to sign in to use the systems			0.00	It takes **longer** for LTC nurses to **sign in** to use the system than for other nurses
NO TO: It takes too long to sign in to use the systems	88 (69.8%)	818 (81.3%)		
It takes too long to sign in to use the systems	38 (30.2%)	188 (18.7%)		
Use of both paper charts and electronic records			0.05	LTC nurses have to **use both paper charts and electronic records** more than other nurses
NO TO: Use of both paper charts and electronic records	65 (51.6%)	612 (60.8%)		
Use of both paper charts and electronic records	61 (48.4%)	394 (39.2%)		
Multiple logins are required to access different clinical information systems			0.00	LTC nurses have to **use multiple logins** to access different clinical information systems than other nurses
NO TO: Multiple logins are required to access different clinical information systems	74 (58.7%)	738 (73.4%)		
Multiple logins are required to access different clinical information systems	52 (41.3%)	268 (26.6%)		
Documented data sometimes disappears from the system, creating a need to re-enter information			0.00	LTC nurses are **struggling more** with documented data disappearing from the system than other nurses
NO TO: Documented data sometimes disappears from the system, creating a need to re-enter information	103 (81.7%)	917 (91.2%)		
Documented data sometimes disappears from the system, creating a need to re-enter information	23 (18.3%)	89 (8.8%)		
Unreliable network connection			0.00	LTC nurses have reported **more unreliable network** connections than other nurses
NO TO: Unreliable network connection	95 (75.4%)	884 (87.9%)		
Unreliable network connection	31 (24.6%)	122 (12.1%)		
Too many other work demands			0.01	LTC nurses have reported too **many other work demands** than other nurses
NO TO: Too many other work demands	89 (70.6%)	811 (80.6%)		
Too many other work demands	37 (29.4%)	195 (19.4%)		
Too many "workarounds" required to use the system			0.00	LTC nurses have reported **too many "workarounds"** required to use the system than other nurses
NO TO: Too many "workarounds" required to use the system	98 (77.8%)	882 (87.7%)		
Too many "workarounds" required to use the system	28 (22.2%)	124 (12.3%)		
Advanced patient/family and care team partnerships in care			0.03	A **higher percentage** of LTC nurses mentioned that they did not find an impact on the advanced patient/family and care team partnerships in care
A great extent	6 (15.0%)	62 (13.2%)		
Somewhat	10 (25.0%)	140 (29.8%)		
Very little	10 (25.0%)	112 (23.8%)		
Not at all	11 (27.5%)	54 (11.5%)		
Don't Know	3 (7.5%)	52 (11.1%)		
Not applicable	0 (0.0%)	50 (10.6%)		
Advanced patient/family advocacy issues within your practice			0.04	Interestingly, a **higher percentage** of LTC nurses mentioned that advanced patient/family advocacy issues have either an "**A great extent" or "Somewhat"** within their practice
A great extent	4 (10.0%)	41 (8.7%)		
Somewhat	14 (35.0%)	135 (28.7%)		
Very little	9 (22.5%)	104 (22.1%)		
Not at all	10 (25.0%)	58 (12.3%)		
Don't Know	3 (7.5%)	79 (16.8%)		
Not applicable	0 (0.0%)	53 (11.3%)		

5.7.3. Descriptive Analysis: An Overview of Data and Key Findings

Descriptive data analysis was performed to present an overview of LTC nurses'

characteristics and adoption/use of digital health technologies (EMR and virtual care) and their impact.

5.7.3.1. Electronic Medical Record Adoption and Use Among Long-Term Care Nurses: Exploring Perceptions, Attitudes, and Practices

The majority of nurses, 75 (59.5%), use a combination of paper and electronic charts to enter and retrieve older adults' clinical notes, followed by 30 (23.8%) nurses who use only paper charts, whereas 21 (16.7%) of nurses use electronic records instead of paper charts. The most commonly cited reasons for HIT use among LTC nurses include electronic communication to other health professionals within the organization (e.g., secure e-mail or messaging) with 74 (77%); electronic communication to other health professionals within the organization, 71 (74%); and electronic older adults care plans, 69 (71.9%). On the other hand, almost 70% of LTC nurse participants identified that *electronic warnings for adverse prescribing and/or drug interactions, electronic lists of all discharge summaries and discharge instructions for a older adults (including outside of the organization), electronic communication with other health professionals outside of the organization (e.g., virtual face-to-face e-consultation such as telehealth consultation),* and *electronic clinical decision support tool (e.g., BMI calculator)* are not available among LTC nurses. The use of electronic records and clinical information systems to *enter clinical documentation on patient encounters* is mostly new among LTC nurses, with a majority of 59 (61.4%) having less than 3–4 years of experience with the systems and only 23 (24.0%) of nurses having used the electronic record/clinical information systems for over six years. Only 15 (11.9%) LTC nurses mentioned the available budget and costs associated with implementing electronic systems as a barrier against HIT use /adoption.

5.7.3.2. Various Digital Health Technologies Adoption among LTC Nurses and their Functionalities

Various digital health technologies (e.g., EMR and virtual care) are available for nurses in their settings (e.g., Wolf, Practice Solutions, and MedAccess). Among them, SCM (Sunrise Clinical Manager) with 77 (80.2%), Omnimed and Meditech with 4 (4.20%) each, and Medesync with 3 (3.1%) are the most used technologies. Interestingly, almost 50% of nurses mentioned that some functionalities of electronic records, such as *electronic medication reconciliation*, *electronic order entry/prescribing of older adults medications*, *electronic warning for adverse prescribing and drug interactions*, *electronic receipt of laboratory test results from external laboratory/diagnostic imaging*, *electronic referral to other healthcare providers,* are not available in their settings. On average, only a quarter of LTC nurses use these functionalities in their environments. When LTC nurses are accessing and documenting older adults' information in their care setting, they mostly get access to older adults' information from two or more electronic systems and a paper chart.

Access to a mobile device to provide and document or communicate with other care team members is highly or moderately essential, with almost 85% of LTC nurses. The LTC nurses use digital health technologies (e.g., EMR) for different purposes. They mainly use digital health technology (e.g., EMR and virtual care) for older adults' safety reporting with 44 (45.8%), clinical outcomes with 38 (39.6%), strategic planning with 27 (28.1%), and government reporting (e.g., local, regional, provincial/territorial), staff assignment, and quality improvement combined with 21 (21.9%). LTC nurses use digital health technologies in their main settings for various purposes (Table 25). Interestingly more than 50% of LTC nurses mentioned that the electronic

flow sheet or checklist for managing older adults with chronic disease and electronic notification of hospital visits are the main reasons for the digital health technologies (e.g., EMR) use.

Table 25: The main reason for digital health technologies adoption/use among LTC nurses

Indicate which of the following you use in your MAIN care setting to support older adults' care	I currently use this functionality in my setting	This is available electronically – but I do not have access	Not available in my setting	Don't Know/ Unsure
Electronic communication with other health professionals within my organization (e.g. secure e-mail or messaging)	74 (77.1%)	9 (9.4%)	12 (12.5%)	1 (1.0%)
Electronic clinical documentation (e.g. assessments, progress notes)	71 (74.0%)	4 (4.2%)	19 (19.8%)	2 (2.1%)
Electronic patient care plans	69 (71.9%)	9 (9.4%)	18 (18.8%)	0 (0%)
Electronic communication with other health professionals outside my organization (e.g. secure e-mail or messaging)	54 (56.3%)	7 (7.3%)	31 (32.3%)	4 (4.2%)
Electronic list of all lab results/diagnostic imaging for a patient (including outside my organization)	59 (46.8%)	14 (11.1%)	49 (38.9%)	4 (3.2%)
Electronic access to provincial/territorial patient electronic health record systems (e.g. encounters, drug, laboratory, diagnostic images, discharge summaries)	52 (41.3%)	15 (11.9%)	51 (40.5%)	8 (6.3%)
Electronic list of all medications taken by an individual patient (including outside my organization)	51 (40.5%)	17 (13.5%)	55 (43.7%)	3 (2.4%)
Electronic flow sheet or checklist for management of patients with chronic disease. (e.g. clinical care pathway)	33 (34.4%)	6 (6.3%)	48 (50.0%)	9 (9.4%)
Electronic notification of hospital visits (e.g. emergency, admission, discharge, death)	32 (33.3%)	8 (8.3%)	48 (50.0%)	8 (8.3%)
Electronic ordering/order entry of laboratory tests	31 (32.3%)	21 (21.9%)	34 (35.4%)	10 (10.4%)
Electronic reminders for recommended patient care following clinical practice guidelines (e.g. complete falls risk assessment)	28 (30.2%)	6 (7.3%)	48 (51.0%)	10 (11.5%)
Electronic transfer of patients' clinical health information securely to other health professionals	26 (27.1%)	6 (6.3%)	50 (52.1%)	14 (14.6%)
Electronic clinical decision support tool (e.g. BMI calculator)	22 (22.9%)	9 (9.4%)	54 (56.3%)	11 (11.5%)
Electronic list of all discharge summaries and discharge instructions for a patient (including outside my organization)	25 (19.8%)	13 (10.3%)	78 (61.9%)	10 (7.9%)
Electronic communication with other health professionals outside my organization (e.g. virtual face-to-face e-consultation such as telehealth consultation)	20 (15.9%)	19 (15.1%)	76 (60.3%)	11 (8.7%)

Note: The top items in each category were highlighted in gray

5.7.3.3. Quality of Healthcare

The overall quality of nursing care provided to older adults was rated as Fair by 46 (36.5%), Good by 38 (30.2%), Poor by 22 (17.5%), and Excellent by 20 (15.5%) respondents. The items related to the quality of care within patient care (e.g., continuity of patient care and coordination of patient care) and nursing documentation mainly increased due to the use of

EMR and clinical information systems per 42 (43.8%) and 43 (44.8%) respondents, respectively (see Table 26 for more details).

Table 26: Quality of nursing care provided by LTC nurses

Thinking about your practice in your MAIN care setting, rate the impact of your use of electronic record/clinical information systems on the quality of nursing care you provide during a face-to-face encounter.	Greatly Increased	Increased	Did not change	Decreased	Greatly decreased	Not applicable	Not sure
Burden of administrative work	33 (34.4%)	30 (31.3%)	17 (17.7%)	8 (8.3%)	3 (3.1%)	3 (3.1%)	2 (2.1%)
Redundant data capture	22 (22.9%)	38 (39.6%)	18 (18.8%)	6 (6.3%)	3 (3.1%)	4 (4.2%)	5 (5.2%)
Nursing documentation	22 (22.9%)	43 (44.8%)	19 (19.8%)	5 (5.2%)	0 (0.0%)	5 (5.2%)	2 (2.1%)
Access to complete patient information	16 (16.7%)	50 (52.1%)	17 (17.7%)	4 (4.2%)	3 (3.1%)	4 (4.2%)	2 (2.1%)
Turnaround time for lab/diagnostic results to make clinical decisions	15 (15.6%)	20 (20.8%)	24 (25.0%)	10 (10.4%)	5 (5.2%)	21 (21.9%)	1 (1.0%)
Coordination of patient care	12 (12.5%)	42 (43.8%)	25 (26.0%)	7 (7.3%)	2 (2.1%)	5 (5.2%)	3 (3.1%)
Productivity in the nursing practice	11 (11.5%)	39 (40.6%)	21 (21.9%)	15 (15.6%)	5 (5.2%)	4 (4.2%)	1 (1.0%)
Facilitation of patient education by using the computer information	10 (10.4%)	26 (27.1%)	34 (35.4%)	2 (2.1%)	2 (2.1%)	18 (18.8%)	4 (4.2%)
Communication with other clinicians outside of the organization	10 (10.4%)	20 (20.8%)	43 (44.8%)	1 (1.0%)	3 (3.1%)	18 (18.8%)	1 (1.0%)
Continuity of patient care	10 (10.4%)	42 (43.8%)	27 (28.1%)	7 (7.3%)	3 (3.1%)	6 (6.3%)	1 (1.0%)
Care team communication	9 (9.4%)	37 (38.5%)	31 (32.3%)	7 (7.3%)	5 (5.2%)	6 (6.3%)	1 (1.0%)
Clinical decision making	9 (9.4%)	27 (28.1%)	45 (46.9%)	5 (5.2%)	0 (0%)	9 (9.4%)	1 (1.0%)
Quality of patient care you provide	8 (8.3%)	33 (34.4%)	37 (38.5%)	6 (6.3%)	2 (2.1%)	3 (3.1%)	7 (7.3%)
Identification of needed lab tests	8 (8.3%)	17 (17.7%)	30 (31.3%)	3 (3.1%)	1 (1.0%)	34 (35.4%)	3 (3.1%)
Communication with patients	6 (6.3%)	21 (21.9%)	47 (49.0%)	9 (9.4%)	1 (1.0%)	11 (11.5%)	1 (1.0%)
Medication errors	2 (2.1%)	9 (9.4%)	34 (35.4%)	13 (13.5%)	2 (2.1%)	26 (27.1%)	10 (10.4%)

Note: The top items in each category were highlighted in gray

Patient safety reporting, clinical outcomes, strategic planning, continuous quality improvement, staff assignment, government reporting (e.g., local, regional, provincial/territorial), nursing care quality reports, patient flow/bed management, and performance review are the most mentioned benefits among the LTC nurses in terms of digital health technology (e.g., EMR) use and organizational changes. The quality improvement of patient care in the organizations and within their process, such as access to complete patient information, nursing documentation, continuity of patient care, coordination of patient care, and productivity of nursing practice, were increased among almost 50% of LTC nurses. On the other hand, communication with patients, clinical decision-making, contact with other clinicians outside of the organization, quality of provided care, medication errors, facilitation of patient

education by using computer information, and ordering of fewer tests (due to better availability of lab results) did not change among 35%–49% of LTC participants' nurses.

5.7.3.4. Technology Design Considerations Among LTC

The LTC nurses mentioned that different electronic record and clinical information systems used in their settings are either partially, 50 (52.1%), or fully, 32 (33.3%), adequate for their work. However, they mentioned they were consulted "none at all", 59 (61.5%), or a little, 11 (11.5%), about decisions to introduce electronic records/clinical information systems and tools in their main care settings. Likewise, 62 (64.6%) of LTC nurses mentioned that they were not adequately consulted about decisions to introduce electronic records/clinical information systems and tools in their main care settings. Moreover, over 84% had "a little" or "none at all" input on using electronic records/clinical information systems and tools in their settings. When asked about design involvement in electronic record/clinical information systems in their primary care settings, more than half of LTC nurses replied, "none at all." Only around 5% to 10% of LTC participants mentioned that they had "a great deal " or "quite a lot" of impact on the aspects of the design, implementation, and ongoing use of electronic record/clinical information systems (Table 27).

Table 27: LTC nurses' input on aspects of the design, implementation, and ongoing use of digital health technology (e.g., EMR) in their main care settings

How much have you personally had input on aspects of the design, implementation, and ongoing use of electronic record/ clinical information systems in your MAIN care setting?	A great deal	Quite a lot	A little	None at all	Not Applicable
Workflow redesign leveraging systems to support continuous improvement	5 (12.5%)	0 (0.0%)	7 (17.5%)	24 (60.0%)	4 (10.0%)
Design and use of clinical order sets applicable to your practice	4 (10.0%)	3 (7.5%)	4 (10.0%)	21 (52.5%)	8 (20.0%)
Reporting requirements of the system	3 (7.5%)	4 (10.0%)	6 (15.0%)	23 (57.5%)	4 (10.0%)
Electronic reports about patient care	3 (7.5%)	7 (17.5%)	4 (10.0%)	21 (52.5%)	5 (12.5%)
Overall system design	2 (5.0%)	5 (12.5%)	9 (22.5%)	22 (55.0%)	2 (5.0%)
Clinical content requirements of the system	2 (5.0%)	8 (20.0%)	6 (15.0%)	21 (52.5%)	3 (7.5%)
The functionality of the system to improve workflow	2 (5.0%)	3 (7.5%)	15 (37.5%)	17 (42.5%)	3 (7.5%)
Access to dashboards to support monitoring and evaluation of clinical outcomes	2 (5.0%)	6 (15.0%)	5 (12.5%)	23 (57.5%)	4 (10.0%)
Usability of the system	1 (2.5%)	6 (15.0%)	8 (20.0%)	22 (55.0%)	3 (7.5%)
Changes to optimize the system(s) to get the most from clinician use	1 (2.5%)	5 (12.5%)	11 (27.5%)	20 (50.0%)	3 (7.5%)

Note: The top items in each category were highlighted in gray

Moreover, 53 (55.2%) LTC nurses require access to mobile devices to provide and document direct patient care, and 31 (32.3%) responded that the devices are moderately essential. Moreover, mobile access helps them to communicate with other care team members in their settings to facilitate day-to-day communication and care coordination (e.g., highly essential with 61 (63.5%) and moderately essential with 21 (21.9%)).

5.7.3.5. Barriers Against Digital Health Technologies (e.g., EMR) Adoption and Getting the Benefits of Adoption/Use

The barriers against digital health technologies (e.g., EMR) adoption/use among LTC nurses play a significant role. Examples of barriers mentioned by more than 90% of LTC nurses include too many clinical decision support (CDS) alerts or prompts by 123 (97.6%), a lack of permission to access systems by 117 (92.9%), and barriers to accessing electronic record/clinical information systems in the main care setting by 115 (91.3%). In addition, more than 50% of nurses identified additional adoption/use barriers, mostly related to available budgets, internal policies, and a combination of paper charts and electronic records. Interestingly, more than

84% of LTC nurses mentioned that HIT was not in place and their practice was not aligned with clinical workflow. However, training-related items, such as the lack of appropriate and applied training in nurses' undergraduate programs, primarily impacted LTC nurses' adoption of digital health technology.

5.7.3.6. Burnout

In addition to identifying barriers against HIT adoption, more than 36.5% of the LTC nurses mentioned some burnout symptoms, whereas 4 (3.2%) felt exhausted. Twelve (9.5%) have experienced burnout symptoms, 30 (23.8%) are burning out, and they have one or more signs of burnout, e.g., emotional exhaustion. They are in a position where they need assistance.

5.7.3.7. Benefits

LTC nurses identified a list of benefits resulting from digital health technology implementation (e.g., EMR) adoption/use. The reported benefits are mainly within three categories: improved communication, improved practice (collaboration, partnership, and evidence-based practice), and advocacy and policy changes. These benefits are mostly related to communication improvement among the LTC nurses to support patient transitions in care, improved communication among interprofessional teams within their practice, and support for communication with patients/families (Table 28).

Table 28: The identified benefits (e.g., communication, practice and policy) among LTC nurses

In your opinion, to what degree do electronic records/clinical information systems use in your MAIN Care setting?	A great extent	Somewhat	Very little	Not at all	Don't Know	Not applicable
Improved communication to support patient transitions in care	10 (25.0%)	10 (25.0%)	6 (15.0%)	12 (30.0%)	1 (2.5%)	1 (2.5%)
Expedited robust clinical research processes	7 (17.5%)	11 (27.5%)	9 (22.5%)	7 (17.5%)	5 (12.5%)	1 (2.5%)
Improved communication among inter-professional teams within your practice	7 (17.5%)	15 (37.5%)	5 (12.5%)	12 (30.0%)	1 (2.5%)	0 (0.0%)
Support communication with patients/families	7 (17.5%)	13 (32.5%)	9 (22.5%)	9 (22.5%)	2 (5.0%)	0 (0.0%)
Led to evidenced informed practice	6 (15.0%)	15 (37.5%)	7 (17.5%)	7 (17.5%)	4 (10.0%)	1 (2.5%)
Advanced patient/family and care team partnerships in care	6 (15.0%)	10 (25.0%)	10 (25.0%)	11 (27.5%)	3 (7.5%)	0 (0.0%)
Afforded more opportunities for research collaboration	5 (12.5%)	10 (25.0%)	12 (30.0%)	6 (15.0%)	6 (15.0%)	1 (2.5%)
Advanced patient/family advocacy issues within your practice	4 (10.0%)	14 (35.0%)	9 (22.5%)	10 (25.0%)	3 (7.5%)	0 (0.0%)
Informed new policy directions for nursing practice	3 (7.5%)	19 (47.5%)	7 (17.5%)	8 (20.0%)	2 (5.0%)	1 (2.5%)
Improved communication among clinical providers within your practice	0 (0%)	7 (17.5%)	14 (35.0%)	6 (15.0%)	12 (30.0%)	1 (2.5%)

Note: The top items in each category were highlighted in gray

5.7.3.8. Satisfaction

LTC nurses are moderately satisfied with 42 (43.8%), followed by moderately dissatisfied with 19 (19.8%) regarding digital health technology (e.g., EMR) implementation. The number of neither satisfied nor dissatisfied or very dissatisfied is 13 (13.5%), and only 9 (9.4%) of LTC nurses are highly satisfied with the digital health technology they currently use in their main care setting.

Only 9 (9.4%) of the LTC nurses are highly satisfied with the digital health technology (e.g., EMR) in their settings. They are mostly either moderately satisfied with 42 (43%) or moderately dissatisfied with 19 (19.80%).

5.7.3.9. Confidence

LTC nurses identified themselves as either very confident or confident, with 89 (92.8%) using digital health technology (e.g., EMR). Moreover, most nurses (82%) say their electronic

record-keeping systems are acceptable or somewhat suited for their profession; nevertheless, over half of them say their systems are only somewhat adequate. Most nurses (60%) feel mobile devices are critical for providing and documenting direct patient care and communicating with care team members to facilitate day-to-day care communication. Most nurses use digital health technology (e.g., EMR) for peer communications, clinical documentation, storing/reviewing lab results, and recording medication use. The LTC nurses have knowledge and experience with technology, whereas almost one-third of them said digital health technology (e.g., virtual care) had improved their abilities, knowledge, and healthcare efficiency. The LTC nurses are moderately satisfied with the quality of the formal training and access to ongoing learning and development training per 37% of participants. In contrast, almost half of the LTC nurses mentioned being neither satisfied nor dissatisfied, moderately dissatisfied, or very dissatisfied.

5.7.3.10. Knowledge and Skills

More than 40% of LTC nurses currently have the skills and knowledge to adopt/use digital health technologies (e.g., virtual care) in their nursing practice. Most LTC nurses (64.6%) are satisfied with the quality of the formal training they have received to support the use of digital health technology (e.g., EMR) systems in their main care settings. In contrast, almost 40% of them are satisfied with access to ongoing learning and development training to advance the use of electronic records and clinical information systems in their main care setting.

5.7.4. Examine the Relationships Between Digital Health Technology (e.g., Virtual care), Adoption/Use and Outcomes (Burnout and Benefits)

5.7.4.1. Bivariate and Regression Analysis of Adoption/Use of Digital Health Technology (e.g., Virtual Care) Impact on Quality Improvement and Benefit and Burnout

The bivariate correlation evaluates the degree of relationship between two variables. There are questions were selected for Bivariate analysis (Appendix 8). The bivariate correlation was conducted between different factors, including IVs, DV, and control variables. Bivariate correlation uses the relationship between the IV, DV, and control variables to predict the DV from knowledge of the IV. Pearson correlation is the most commonly used measure of the bivariate relationship without distinguishing between the IV, DV, or control variables. In this study, the bivariate correlation test was conducted among the adoption/use and its impact on efficiency and quality improvements.

Moreover, the correlation relationships between adoption/use and other factors, such as age, hours of work, and years of experience, were investigated. This analysis aims to examine and understand if there are any regression relationships between adoption/use and these identified outcomes. The null hypothesis is there is no significant prediction (regression relationship) between adoption/use and the pre-identified factors. The alternative hypothesizes the existing relationship between adoption/use and these factors.

5.7.4.1.1. Pearson Correlation Between Scale Factors

A significant negative correlation exists between the adoption and use of virtual care technology, the age of the individual, and their years of experience. When the percentage of

long-term care nurses who are older or more experienced increases, the adoption and use rates for virtual care technology tend to decrease (table 29).

Table 29: Pearson correlation analysis; Adoption/use and other factors (Scale-Scale)

	Adoption/use	Age	Hours of work	Year of experience	Population	Long of Adoption/use
Adoption/use		-.229**	0.107	-.156*	-0.111	0.067
Age			0.052	.801**	-0.014	0.114
Hours of work				-0.058	0.023	-0.004
Year of experience					-0.09	0.11
Population						0.059

**** Correlation is significant at the 0.01 level (2-tailed)**
*** Correlation is significant at the 0.05 level (2-tailed)**

It should not be surprising that a positive connection exists between years of experience and one's age, and this correlation is relatively high. I continue to examine both factors, years of experience and one's age, and I look into whether or not they have multicollinearity.

5.7.4.1.2. Spearman Rank-Order: **Adoption/Use and Other Factors (Scale-Ordinal)**

The correlation between adoption/use, burnout, efficiency, and quality factors was conducted. The Spearman rank-order correlation coefficient (also known as Spearman's correlation) is a non-parametric measure of the degree and direction of the relationship between two variables assessed with at least one in an ordinal scale. The test is used for ordinal variables or continuous data (Siegel & Castellan, 1988) (Table 30).

Table 30: Spearman rank-order; Adoption/use and other factors (Scale-Ordinal)

	Burnout	Efficiency	Quality
Adoption/use	-0.053	0.147**	.155***
Burnout		0.039	0.071
Benefits			-0.034

***** Correlation is significant at the 0.05 level (2-tailed)**
**** Correlation is significant at the 0.1 level (2-tailed)**

Significant and positive correlations exist between adoption/use and efficiency and quality. The more LTC nurses used virtual care technologies, the more they reported efficiency and quality improvements. However, the relationship between adoption/use and burnout is

not significant.

5.7.4.3.2. Point-Biserial Correlation: **Adoption/Use and Other Factors (Scale-Nominal)**

A point-biserial correlation is used to quantify the strength and direction of the relationship between one continuous variable and one dichotomous variable. It is a subset of Pearson's product-moment correlation, used when there are two continuous variables, but one is assessed on a dichotomous scale in this case (Brody et al., 2004) (Table 31). As shown in Table 31, there is no correlation between adoption/use, gender, or direct care.

Table 31: Point-Biserial Correlation; Adoption/use and other factors (Scale-Nominal)

	Gender	Direct care
Adoption/use	-0.028	-0.023
Gender		-0.045

5.7.4.2. Linear Regression

In statistics, linear regression models quantify the connection between a response variable and one or more predictor variables. Linear regression is the most commonly utilized regression technique. It examines the relationship between a single dependent variable and one independent variable. This technique determines the linear relationship with the lowest sum of squared variances. The linear regression identifies a single DV's best predictor variables (IVs) combination. The indicators are comparable with R-squared in linear regression analysis. All variables were entered into the measurement model to analyze the R-squared values, show the coefficients of multiple determination (i.e., variance explained), and interpret the beta coefficients (β). This coefficient shows the change in the dependent variable for a unit change in the independent variable. The independent variables do not provide association values if the R-squared value is zero or close to zero. The SPSS software was used to analyze linear regression

with different R parameters to make these values a judgment tool for hypotheses testing. The linear regression focused on the analysis of variance and was mainly used to get the sequence of regression in terms of weight and tension factors. The weighting scheme provides the highest R-squared value for the elements. It is also used to test the internal validity and consistency of the constructs in the model.

Factors with significant correlation were included in regression analysis in the next phase. Several assumptions must be met for linear regression. Firstly, the dependent and independent variable(s) relationship must be linear, i.e., the association should follow a straight line. The observations must also be independent of each other, which means that the value of the dependent variable for another observation should not influence the value of the dependent variable for one observation. In addition, the variance of the error term should be constant across all levels of the independent variable(s), known as homoscedasticity. This means that the spread of the residuals (i.e., the differences between the predicted and actual values) should be the same for all independent variable values (s) values. The residuals should also be normally distributed, with most residuals falling close to zero and fewer residuals farther from zero.

Furthermore, if there are multiple independent variables, there should be no high correlation between them, known as multicollinearity. The presence of multicollinearity can lead to unstable or unreliable estimates of the coefficients in the model. To check whether these assumptions are met, I performed various diagnostic tests on the model, such as plotting the residuals against the predicted values to check for linearity and homoscedasticity and using a normal probability plot or a histogram to check for the normality of residuals.

5.7.4.2.1. The Relationship between Electronic Medical Record Adoption/Use and Quality of Care in Long-Term Care Facilities: Age and Years of Experience as Moderators

Linear regression was used to test if digital health technology (e.g., virtual care) adoption/use significantly predicted quality improvement after controlling for the moderating variables. The overall regression was statistically significant, with R^2=0.028 and significant F change=0.03. Moderating factors (age and years of experience) significantly correlated with adoption/use. However, these moderating factors reduced R^2 to 0.021, and significant F change became 0.063 (Table 32). The adoption/use significantly predicts quality improvement, and age or years of experience decrease this impact.

Table 32: Quality of healthcare: Adoption/use with Age and Years of experience as moderators

Dependent Variable: Quality	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	*F Change*	*df 1*	*df2*	*Sig. F Change*
1: Adoption/use	0.17	0.028	0.022	0.98	0.028***	4.783	1	164	0.030***
2: Years of experience, Age	0.12	0.014	0.002	0.98	0.014	1.17	2	163	0.313
3: Years of experience, Age, Adoption/use	0.19	0.035	0.017	0.98	0.021**	3.506	1	162	0.063**

***** Correlation is significant at the 0.05 level (2-tailed)**

**** Correlation is significant at the 0.1 level (2-tailed)**

The results showed a significant correlation between adoption/use and quality as outcome factors, including age and years of experience as moderating factors (Table 32). These correlation coefficients are significant between adoption/use and quality, and control factors, including age and years of experience, do not impact this relationship (Table 33).

Table 33: Coefficients of linear regression model between adoption/use, age, years of experience & quality

Dependent Variable: Quality		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	*Std. Error*	*Beta*			*Zero-order*	*Partial*	*Part*	*Tolerance*	*VIF*
1: Adoption/use	(Constant)	2.389	0.081		29.436	0					
		0.033	0.015	0.168	2.187	0.03	0.168	0.168	0.168	1.000	1.000
2: Age, Years of experience	(Constant)	2.806	0.251		11.171	0					
	Age	-0.125	0.108	-0.151	-1.16	0.248	-0.116	-0.091	-0.09	0.358	2.791
	Years of experience	0.004	0.011	0.043	0.333	0.74	-0.078	0.026	0.026	0.358	2.791
3: Age, Years of experience and Adoption/use	(Constant)	2.647	0.263		10.054	0					
	Age	-0.089	0.108	-0.107	-0.82	0.413	-0.116	-0.064	-0.063	0.347	2.881
	Years of experience	0.003	0.011	0.032	0.246	0.806	-0.078	0.019	0.019	0.358	2.797
	Adoption/use	0.029	0.016	0.149	1.872	0.063	0.168	0.146	0.145	0.945	1.058

5.7.4.2.2. Linear Regression Between Benefits (e.g., Efficiency Improvement), Adoption/Use, Age, and Years of Experience

A similar linear regression was conducted to identify the relationship between benefits (e.g., efficiency), adoption/use, age, and years of experience (Table 34).

Table 34: Model fit: Adoption/use and efficiency with age and years of experience as moderators

Dependent Variable: Efficiency	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	*F Change*	*df1*	*df2*	*Sig. F Change*
1: Adoption/use	0.018	0.000	-0.007	1.015	0.000	0.044	1	144	0.833
2: Age, Years of experience	.121	0.015	0.001	1.011	0.015	1.064	2	143	0.348
3: Age, Years of experience and Adoption/use	.122	0.015	-0.006	1.014	0.000	0.018	1	142	0.894

As shown in Table 35, there is no regression relationship among any combination of efficiency, adoption/use, age, and years of experience. Even the moderating impact of age and years of experience do not impact the relationship between efficiency and adoption/use (Table 35).

Table 35: Coefficients: Adoption/use and Efficiency with Age and Years of experience as moderators

Dependent Variable: Efficiency	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	*Std. Error*	*Beta*			*Zero-order*	*Partial*	*Part*	*Tolerance*	*VIF*
(Constant)	2.699	0.090		30.027	0.000					
Adoption/use	.004	.017	.018	0.211	0.833	0.018	0.018	0.018	1.000	1.000
(Constant)	3.07	0.274		11.19	0					
Age	-0.126	0.118	-0.148	-1.07	0.287	-0.119	-0.089	-0.089	0.358	2.791
Years of experience	0.003	0.012	0.036	0.263	0.793	-0.082	0.022	0.022	0.358	2.791
(Constant)	3.083	0.291		10.6	0					
Age	-0.129	0.12	-0.152	-1.073	0.285	-0.119	-0.09	-0.089	0.347	2.881
Years of experience	0.003	0.012	0.037	0.268	0.789	-0.082	0.023	0.022	0.358	2.797
Adoption/use	-0.002	0.017	-0.011	-0.133	0.894	0.018	-0.011	-0.011	0.945	1.058

Multicollinearity was checked in both regression analyses. The VIF is less than 3 and shows no multicollinearity issue in the study.

5.7.5. Hypothesis Test Results

This study found no relationship between adoption/use and burnout among LTC nurses. However, there is a strong inverse relationship between age, years of expertise, and the acceptance and use of virtual care technology. The acceptance and use rates for virtual care technology tend to decline as the proportion of elderly or more seasoned long-term care caregivers rises. Significant and favourable relationships exist between the acceptance and use of technology and its effectiveness and quality. The greater the use of virtual care technologies by LTC nurses, the more they reported improved productivity and quality. On the other hand, there is no correlation between adoption/use, gender, or direct care.

The study investigated the relationship between the adoption and use of digital health technology, specifically virtual care, and the quality of care provided by LTC nurses. To test this relationship, linear regression analysis was used to examine whether the adoption and use of

virtual care significantly predicted quality improvement after controlling for potential moderating factors. Two moderating variables, age and years of experience, were significantly correlated with adoption and use. The analysis revealed a significant correlation between the adoption and use of virtual care and the quality of care provided. Age and years of experience were also found to moderate this relationship.

Moreover, the study examined the potential regression relationship among the variables of efficiency, adoption/use, age, and years of experience. However, the analysis showed no significant regression relationship among any combination of these variables. In summary, the findings of the secondary data analysis showed a significant relationship between the adoption and use of virtual care technology by LTC nurses and improved quality and productivity of care. This is important to consider when implementing virtual care technology in LTC settings and highlights the potential benefits of such technology for both nurses and residents.

This research also revealed two major themes that can contribute to improving the quality of care in LTC settings: enhancing working conditions and improving communication and collaboration among team members. To address the first theme, policymakers and healthcare leaders should prioritize providing better staff support, reducing workload, and improving safety to enhance staff well-being and lower turnover rates. For the second theme, strategies such as training programs, regular team meetings, and other initiatives to foster collaboration and communication should be implemented to improve the working environment and enhance the quality of care for residents. By addressing these two themes, long-term care settings can

improve the overall quality of care and satisfaction for staff and residents.

5.8. Study Limitation

It is crucial to note that the research design and the available data have certain restrictions. This research relies on data from a single nation, which limits its generalizability. Moreover, too many missing values are in the dataset, reducing the accuracy of the results. I suggest adding a response mechanism in future surveys to encourage participants to respond to the survey questions as much as possible. Despite adequate participants in this survey, the number of LTC nurses is limited. There is a need for further studies among a larger sample size of LTC nurses. The coverage of questions in the survey was mainly related to a pre-defined information system success model (i.e., DeLone & McLean, 2003), such as the quality of healthcare and net benefits. However, there are factors identified in prior studies that impact the adoption and its effects, such as culture, habit, and practice change. The previous models do not include these factors, and there are no questions in the survey to refer to these factors.

Moreover, the identified factors are mainly limited to individual characteristics, and factors related to the Organizational dimension (such as practice change or organizational perspective) are missing in the studies. Future studies should use multidimensional models and factors to investigate the adoption factors beyond well-known adoption models and not limit these models and relations. The language of questions needs significant changes. Each question should specifically ask about one specific factor, and questions should not mix the adoption factors and results of adoption in one query. The data collected for this study primarily consists of data obtained from female nurses in Quebec. However, it is worth noting that the oversampling of Quebec may lead to different characteristics in the data, such as variances in

the health system and long-term care facilities compared to other provinces. It is essential to acknowledge that this study's sample of predominantly female nurses is consistent with the national percentage of women in the nursing profession, which is over 90%. Future research should diversify the sample population among other provinces/regions and genders to represent all nurses' populations.

The cross-sectional study prevents saying confidently if there is a causality or simply an association. Most of the questions are nominal (e.g., barriers). Nominal data is used to label variables without providing numerical values. They are inadequate for advanced statistical analysis, such as a structural equation model (SEM), requiring ordinal or scale responses. In contrast to ordinal data, nominal data cannot be ordered or measured. Unlike those using the Likert scale, these questions do not allow advanced statistical analysis, such as SEM. Unlike first-generation approaches, SEM enables researchers to evaluate complicated models, including the direct and moderating effects (Hair et al., 2010; Schumacker & Lomax, 2010). Advanced statistical analysis, such as SEM, also allows mistakes in verifying measurement (Hair et al., 2010; Schumacker & Lomax, 2010; Byrne, 2016). Additionally, unlike most exploratory multivariate approaches, SEM is regarded as a confirmatory rather than an experimental approach, albeit the latter might be handled using SEM (Anderson & Gerbing, 1988; Kline, 2015; Byrne, 2016). As a result, it is more suited to testing hypotheses than other multivariate methodologies (Byrne, 2016). Finally, SEM assists researchers in determining how well a suggested model fits the data obtained and gives numerous statistical indicators to help enhance model fit (Hair et al., 2010; Blunch, 2012; Kline, 2015). The data quality is primarily measured by 1) completeness, 2) availability and accessibility, 3) currency, 4) accuracy, 5)

validity, 6) usability and interpretability, 7) reliability and credibility, and 8) consistency (Hair, Black, Babin, & Anderson, 2018). Based on these criteria, the data completeness was “very low,” availability and accessibility were “good,” currency and accuracy were “fair,” validity was “low,” usability and interpretability were “low,” reliability and credibility were “low,” and consistency was “low”. Overall, data quality was deficient in this dataset. Future studies should use these criteria in their design and collect high-quality data.

The data is mainly collected from Quebec, which may result in a bias toward this region. It is essential to ensure that the sample is representative of the overall population and that the data accurately reflects the experiences of nurses from each area. This can be done through careful sampling strategies, such as ensuring that the sample includes nurses from different geographic locations, healthcare settings, and demographic groups.

5.9. Study Implications

5.9.1. Implication of Theory

Prior research has not necessarily used models that were defined to consider the particularities of LTC. This study showed that digital health technology adoption/use in LTC is associated with significant impacts, including quality improvement. This study showed a difference between LTC nurses and other nurses in LTC settings. The LTC nurses have more difficulties with documentation, order entry, access to data, healthcare system notifications, supporting tools, communication within the organization and with outside organizations, policy and regulations, documentation, consultation, training, and design requirements than other nurses. The LTC organization should consider these characteristics and provide facilitation for them. These factors were studied, investigated, and researched beyond these well-known

models within the individual, technological, and organizational factors. In addition, the results of this study showed that the impact of adoption/use should be studied beyond the factors and in individual, organizational, and technological dimensions. This model should be further developed and tested with more diverse samples and other environments.

5.9.2. Implication to Practice

There is a connection between adopting or using digital health technologies and quality improvement. Long-term care nurses who reported adopting or using digital health technologies suggested this specific effect. Building on these results and developing measures to improve or reinforce existing procedures in light of what was discovered is something that LTC homes can do. The provincial governments may educate their policies and regulations with comparable information indicating that digital health technology increases healthcare quality. This is significant not just at the policy level but also at the level of the general public.

LTC organizations' leadership and policymakers should facilitate digital health technologies adoption/use and reduce the barriers to the impact of digital health technologies on LTC nurses. Leadership teams and policymakers should use the effects of HIT adoption within the *Individual* and *Organizational* dimensions. They should apply these impacts to their practice. Moreover, LTC nurses are satisfied with digital health technologies; however, there are significant differences between LTC nurses and other nurses. LTC nurses face more barriers in accessing digital health technologies, using paper charts and electronic records, using multiple logins, and having more unreliable networks. The leadership team and policymakers should facilitate LTC nurses and reduce barriers to full benefits.

6. Research Conclusion

6.1. Summary of research

This thesis explores the adoption/use of HIT in older adult care, focusing on understanding stakeholders' perspectives, including LTC nurses and older adults in the community. By examining the perspectives of these stakeholders, the thesis aims to provide a comprehensive understanding of the factors that influence the adoption and use of innovations and technologies in LTC settings. LTC nurses are critical in implementing new practices and caring for older adults in LTC facilities. As such, it is essential to understand their views and experiences regarding adopting and using new technologies. Older adults in the community are also an important stakeholder group to consider, as they are the ultimate beneficiaries of LTC services. Understanding their perspectives on the use of technologies in LTC can help ensure that these technologies are responsive to their needs and preferences and are integrated to maximize their benefits. By examining the perspectives of these different stakeholder groups, the thesis seeks to identify the most significant factors in promoting the adoption and use of Health information technology in LTC settings. This information can be used to develop strategies tailored to the needs and preferences of different stakeholders, and that can be used to promote the successful implementation of new practices in the LTC industry. Overall, by examining the perspectives of various stakeholders, including LTC nurses and older adults in the community, the thesis aims to provide a comprehensive understanding of the challenges and opportunities associated with adopting and using health information technology in the LTC industry. Moreover, this study highlights the importance of individual-level factors, such as user readiness, user training, and user support, in successful HIT technology adoption. Organizations

should provide adequate training and support to users to ensure they can use the technology effectively. Additionally, the study recommends that technological factors, such as system reliability, data security, and user interface, should be considered while evaluating HIT technology adoption.

It is challenging for older adults to continue living independently or participate in community activities, particularly if they have additional healthcare needs and varying degrees of frailty (Metzelthin, van Rossum, de Witte, Ambergen, Hobma, Sipers, & Kempen, 2013). Given the examination of existing knowledge and research addressing the information from older adults' technology adoption, a systematic review addresses this state of evidence on technology adoption by older adults in the community. A comprehensive literature review was conducted to synthesize and integrate research on the impact of various factors related to the adoption of HIT among older adults. Due to the scarcity of accessible research, particularly in the Canadian healthcare system, a Delphi study was conducted by gathering data from one of Ontario, Canada's most important older adult healthcare institutions. The Delphi study was conducted with 20 nurses working in an LTC institution to investigate variables influencing their acceptance of new technology and care delivery techniques. Secondary data analysis was conducted to examine the impact of the adoption on the benefits and quality of healthcare. The obtained evidence will guide future research on implementing HIT and treating older adults.

6.2. Contribution of the thesis

6.2.1. HIT Adoption and Impacts in LTC

In a comparison of previous studies, the result of this study offers a framework for

understanding characteristics impacting nurses' adoption/use of HIT in older adults' care and its impact. It expands theory by integrating crucial elements that previous theories do not cover. It also contains a synopsis of the current studies' outcomes. The Organizational layer encompasses process, task, and benefit levels comprising multiple adoption factors such as cost and pricing value, improved communication, leadership support, learning and training, policy and regulation, and quality improvements. Despite many rules about healthcare service finance, nurses in various locations have worries about the cost and price impact of HIT adoption. Communication enhancements among nurses and patients are critical to nurses' HIT adoption, and overall, the technology expense should provide consumers with value. Policy and legislation are driving factors in nursing technology adoption/use. Additionally, the Organizational dimension of HIT adoption includes leadership support, organizational viewpoint, and policies and regulations as highlighted factors. Encouraging HIT adoption and use requires essential support from leaders and clinical advocates. Likewise, a process-level viewpoint is a foundation for the necessary changes and adoption of current rules and procedures.

The benefit is the positively perceived, quantified, and measurable change from fulfilling healthcare deliverables. Although the benefit has been utilized for numerous years in various fields, including business, its implementation in healthcare research has been limited. Although HIT is a vital tool for improving healthcare services for older adults, little is known about the advantages and outcomes of its adoption/use by LTC nurses. There is a deficiency in the HIT-benefit research in the healthcare sector, particularly among LTC nurses. Most research in this field relates to other areas, such as acute care. In addition, there was little involvement of

geriatricians in the treatment process, and none of the current information systems were designed with older adult healthcare requirements in mind. Using HIT for geriatric emergency treatment may aid in overcoming current barriers. Identifying the potential benefits of adopting HIT for nurses in LTC will enhance the utilization of financial, physical, and human resources and staff performance. These systems must be constructed for several purposes, including reducing workload, hospitalization, and readmissions. Additionally, these solutions facilitate data accessibility and collaboration amongst multiple specialties. However, further research is required to establish the effectiveness of technology in this sector.

The literature review presented a contribution to the literature on HIT adoption by nurses in the LTC. Its results indicate that healthcare practitioners need mixed abilities and technology-specific competencies to obtain the essential attitude toward HIT use. I argued that multidimensional models better capture the complexity of HIT adoption issues and their implications and would be more effective in promoting HIT adoption/use among older adults and their healthcare providers (i.e., nurses). In addition, the TAM and UTAUT models missed some essential factors specific to the healthcare domain (task, communication challenges). A complete and integrated methodology is required to quantify the intention of healthcare professionals to utilize HIT. The specific adoption model should integrate different adoption factors and utilities and their impact and influence on a successful HIT adoption/use.

6.2.2. Older Adults' HIT Adoption in the Community

I synthesized empirical studies that evaluated adoption factors and moderators taken into consideration by selected studies. The SR contributed to older adults' HIT adoption and critically evaluated and synthesized the information already available on the adoption of HIT by

older adults. The systematic review results suggest that most studies on adopting HIT by older adults did not consider a technology adoption model or framework. In many instances, the authors defended their choice of the adoption model explored in the empirical study by situating it within the framework of their research. On the other hand, some technologies, such as telehealth at home, and models for embracing information technology, like UTAUT(2), have been explored more often than others. There is a need for an adoption model to go beyond prior adoption models, such as UTAUT and TAM, to examine and explain the adoption of HIT among older adults.

Despite increasing efforts made in recent years to examine the adoption of HIT by older adults, the data in this field remains fragmented, with a continuing emphasis on using existing models and standard rationalistic methodologies to investigate this subject. To this day, we do not seem capable of explaining the low level of HIT adoption by older adults and the variance in technology use within this population. As a result, comprehension is critical for adequately capitalizing on the potential of these technologies to improve elderly care in the community. It seems we have reached a minimal yield to our ability to explain the relatively low level of HIT adoption by this group of users in the context of diverse healthcare systems. The inconsistent and ambiguous data related to most of the criteria considered in the published research serves as further evidence. The concern is whether the study done in this area, within the framework of the current paradigm, is appropriate to understand better older adults' behaviour regarding HIT and to effectively meet their care requirements by using these tools. I propose that research on older adults' HIT adoption should go beyond the traditional paradigm and explain the low rate of HIT adoption in today's environment and the variation in elderly HIT adoption

across countries and regions. The low level of HIT adoption among older adults in today's environment directly results from the traditional paradigm of HIT adoption. Information systems research on HIT innovations in organizations has historically challenged pre-existing paradigms to broaden the perspective and investigative lens, thereby contributing to a more comprehensive understanding of innovation diffusion in these environments. In the context of older adults' HIT applications, would a paradigm shift help us understand how HIT helps healthcare for older adults in the community and the conditions that enable them to adopt these technologies and get the most out of them.

Moreover, there has been very little research to explore the adoption of information technology by older adults, considering their communal environment, which may be influenced by the web or network of contacts between them and their surroundings. It is crucial to investigate the discourse between older adults, their families and other caregivers, their peers, their healthcare professionals, and the technology suppliers in an environment as complicated as healthcare, where older adults engage with various people who contribute to their care. In agreement with Schulz et al., research on the elderly and technology uptake should go beyond documenting the facilitators and impediments. Instead, we need to understand better the environment (organization and technology) the elderly live in and how they interact with it (Schulz et al., 2015). To better inform efforts and initiatives in this area, further study should examine the nature and significance of interactions, such as older adult family/caregiver, older adult/older adult, and older adults/vendor, that may affect an older adult's choice to use or not use technology. I think an "older adult-centred" digital health research plan that contributes to the care of older adults in the community would be supported by discovering the function of

communication and interaction between the aged and their surroundings. Future research should also investigate the viewpoints of those who provide healthcare (i.e., nurses). In addition, many healthcare systems in the world's nations and regions are distinct. For instance, the HIT cost is not a concern for older adults living in areas where the state provides healthcare, but it might be a challenging obstacle to overcome in other regions. Therefore, factors at the system level may play an essential part in influencing the uptake of HIT by older adults, particularly at the community level. When researching this field, it is essential to thoroughly investigate and explain how policies and HIT cost coverage might differ.

Living independently or remaining in the community can be challenging for older adults, especially if they have additional healthcare needs and different levels of frailty. HIT presents opportunities to support older adults by enabling independent living, increased safety, better symptom management, and enhanced quality of life. Despite these opportunities, this group's relatively low level of HIT adoption calls for more research in this area and more rigorous and qualitative studies that better understand this population's perspectives and preferences, considering their collaborative environment and discourse and interactions within it. Due to the older adults' low HIT adoption, I am advocating for more in-depth research to be conducted in this field using an "older adult-centred" perspective. This perspective considers the discourse and interaction between older adults and their healthcare providers (i.e., nurses) to understand better the factors that influence the rate at which older adults adopt technology and meet their requirements.

6.3. Long-term Care Nurses HIT Adoption in a Canadian Setting

The results of the Delphi study identified and rated the following variables as being the

most important in terms of adoption: *workload impact*, *ease of use and technology complexity*, *training and education*, *quality of healthcare*, *technology benefits and usefulness, reliability of technology, troubleshooting and technical support, communication challenges, data/information accuracy, limited time for learning, privacy and security concerns, accessibility of technology, compatibility and adaptability of technology, funding availability, technology-related anxiety, technology design considerations, experience with technology,* and *adequacy of change management*. In this research, nurses indicated the top five factors: *workload impact*, *ease of use and technology complexity*, *training and education*, *quality of healthcare*, and *technology benefits and usefulness*. Notably, technology-related criteria such as *technology-related anxiety*, *technology design considerations*, and *experience with technology* were placed lowest, along with the *adequacy of change management*. This research's findings align with previous studies that investigated the factors influencing nurses' adoption of HIT (Asua et al., 2012; Barakat et al., 2013; Alaiad & Zhou, 2014; Luciano et al., 2020). The HIT adoption factors such as social influence, performance expectancy, trust, privacy concerns, ethical concerns, facilitating conditions, perceived usefulness, compatibility, culture, and training are identified and mentioned in prior studies such as Asua et al., 2012; Barakat et al., 2013; Alaiad & Zhou, 2014; Luciano et al., 2020. These factors are mainly in the individual dimension (age, trust, social influence). At the same time, factors in the organizational dimension are missing in studies (e.g., workload impact and healthcare quality). In addition, there are factors mostly related to the technological aspect (e.g., reliability of technology, data/information accuracy) of adoption, which is neglected in prior studies.

On the other hand, a review of prior studies shows some inconsistency. Even though

several technology adoption models and adoption factors have been found in previous studies, researchers have not compiled a complete list of recognized adoption factors with reliable predictive power among LTC nurses. In addition, the medical informatics literature is lagging regarding nurses' perspectives on implementing HIT.

Since Canada has a public health system, the government must approve certain healthcare institutions' decisions and regulations. These decisions and restrictions affect the adoption of these technologies among healthcare providers (i.e., nurses). Despite many adoption models that have arisen, are extensively used in healthcare organizations, and have been introduced in previous studies, information system adoption continues to be a lengthy and challenging process, especially among nurses in LTC and older adults' care (Vest, Jung, Wiley, Kooreman, Pettit, & Unruh, 2019; De Leeuw, Woltjer, & Kool, 2020). The results of the Delphi study show various adoption factors grouped in the Individual, Organizational and Technological dimensions and their layers. The Individual dimension's human-technology interaction layer includes ease of use and technology complexity, training and education, troubleshooting and technical support, privacy and security concerns, technology-related anxiety, and experience with technology. The Organizational dimension includes a process (e.g., quality of healthcare, communication challenges, funding availability, and adequacy of change management), task (e.g., workload impact and limited time for learning), and benefits (technology efficiency and usefulness). Finally, the Technological dimension includes functionality within the reliability of technology, data/information accuracy, accessibility of technology, compatibility and adaptability of technology, and design consideration layers.

6.4. Impact of HIT Adoption in the Canadian LTC Setting

The national survey aims to determine the professional characteristics of Canadian nurses who access virtual care in 2020, how these characteristics vary across different technologies, and whether these nurses have the necessary skills and knowledge to use these technologies. The identified factors were categorized into Individual, Organizational, and Technological dimensions aligned with prior sections in literature reviews. The Individual dimension includes LTC nurses' concerns, such as satisfaction (e.g., desires, expectations, or needs are met), burnout (e.g., mental, emotional, and physical exhaustion from intense stress), confidence (e.g., a sense of one's abilities or circumstances), knowledge (e.g., applying the knowledge to business decisions or opportunities is knowledge use), skills (i.e., ability to employ computer-based technologies to perform tasks such as computer skills, database administration), and information security (i.e., secure communication between healthcare providers and older adults).

The Organizational dimension consists of benefits (e.g., improved communication to support patient transitions in care, expedited robust clinical research processes, and improved communication among interprofessional teams within the practice), and quality improvements (e.g., the burden of administrative work, redundant data capture, and nursing documentation). The quality of healthcare services such as care quality and patient data, knowledge and training (e.g., sufficient training in healthcare institutions is not always accessible), communication difficulties (e.g., low communication among nurses, who favour verbal over digital communication, and communication issues), and funding availabilities (long-term care has limited resources and new technology may be expensive) are dividing factors toward HIT

adoption among the LTC nurses.

Lastly, the Technological dimension comprises various technology design characteristics and functionality (e.g., electronic communication to other health professionals within the organization, electronic clinical documentation, and electronic communication to other health professionals outside the organization). In the design layer, technology design considerations are included (their current system and equipment are sufficient for their needs) and technology functionality with the accessibility of technology (e.g., technology availability and accessibility at the institution for all groups, such as computer for point-and-click care and cell phone to communicate with staff) and compatibility and adaptability of technology (e.g., new technologies' adaptability to the long-term care setting, integration with existing records, and compatibility with various equipment are essential).

6.5. Studies' Integration and Future work

Despite increased efforts in recent years to investigate HIT adoption/use by older adults and healthcare providers, evidence remains scattered. To date, we seem unable to explain the low level of HIT adoption by older adults and healthcare providers (i.e., nurses). We have yet to reach a point to explain this group of users' relatively low level of HIT adoption. Integrating this study in different phases (SR, Delphi, and survey) posits that research on older adults and nurses should extend beyond the traditional IT adoption paradigm to explain the low level of HIT use among older adults and nurses in today's environment. Advocates of HIT have claimed benefits by identifying and analyzing threats to successful adoption among nurses. Yet, limited information is available on nurses' perceived challenges concerning using these technologies and the issues they might face. This research aims to fill the understanding gap of factors and

challenges that affect adopting these technologies from the older adults and nurses' perspective by providing several implications for practitioners. The individual, organizational, and technological adoption factors affect the adoption/use among older adults and their health providers. Moreover, the adoption/use impacts the Individual, Organizational and technological dimensions.

Healthcare organizations should take this older adult technology adoption and impact framework as a starting point and test it in future studies. These factors should be applied within the organization through change management. Since older adults may have a specific health condition in using EMR, their health condition was mentioned as an adoption factor; however, this does not impact adoption among LTC nurses. Interestingly, despite prior studies mentioning the impact of burnout on adoption, this study could not find any effect of adoption/use on burnout.

The adoption factors within all its layers, including *process*, *task,* and *benefits,* impact the adoption/use. Interestingly, adoption/use improved the quality of care. Technology compatibility, accessibility, and reliability impact the adoption of HIT among LTC nurses. Similarly, technology design as per LTC nurses' requirements affects the adoption, and Health information technology which meet these requirements have a higher chance of being adopted/used.

Table 36 indicates a significant overlap in the identified factors that impact the adoption of HIT between older adults and LTC nurses, except for health conditions and habits. The health condition of older adults is a critical driver for their adoption of HIT. In comparison, the habit of using technology is a significant factor for older adults but not for LTC nurses. Additionally, the

table suggests that LTC nurses may have different factors influencing their adoption of HIT, such as their workload and work conditions, which are not significant factors for older adults. It is important to consider these differences when developing strategies to increase the adoption of HIT among LTC nurses and older adults. For example, interventions aimed at improving the ease of use of HIT may be more effective for older adults.

In contrast, interventions that address workload and resource constraints may be more effective for LTC nurses. Further research is necessary to explore these differences and develop targeted interventions to overcome barriers to HIT adoption in these populations. Additionally, it is essential to consider technological and organizational factors that may impact HIT adoption among LTC nurses, such as attitudes toward technology and management support for HIT implementation.

It is also important to note that while there is overlap in the factors that impact HIT adoption for older adults and LTC nurses, these populations may have different needs and preferences regarding HIT design and functionality. For example, older adults may benefit from larger font sizes, simpler user interfaces, and features that support medication management, while LTC nurses may require HIT systems that integrate with other clinical systems, support care planning and documentation, and allow for easy communication with other members of the care team. Overall, understanding the similarities and differences in the factors that impact HIT adoption among older adults and LTC nurses is crucial for developing effective strategies to promote HIT adoption and use in these populations. Further research is needed to identify the most effective interventions and HIT design features for each population, as well as strategies for addressing the unique challenges and barriers faced by LTC nurses in particular.

Table 36: Health information technology adoption and its impact on older adults' healthcare

SLR (Older adults)	LR and Delphi (LTC nurses)				2020 National survey (LTC Nurses)		
Factors	**Factors**	**Layer**	**Dimensions**		**Dimensions**	**Layer**	**Factors**
Age	Age	Demographic	Individual	**Usage / Adoption**	Individual	Demographic	Age
Level of education	Level of education						Level of education
Gender	Gender						Gender
Experience/ Training	Knowledge and experience with technology						Knowledge and experience with technology
Health condition							
Self-Efficacy	Self-confidence	Human-technology interaction				Human-technology interaction	Confidence
Habit							
	Satisfaction						Satisfaction
Technology anxiety	Technology-related anxiety						
Effort Expectancy	Ease of use (system Complexity)						
Performance Expectancy	Usefulness						System usability
Privacy/Security	Privacy and security concerns						Privacy and security concerns
	Culture	Social influence					
	Developing competence						
	Ethical concerns						
Culture	Motivation						
	Project champions						
	Environmental influence						
	Leadership support						
	Burnout	Burnout				Burnout	Burnout
	Learning and Training	Process	Organizational		Organizational	Process	Learning and Training
	Policy and Regulation						Policy and Regulation
High Price/Cost Value	Cost and price value						
	Practice change						
Facilitating Conditions	Facilitating condition						
	Workload impact	Task				Task	
	Time constraints						
	Users' engagement						Patient/family partnerships
	Organizational perspective	Benefits				Benefits	
	Improved communication						Improved communication
Intrinsic Technology Quality	Quality improvement						Quality Improvement
	Data/information accuracy	Functionality	Technological		Technological	Functionality	Documentation/Administration quality
	Technology compatibility						Clinical decision support
	Technology accessibilities						
	Technology reliability						
	Enhance safety						
Older adults-centred Product Design	System design as per nurses' requirements	Design Implications				Design Implications	System design as per nurses' requirements
							Visualizations

All four resources (SLR, LR, Delphi and Survey)
Not all resources (LR & Delphi) with other resources
Not all resources LR with other resources
Not all resources Delphi with other resources
Only SLR or Survey

Despite increased efforts in recent years to investigate HIT adoption/use by older adults and healthcare providers, evidence remains scattered. To date, we seem unable to explain the low level of HIT adoption by older adults and healthcare providers (i.e., nurses). This is where technology adoption studies can help to understand the factors that influence the adoption of HIT by different user groups. The adoption factors can be classified and grouped into different layers and dimensions, including Individual, Organizational, and Technological dimensions. These factors affect the adoption/use among older adults and their health providers, and the adoption/use impacts the Individual and Organizational dimensions with moderating effects by demographic factors, barriers, functionality, and design. Factors such as self-efficacy, self-confidence, satisfaction, technology anxiety, effort expectancy, privacy/security, culture, developing competence, ethical concerns, motivation, project champions, environmental influence, and leadership impact the adoption.

Interestingly, the study found no effect of adoption/use on burnout, contrary to prior studies. Adoption factors within all layers, including process, task, and benefits, impact the adoption/use. Adoption/use improved the quality of care, and technology compatibility, accessibility, reliability, and design as per LTC nurses' requirements affect the adoption. LTC nurses may have different factors influencing their adoption of HIT, such as workload and work conditions, which are insignificant for older adults. Further research is necessary to explore these differences and develop targeted interventions to overcome barriers to HIT adoption in these populations. Technological and organizational factors, such as attitudes toward technology and management support for HIT implementation, should also be considered.

It is crucial to note that while there is overlap in the factors that impact HIT adoption for older adults and LTC nurses, these populations may have different needs and preferences regarding HIT design and functionality. Understanding the similarities and differences in the factors that impact HIT adoption among older adults and LTC nurses is crucial for developing effective strategies to promote HIT adoption and use in these populations. Further research is needed to identify the most effective interventions, HIT design features for each population, and strategies for addressing LTC nurses' unique challenges and barriers.

Adoption and change management are closely related because change management is the process of preparing an organization and its people to effectively adopt and implement changes, while adoption is the successful acceptance and integration of these changes into the organization's culture and operations. Change management involves various activities, such as planning, communication, training, and stakeholder engagement, to ensure that employees are ready and willing to accept the changes. On the other hand, adoption results from effective change management, where employees have embraced the new processes, technologies, or strategies and are using them to achieve the desired outcomes. Successful adoption depends on effective change management. When organizations fail to manage change effectively, adoption rates can be low, and the organization may not realize the benefits of the change.

Conversely, when change management is done well, adoption rates are higher, and the organization can realize the full potential of the change. Therefore, adoption and change management are inextricably linked, and organizations must focus on both aspects to achieve successful change initiatives. Change management is the process of preparing an organization and its people to accept and integrate changes effectively. The goal of change management is

to minimize resistance to change, reduce the negative impact of change, and increase the likelihood of successful adoption of the change. Adoption is the successful acceptance and integration of the changes into the organization's culture and operations. It is the ultimate goal of change management and is critical for realizing the benefits of the change. Adoption is how employees transition from old ways of doing things to new ways. It involves embracing new processes, technologies, or strategies and using them effectively to achieve the desired outcomes. Effective change management helps to facilitate adoption by providing a clear understanding of the reasons for the change, the benefits to the organization, and the impact on employees. It also involves providing the necessary resources, training, and support to help employees adapt to the change.

The relationship between adoption and change management is cyclical. Effective change management leads to successful adoption, and successful adoption, in turn, reinforces the effectiveness of the change management process. Conversely, poor change management can lead to low adoption rates, undermining the change initiative's effectiveness and reducing the organization's ability to achieve its goals. In summary, adoption and change management are essential to any change initiative. Successful adoption requires effective change management, which involves careful planning, communication, training, and stakeholder engagement. By focusing on adoption and change management, organizations can achieve the desired outcomes and realize the full benefits of the change initiative.

6.6. Limitations

This study explores the attitudes and experiences of older adults and healthcare providers, particularly nurses, towards adopting healthcare technology. The study seeks to

identify the barriers and facilitators to technology adoption in healthcare and the impact of health information technology on older adults. Through this investigation, the study hopes to contribute to developing effective strategies for successfully integrating healthcare technology into the care of older adults.

It started with a systematic review of the adoption of older adults' health information technology. My literature reviews in the early stages of the study were based on previously published studies, and they may contain flaws inherent to the biases present in the studies that were used as sources. For instance, the number of studies focused on mobile health and electronic health was deficient compared to other technologies, such as telehealth, highlighting the need for more research in these fields. Additionally, the rigour level applied in the empirical studies varied. The number of studies also varied considerably based on the type of technology, which may also affect the generalizability of the findings. Furthermore, the impact of various adoption factors did not differ significantly across different technologies.

The systematic review showed that HIT adoption in older adults' settings should go beyond the older adults and consider their healthcare providers. Moreover, due to COVID-19 restrictions, I lost access to older adults to collect the required data.

The literature review on LTC nurses' HIT adoption and its impact showed limited evidence on LTC homes and technology, the pressure on LTC homes, the limited surveys and secondary data, and the specific limitations. Moreover, the impact of the adoption was missing in the studies. There are minimal studies in Canadian healthcare settings, and it is unclear whether the identified adoption factors within other countries and healthcare settings apply to Canadian healthcare settings.

A Delphi study as an exploratory study was conducted to collect data from Canadian nurses in LTC settings and as a secondary data analysis to understand and verify the impact of adoption/use benefits and quality improvements. Overall, Health information technology are primarily new among LTC nurses and may cause low benefit identification among LTC nurses. HIT adoption and its impact increase over time. So, the study should be repeated over time, and the results should be compared.

Most LTC nurses in this research within Delphi and the national survey are females; however, there is a non-significant difference regarding health information technology use between females and males. On the other hand, participant LTC nurses are a good sample from different age groups with a good distribution from different provinces and regions.

It is important to note that, given the scope of this study, I focused on older adults and their healthcare providers as the target participants. Future studies should also look at other healthcare providers, such as physicians since they work closely with older people and know their needs. Also, different regions and countries have various healthcare systems. For example, the cost of HIT is not a problem in places where the state provides healthcare, but it can be a huge problem in other places. So, system-level variables may be significant in determining whether older adults use HIT, especially at the community level. When researching this area, policy differences and how HIT costs are covered should be carefully examined and investigated.

This study's phases (except in the secondary data analysis with the national survey) were in English, excluding potentially relevant studies that may have been published in other languages. In the systematic review, the level of evidence in the original papers was generally

low to moderate, which may reduce the credibility of the results in this evaluation. Consequently, I recommend that future empirical studies incorporate more rigorous designs/approaches and longitudinal evaluations to assess the factors that significantly influence the adoption of different types of HIT by LTC nurses in the community, as well as the differential effects that may exist among different groups of elderly individuals. Prior research has identified various adoption characteristics that help LTC nurses embrace HIT, but these studies are modest and only examined a small number of nurses using a narrow range of technologies. The national survey took samples mainly from Quebec. Future studies should diversify the sample from different regions and provinces.

Additionally, the majority of research was conducted outside of Canada without taking into account the healthcare system in this country. Therefore, it is uncertain if the criteria discovered apply to Canada's healthcare system. The determined adoption variables also differ between various research and medical technology. Most research was mainly conducted with nurses and patients or nurses in multiple contexts. Studies for LTC nurses are few, with fewer participants. Furthermore, the technology utilized in different studies varies with a limited number of participants, making it hard to conclude the used technology and the selected adoption model.

6.7. Implications

Health information is an application intended to increase organizational productivity and improve performance. The perception of a need for significant change in healthcare settings, especially in the Canadian healthcare system, is widespread. The landscape of change facing healthcare systems is broad. It encompasses issues such as the needs of an ageing

population and managing chronic conditions and end-of-life care. The challenges ahead include other focus areas, such as shifting to service delivery models that promote patient-centeredness through introducing new technology and the expected transformation with the development of HIT through community care facilities. Workers' behaviour and ability to embrace emerging technologies will be significantly affected such that innovative forms of performing activities are adopted.

This study is a robust triangulation approach achieved by utilizing multiple research methods to explore the research questions from different aspects. A comprehensive multiple-method approach included a systematic literature review, a Delphi-based study incorporating workshops, surveys, and prioritization exercises, and a quantitative analysis of a large existing dataset. Such an approach allows for the cross-validation of findings from various sources, enhancing the reliability and validity of research outcomes. Additionally, this approach provides a comprehensive and nuanced understanding of the research question, which can lead to more informed and evidence-based decision-making. This study's findings have various repercussions, both theoretical and practical. In implication to theory, this study offers a list and framework by exploring and explaining HIT adoption/use for older adults and professional healthcare providers, especially nurses. This strengthens the theoretical foundation of technology adoption research and expands the application of technology adoption theories to long-term care and care for older adults. To the best of my knowledge, this is the first multimethod (qualitative and quantitative) research study in HIT that considers the perspectives of various stakeholders, including older adults and their healthcare providers. In this study, I explored, tested, and added a few new factors within different adoption

dimensions, including *Individual*, *Organizational,* and *Technological*. These new factors include privacy issues, ethical considerations, and system design as per users' requirements.

In practical implementation, this study's findings will assist older adults and their professional healthcare providers in realizing and identifying healthcare requirements. According to the results, the work-related advantages of deploying HIT must be perceptible, recognizable, and substantial. Service providers should stress, demonstrate, and discuss the technology's use in routine chores and/or occupations during the first information sessions and training programs to hasten adoption. Furthermore, from both the top-down and bottom-up viewpoints, creating an atmosphere in which the use of technology is desirable and the idea that it is a choice might greatly aid the adoption process. This research extended existing knowledge regarding HIT and technology adoption and provided a new framework for HIT adoption factors and the impacts of adoption in older adult settings. These findings have significant implications for HIT providers and designers. Having advocates with experience and passion for new technologies will help healthcare professionals and patients embrace HIT. This study's results assist policymakers in pushing informatics and other professional nursing organizations to approve and implement HIT. All key stakeholders, including home care practitioners, IT suppliers, and policymakers, should consider the suggestions from this research to ensure the success of future IT efforts and initiatives in the home care setting. Home care providers, IT suppliers, and legislators should consider the study's suggestions to make future IT projects in-home care more successful.

With the growing interest and desire to integrate telehealth into nursing practice, telehealth technologies will rise exponentially. Leadership and clinical advocates must work

together to promote this dramatic shift. Care providers should use telehealth to increase service delivery and collaborate with customers. Many home care nurses have different views on whether HIT should be adopted and used. Most nurses do not know that a healthcare technology system is a worthwhile investment. Nurses are just using parts of the system or simply using it to support other methods, such as the primary patient database or smartphones. These results suggest further research is needed to determine how the adoption and use of HIT for interactive support with older adults' healthcare, well-being, health status, health literacy, and the economic aspects of home-based healthcare.

Limiting ourselves to the well-known and traditional adoption factors and models will result in missing a bigger picture of adoption beyond the conventional adoption models and factors, as these models and factors were primarily designed to measure users' adoption from a business perspective. When asked about it, healthcare professionals and caregivers were mainly positive about using HIT in their work environments. However, the connection between positive or negative attitudes about new technologies and the desire to use HIT shows how important these factors are for HIT adoption among nurses. There is a lack of knowledge about using HIT in the workplace, especially for certain groups of people. Thus, it is essential to get adequate training to use HIT in nursing homes. Finally, using HIT in nursing homes should be easy and intuitive for residents and caregivers to get the most out of it.

The findings of this study will be helpful as a benchmark for future efforts by LTC facilities considering the adoption of Health information technology, as well as technology developers and suppliers developing or selling technologies in the context of elderly care. Future HIT initiatives should address concerns about increasing workload and restricted training

and education sessions, emphasizing the technology's simplicity and convenience rather than the complexity and cost. Efforts to encourage nurses in long-term care facilities to use health information technology must be supported by simple and integrated technology. To guarantee that nurses working in LTC institutions are adequately motivated to utilize health information technology, it is crucial to consider how user-friendly a system is and how well it should relate to other infrastructures. Future studies should consider the increased workloads and nurses' lack of training and education accessibility while planning future health information technology endeavours.

Technology adoption should go beyond individual factors. Moreover, future studies should take additional steps beyond the traditional adoption factors and take the adoption to a higher level within the adoption layers (such as human-technology interaction, process, and implications to design) and dimensions (Individual, Organizational, and Technological). We should also consider organizational and technological dimensions in our considerations. This study examined these elements for future research on management and the LTC home care process and nurses' work, managers' decisions to accept and deploy new technology, and policymakers to see adoption in multiple dimensions.

Organizational factors are crucial in adopting Health information technology within LTC healthcare settings. Technology implementation is not just about the technology itself, but also about the processes and practices of the organization that will be using it. The decision to adopt new technology is often driven by the need to improve healthcare outcomes, reduce costs, and increase efficiency. However, if the organization's structure and culture are not supportive of the technology, adoption can be slow or unsuccessful.

I examined the relationship between individual nurses' use of HIT and its impact at the organizational or patient level. The study investigated the potential benefits and challenges of HIT adoption, such as improvements in patient outcomes, cost-effectiveness, and the role of organizational factors in facilitating or impeding HIT implementation. The findings indicate that using HIT can positively impact healthcare outcomes, but their efficacy is contingent on organizational factors that support their implementation and utilization.

Policymakers need to recognize that organizational factors are critical drivers of HIT adoption and should consider them when developing technology implementation policies. For example, policies should take into account the readiness of organizations to adopt technology, including the availability of resources and the capacity of staff to effectively use and integrate new technology into their workflow. Policies should also promote the development of a supportive organizational culture and leadership that values technology adoption and innovation. Moreover, policies should recognize the importance of collaboration and communication among healthcare providers, patients, and other stakeholders. Policies should encourage the formation of partnerships among healthcare organizations and technology vendors to facilitate the adoption of technology and promote its effective adoption/use.

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Appendix 1: Exploring Multi-dimensional Factors in Health Information Technology Adoption Among Nurses

Reference	Technology	Participants	Method
Alaiad and Lina Zhou, 2014	Home healthcare robots	Patients & healthcare professionals	Survey
Allen et al., 2015	Telehealth	Nurse	Review of the telehealth usage status
Asan, 2017	Health information technology	55 PICU nurses in seven focus groups	A qualitative research design to collect and analyze data
Asua et al., 2012	Telemonitoring	605 nurses, general practitioners and pediatricians	Questionnaire
Barakat et al., 2013	E-health (telecare and ambient assisted living (AAL), mobile health, and fall detection systems.)	health care professionals working in home care	A two-day collaborative workshop
Gartrell et al., 2015	Electronic Personal Health Record	183 nurses in the Nursing informatics community	descriptive cross-sectional survey
Göransson et al., 2017	Health Application	Older people with home-based health care and their nurses	Explorative qualitative design.
Huter et al., 2020	Digital technologies	A total of 123 single studies and 31 reviews were subjected to the analysis	A Scoping Review
Ibrahim et al., 2019	Electronic Documentation System in Home Care:	Nurses (N = 217)	An online survey
Johannessen et al., 2018	Telecare	Two focus group interviews with ten female homecare professionals (nine	An exploratory qualitative design was employed.
KAMEI, 2013	Information and Communication technology	Nurse	published work database search.
Kang, 2019	Health Information Management	17 registered nurses	Semi-structured phone interviews
Koru et al., 2016	Information technology	home health agencies (HHAs)	Semi-structured interviews
Luciano et al., 2020	Telemedicine	Healthcare professionals	A survey
Mahony et al., 2014	Electronic medical records	Nurses at three community health centres (CHCs)	A qualitative design was used. Semi-structured interviews
Moore et al., 2020	Health Information Technology	Total of 1647 articles. Twenty-one studies reported the impact of 12 different health information technology (HIT) implementations on nurses' documentation time.	A systematic review
O'Sullivan et al., 2017	ICT	Healthcare professionals	Mix-methods
Radhakrishnan et al., 2016	Tele-Homecare	The initial 3,920 citations	Systematic review
Seto et al., 2019	Telemonitoring (TM) of heart failure (HF)	Home Care Nursing	Feasibility Study
Sousa Leite et al., 2017	Assistive technology	45 professionals working in a community group	The exploratory, descriptive qualitative study
Thoma-Lürken, et al., 2018	Decision support App	individual and group interviews with professionals (n=8) and	Mix-methods

		researchers (n=5)	
Vasalampi et al., 2017	Mobile system	Home care nurses	12 nurses were interviewed and observed at-home visits to gain insights on how the system could better facilitate their work routines
Wang et al., 2016	Mobile and Wearable Technology	29 residents living in a	A cross-sectional study design
Yada et al., 2019	Health Care Virtual Communities of Practice	86 healthcare workers	Survey

Appendix 2: Systematic literature review keywords

Group 1 (G1): Acceptance OR Usability OR Use OR Adoption OR "behavioral intention"
Group 2 (G2): Elderly OR Seniors OR Aging OR Old
Group 3 (G3): Information and Communication Technology OR ICT OR Telemonitoring OR "E health" OR E-health OR Ehealth OR Telehealth OR Telemedicine OR "Assistive technology" OR "Personal health record" OR telecare OR "home automation systems" OR "Telehome care" OR "E consultation" OR E-consultation OR "smart home"
Group 4 (G4): Home OR "retirement home" OR "Nursing home" OR "Community dwelling" [1]OR "Community residence" OR "Living in the community" OR "aging in place" OR "independent living" OR Community OR "home care"
Query: Group 1 AND Group 2 AND Group 3 AND Group 4

[1]: The "community dwelling" elderly are group of seniors with age (60 years or older) who live independently. This age group may or may not suffer from any disease with or without need for specific health care requirements (Steultjens, E. M., Dekker, J., Bouter, L. M., Jellema, S., Bakker, E. B., & Van Den Ende, C. H. (2004). Occupational therapy for community dwelling elderly people: a systematic review. Age and ageing, 33(5), 453-460).

Appendix 3: (Ethics certificate for Delphi study)

Consent Text

Principal Investigator (Student):
Hamidreza Kavandi
Ph.D. Candidate
Digital Transformation and Innovation
Telfer School of Management, University of Ottawa,
55 Laurier Avenue East, Ottawa Canada K1N 6N5

Thesis Supervisor (Professor):
Mirou Jaana
Health Care Management and Informatics
Telfer School of Management, University of Ottawa,
55 Laurier Avenue East, Ottawa Canada K1N 6N5

Invitation to Participate: You are invited to participate in the above-mentioned research study, funded by the Social Sciences and Humanities Research Council of Canada (SSHRC), and conducted as part of Hamidreza Kavandi's Ph.D. thesis project under the supervision of Professor Mirou Jaana at the University of Ottawa.

Participation: Your decision to complete and submit your responses will be considered as your consent for participating in this research project. The survey should take you approximately 10-15 minutes to complete. You do not have to answer any questions that you do not want to answer. We would appreciate receiving it within 7-10 business days. If we do not receive it by said date, we will send you a notice of reminder. This study will be three rounds of surveys.

Compensation: As a token of appreciation for your time, we would like to offer all participants in this project a 10$ Starbucks gift card. The participants will be compensated based on the number of participation (e.g. all three rounds, or just one or two rounds). The participants in one or two sessions will be compensated accordingly (will they only receive $3.5/session in a Starbucks gift card).

Purpose of the Study: Canada's healthcare system is facing challenges associated with population ageing and seniors' need. Health information technology presents opportunities for supporting the care provided by nurses to seniors. However, to effectively leverage some technologies, it is important to first understand the factors that affect their adoption and use by nurses. Therefore, there is a need to learn about the nurses' perspectives regarding these technologies and the facilitators and barriers that affect their adoption.

Benefits: The nurses will benefit from the development of a consolidated list of the factors that are considered most important from their perspective. The list can inform the development of a survey that can be used on a larger scale to assess the extent to which these factors play a role in the adoption of HIT by nurses providing care for seniors. These studies also give opportunities to nurses in voicing their opinions and concerns about factors that play an important role in the adoption of health information technology. In addition, participants in prior studies have repeatedly indicated that they find it helpful to consider the research questions because they presented them with fresh viewpoints on areas of their job that they do not generally consider. Moreover, after the research project is completed the research project team will share with Perley Rideau relevant reports, publications, presentations that result from this work.

Risks: Participation in this study will involve no foreseeable risk other than those encountered in everyday life.

Confidentiality and Anonymity: The information that you will share will remain strictly confidential and will be used solely for this research. The only people who will have access to the research data are Hamidreza Kavandi and Mirou Jaana. The results of this research will only be reported at the aggregate level.

This project is funded by the Social Sciences and Humanities Research Council of Canada and this study is being conducted as part of Hamidreza Kavandi's Ph.D. thesis project. Please be advised that the project is being conducted independently from the Perley and Rideau Veteransè Health Centre and/or the Centre of Excellence in Frailty-Informed Care. Therefore, a person's decision to participate (or not) will not be known and your participation will not be the source of any prejudice or bias towards you. Completing and submitting your responses will be considered as your consent for participating in this research project.

Conservation of data: The data collected, i.e. questionnaires, notes will be kept securely. The Delphi study documents will be kept by (Prof. Mirou Jaana & Hamidreza Kavandi) within a password in a secure place. After 10 years after the completion of the research, the questionnaires, notes and transcripts will be shredded, and any digital versions deleted.

Voluntary Participation: You are under no obligation to participate and if you choose to participate, you may refuse to answer questions that you do not want to answer. Completion and submission of the questionnaire by you imply consent.

You have the freedom to refuse to be involved in this research project, and you may decide at any point in time to stop participating in the Delphi survey; if this is the case, the information that you have provided will be deleted.

Information about the Study Results: The research findings will be presented in the form of a final report/paper. The Perley and Rideau Veterans' Health Centre will be identified in the report/paper as being the site from which the nurses were recruited.
If you have any questions or require more information about the study itself, you may contact the principal investigator or his supervisor at the numbers mentioned herein.
If you have any questions with regards to the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5, tel: (613) 562-5387 or ethics@uottawa.ca.

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

S-04-21-6727 - REG-6727 - Certificat d'approbation éthique / Certificate of Ethics Approval

(English message follows)

Cher/Chère Hamidreza Kavandi,

Veuillez trouver ci-joint le certificat d'approbation éthique pour le projet intitulé «Health information technology and senior care: seniors and nurses' perspective of technology adoption.».

Le certificat est valide jusqu'au : 13-05-2022

Recherche financée : veuillez faire suivre une copie du certificat au Service de gestion de la recherche.

Si vous avez des questions, n'hésitez pas à communiquer avec le Bureau d'éthique à ethique@uottawa.ca ou en composant le 613-562-5387.

Vous pouvez voir votre demande en vous connectant à votre compte eReviews.

Cordialement,

Kim Thompson
Responsable d'éthique en recherche

Ceci est une réponse automatisée, merci de ne pas répondre à ce courriel.

Dear Hamidreza Kavandi,

Please find attached the certificate of ethics approval for your research project titled "Health information technology and senior care: seniors and nurses' perspective of technology adoption.".

This certificate is valid until: 13-05-2022

Funded research: A reminder that you must provide a copy of this certificate to Research Management Services.

If you have any questions, please contact the Ethics Office at ethics@uottawa.ca or by telephone at 613-562-5387.

You can view your project at any time by logging into eReviews.

Best regards,

Kim Thompson
Protocol Officer

This is an automated message. Please do not reply directly to this email.

Attachement(s) / Attachment(s)
approvalLetter1621020282803.pdf

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Appendix 4: Delphi study questions

Phase 1: Brainstorming:

In today's dynamic healthcare environment, we face uncertainties, new demands, and shifting priorities that may have impacts on individuals, groups, and healthcare organizations. Among the changes observed in health care today, it is the proliferation of new technologies that support communication, remote connectivity, and the delivery of care to seniors.

Health information technologies (HIT) refer to a variety of technologies and systems involved in managing and sharing patient information electronically, which support the care provided to patients. Examples include telemonitoring devices for chronic conditions, mobile-health technologies (e.g., mobile applications - mApps, wearables such as smartwatches, wristbands, sensors for falls etc.), electronic medical records etc. Some of these technologies measure vital signs regularly, others send reminders and alerts, or make relevant information readily and remotely available, thus supporting timely and integrated care.

Technology adoption is defined as the acceptance and use of new products or innovations, which may be affected by various factors related to, among others, the work environment, the context, the type of technology, the condition of the elderly, the individual preferences etc. These factors may act as facilitators or barriers to the adoption of HIT. Examples include:

1. The ease of use of the technology
2. The perceived usefulness of the technology
3. The nurse's prior experience with the technology
4. Etc.

***Instructions*:**
Please identify 5-10 most important factors that, in your opinion, affect the adoption of HIT by nurses in the context of long-term and elderly care.

Specify each factor (A, B, C, etc.) with a brief description

Phase 2: Validation and ranking:

Following the first stage of « brainstorming » conducted during the past month, we combined the responses of the 24 nurses participating in this study. During the analysis of the responses, a list of 21 factors was produced, including each factor's description as per below. The list of key factors that affect the adoption of technology by nurses and their brief description is presented in random order in the table below.

In this second stage of the Delphi survey, we ask you to perform the following two tasks:

First, we ask you to validate each key adoption factor name/label and its associated description. If you agree with the label and description of the factor, please select (√) the box. Otherwise, you may provide suggestions regarding the name/label or description changes under "Other" presented below.

Second, please check (√) on a 1 to 7 scale (1=least important and 7=most important), the degree of importance of each factor identified in the table.

Please remember that there is no right or wrong answer. Your individual opinion is the one that matters.
Thank you for your collaboration on this important research project.

Phase 3: Ranking_ First round

Following the second stage of this Delphi survey, which was conducted during the past month, we combined the responses of the nurses who participated on the Delphi study Panel. The analysis of the responses

allowed us to have a consolidated final list of 18 factors that affect the adoption of health information technology by nurses in long-term and elderly care. This complete list with the definition of each factor is presented in the table.

In this third and last stage of the Delphi survey, we ask you to rank from 1 to 18, in order of importance (1=most important; 18=least important), the factors presented below, the adoption factors, which were identified and validated in the previous two stages. Please use any number between 1 to 18 to rank each factor.

- Funding availability
- Adequacy of change management
- Ease of use and technology complexity
- Troubleshooting and technical support
- Communication challenges
- Privacy and security concerns
- Experience with technology
- Training and education
- Quality of healthcare
- Data/information accuracy
- Reliability of technology
- Technology-related anxiety
- Compatibility and adaptability of technology
- Technology design considerations
- Technology benefits and usefulness
- Workload Impact
- Limited time for learning
- Accessibility of technology

Question 3.2: We ask you to please answer the following questions:

Please indicate your sex?

- Female
- Male
- Prefer not to answer

Question 3.3: What is your age? (in years)

- 18-29
- 30-39
- 40-49
- 50-59
- 60 and over
-

Question 3.4: What is your job position?

- Registered Nurse (RN)
- Registered Practical Nurse (RPN)

Question 3.5: What is the number of years of experience that you have as a nurse? (in years)

- Less than 5
- 5-10
- 11-15
- 16-20
- 21-25
- More than 25

Question 3.6: What is the number of years of work that you have at the Perley and Rideau Veterans Health Centre? (in years)

- Less than 5
- 5-10
- 11-15
- 16-20
- 21-25
- More than 25

Question 3.7: How familiar are you with Health Information Technologies (e.g., mobile health, electronic medical records)?

- Very unfamiliar
- Unfamiliar
- Familiar
- Very familiar

Question 3.8: Have you used health information technologies in the past in the process of delivering care to seniors?

- No
- Yes

Question 3: Ranking Phase_ Round 2

The list of health information technology adoption factors is presented below according to the average order of importance (i.e. from the most important to the least important) based on the responses of the panellists to the first round of ranking.

Given the low level of agreement among the respondents in the first ranking, we ask you to rank again from 1 to 18, in order of importance (1=most important; 18=least important) the factors presented in the table below. A complete list of the adoption factors and their respective definition is presented in the table at the end of this page for your reference.

Appendix 5: Collected responses in the first round of Delphi study

"Access for all groups," "Access to device, internet, wifi," "Availability of HIT across a larger facility/how will it be dispersed," "Availability of HIT in the facility," "Ensuring the entire health care team is on the same page and utilizing HIT as recommended," "buy in from physicians to support the use of technology," "low level communications skills between nurses," "Nurses like to communicate verbally," "flexibility," "HIT adaptability; ideally HIT can adapt w/different facilities/procedures," "How invasive is the technology? What is necessary for setting up the technology and the patient for use?", "many different resources about the same diagnose," "The technology the patient uses may not sync with the home's," "incorrect information," "Accuracy of information coming from the technology. How accurate is the information? What range of variations is deemed acceptable before it's deemed not accurate?", "accuracy of the results the technology provides", “Accuray of data”, “Complexity of the technology”, “Does the nurse believe the tech will be easy to use for the patients?”, “Experience/Training”, ”age - experience with technology may vary with age and type of work”,”Knowledge-to-use technology”, ”Cost/funding”,”Expense to fix damaged devices”,”Funding for the use of the technology. Long term care is underfunded”, ”New Technology will require tranning. This will cost money and time”,”Not enough funding allocated HIT”,”Technology that is affordable”,”Routine”,”Usual practice/habit”, “Limited time and availability of staff to properly train and orient staff and clients to new technologies”, “Time for the nurse to learn the technology”, “Fear of breach of confidentiality or misuse of personal health information”, “Privacy/security”, “Durability; if HIT is easily breakable it is not fit for health care”, “Heavy reliance on tech when there is loss of power”, “How reliable the technology is - does the system crash often”, “Internet connections/what happens when there is a disruption or power outage”, “when the system crashes it creates more work”, “Non-compliance by staff and/or residents and families”, “Ability to make decisions with information received”,”benificial as the information is passed

accessable”,”not enough time to found correct information”,”Perceived usefulness”,”Product/services execute”,”The technology having a positive effect on residents that can be seen by the care team”,”usefulness - it must serve a purpose”,”Advanced technology anxiety”, ”Does the nurse believe the tech will replace them?”,”Does

the nurse think the tech will take away from their job?”,”access to training to use the technology”,”Adequate training should be provided”, ”Experience/Training”,”In class training is lacking.” ,”leaning how to operate and use technology.”," Learning to use computer use at old age."," Nurses' willingness to learn how to properly use the technology"," Proper amount of training for the use of the technology"," Required training"," IT troubleshooting support"," Not all nurses are tech smart"," Help decrease workload"," When the system crashes it creates more work.", "Does it save time or make the workload easier" "Does the nurse believe the tech will add work for them at their job?", "sometimes creates double work."

Appendix 6: Factor rank in different phases of Delphi study with various layer and dimension

Dimension	Layer	Factor	Brainstorming (rank by number repetition)	Narrowing down (rank by the level of importance)	Ranking - 1st round	Ranking - 2nd round
Organizational	Task	Workload Impact	9	1	1	1
Individual	Human-technology interaction	Ease of use and technology complexity	1	2	2	2
Individual	Human-technology interaction	Training and education	2	4	3	3
Organizational	Process	Quality of healthcare	21	9	6	4
Organizational	Benefits	Technology benefits and usefulness	4	5	8	5
Technology	Functionality	Reliability of technology	13	3	11	6
Individual	Human-technology interaction	Troubleshooting and technical support	7	8	4	7
Technology	Functionality	Data/information accuracy	15	6	14	8
Organizational	Process	Communication challenges	18	18	12	9
Organizational	Task	Limited time for learning and training	17	11	5	10
Individual	Human-technology interaction	Privacy and security concerns	20	13	15	11
Individual	Demographic	Accessibility of technology	6	7	7	12
Technology	Functionality	Compatibility and adaptability of technology	11	12	13	13
Individual	Human-technology interaction	Funding availability	5	10	9	14
Individual	Human-technology interaction	Technology-related anxiety	14	17	17	15
Technology	Design	Technology design considerations	3	15	18	16
Individual	Human-technology interaction	Experience with technology	8	16	10	17
Organizational	Task	Adequacy of change management	10	14	16	18
Individual	Demographic	Age of users	12	21	#N/A	#N/A
Individual	Human-technology interaction	Resistance from users	16	20	#N/A	#N/A
Individual	Human-technology interaction	Habits and routine	19	19	#N/A	#N/A

Appendix 7: The adoption factors' correlations among nurses in the Delphi study

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Workload impact	1																
2	Ease of use and technology complexity	0.145	1															
3	Training and Education	-0.434	0.091	1														
4	Quality of healthcare	0.224	-0.188	-0.131	1													
5	Technology benefits and usefulness	.451*	0.283	-0.265	-0.12	1												
6	Reliability of technology	0.087	0.239	-0.146	0.254	0.189	1											
7	Troubleshooting and technical support	0.146	0.236	0.218	0.247	-0.314	-0.148	1										
8	Data/information accuracy	-0.424	-0.048	-0.086	0.047	-0.385	0.384	-0.065	1									
9	Communication challenges	-0.069	-0.205	0.127	0.326	-.481*	-0.292	0.176	-0.017	1								
10	Limited time for learning	0.117	-0.274	0.173	-0.039	-0.312	-0.038	-0.137	-0.231	0.42	1							
11	Privacy and security concerns	-0.268	-.472*	-0.115	-0.041	0.066	-0.248	-0.272	0.213	-0.204	-0.283	1						
12	Accessibility of technology	0.089	-0.147	-.665**	0.036	0.009	-0.409	-0.028	0.109	0.006	-.518*	0.362	1					
13	Compatibility and adaptability of technology	0.191	-0.07	-0.052	-.482*	0.179	-0.049	-0.292	0.012	-0.352	0.048	0.138	-0.034	1				
14	Funding availability	-0.168	-0.27	0.131	-0.038	-0.13	-0.183	0.041	0.033	-0.265	-0.159	-0.071	0.046	0.209	1			
15	Technology-related anxiety	-.459*	0.072	0.198	-0.212	-0.404	-0.192	0.002	0.061	0.361	0.376	-0.195	-0.175	-.473*	-0.281	1		
16	Technology design considerations	-0.005	-0.095	-0.25	-0.175	.539*	0.334	-0.435	-0.097	-.444*	-0.314	0.197	0.132	0.007	-0.164	-0.3	1	
17	Experience with technology	-0.143	0.232	-0.069	-0.281	0.007	-0.13	-0.331	-0.328	-0.002	0.149	-0.096	0.026	-0.295	-0.408	.609**	0.169	1
18	Adequacy of change management	0.037	-0.44	-0.069	-0.229	0.031	-0.36	0.04	-0.184	-0.057	-0.112	0.16	0.277	.490*	0.418	-0.432	0.099	-0.438

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Appendix 8: The selected questions for inferential statistical analysis in secondary data analysis

Burnout: (Only one question for Burnout)

Overall, based on your definition of burnout, how would you rate your level of burnout?

|1 |I enjoy my work. I have no symptoms of burnout.
|2 |I am under stress, and don't always have as much energy as I did, but I don't feel burned out.
|3 |I am definitely burning out and have one or more symptoms of burnout, e.g. emotional exhaustion.
|4 |The symptoms of burnout I am experiencing won't go away. I think about work frustrations a lot.
|5 |I feel completely burned out. I am at the point where I may need to seek help

Efficiency: (Only one question for Efficiency)

I provide more efficient health care with virtual videoconference and/or telemonitoring (e.g. telehomecare) - As you have consulted directly with a patient via virtual videoconference or used remote telemonitoring services (e.g. telehomecare) in the Main settings.

|1 |Strongly Agree
|2 |Moderately Agree
|3 |Moderately Disagree
|4 |Strongly Disagree
|8 |Not Sure

Quality: (Only one question for quality improvement and not specifically for EMR technologies)

How would you describe the quality of nursing care delivered to patients in your care area?

|1 |Excellent
|2 |Good
|3 |Fair
|4 |Poor

Adoption/Use

Merged question Q43, Q44A, Q44B (Beausejour and Hagens, 2022)

Q43: An e-visit is where a patient initiates a consultation via secure e-mail to their health provider(s) about a specific health question or concern. In the past three months, how many times have you carried out an e-visit using secure e-mail to respond to

Q44A: Consulted directly with a patient via virtual videoconference

Q44B: Carried out a virtual visit while in-person with a patient with a remote clinical provider (e.g., telehealth)

Gander

Are you:

|1 |Male
|2 |Female
|96|Other, please specify

|99|Prefer not to answer

Direct care

Do you currently provide direct care to patients?

|1 |Yes
|2 |No

Population

What would be the best estimate of the population size of the community served by your MAIN work setting?

|1 |5,000 people or less
|2 |5,001 to 10,000 people
|3 |10,001 to 100,000 people
|4 |100,001 to 500,000 people
|5 |500,001 or more people
|99|Prefer not to answer

Long of adoption|use

How long have you been using electronic record /clinical information systems to enter clinical documentation on patient encounters in your MAIN care setting?

|1 |Less than a year
|2 |1-2 years
|3 |3-4 years
|4 |5-6 years
|5 |Over six years
|99|Prefer not to answer

Age

Age group or category of the respondent

|1 |Less than or equal to 24 yrs
|2 |25 - 34 yrs
|3 |35 - 44 yrs
|4 |45 - 54 yrs
|5 |55 - 64 yrs
|6 |65 yrs and older

Hours of work

On average, how many hours do you work per week in your MAIN work setting?

Years of Experience

Years - How many years have you been a nurse?