Unified Theory of Acceptance and Use of Technology to inform Health Technology Assessment

by

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Abstract

Rising healthcare cost and improving the quality of care delivered by Alberta's healthcare system has long been a part of popular discourse. This need to reduce healthcare spending while still maintaining or improving pre-existing quality of care has led many to look towards incorporating new health technology. However, before we can deploy innovative health technologies into the healthcare system, an evaluation of its pros, cons, capabilities, usability, and amongst factors is done. This assessment, or more formally known as a health technology assessment, is where a committee collects evidence and research about a health technology to be presented to healthcare authorities and decision makers.

One attribute that is less studied in health technology assessments compared to other elements such as economic evaluation is user adoption and acceptance of technology. Research into the methodologies and reasoning's behind individual-level adoption of technologies is one of the most mature streams of research within information system (IS). When expanding the scope of current health technology assessments to understand the adoption of technology from an organization-level or group-level exposes new facets for analysis that explores what influences employees' productivity, output, and job performance. Over the years, different theoretical models have been developed to describe technology adoption such as the Technology Acceptance Model (TAM and TAM2) (Davis, 1985; Venkatesh & Davis, 2000). In 2003, Venkatesh, Morris, Davis, and Davis proposed a synthesis of these technology adoption models, the Unified Theory of Acceptance and Use of Technology (UTAUT).

This research proposes that UTAUT can be used as a framework to be used in health technology assessment in Alberta Health Services. This translation is done to showcase how

users adopt and accept new health technology, challenges they face, potential solutions, and demonstrating that UTAUT is a worthwhile, effective, and simple framework in analyzing user adoption and acceptance of new health technology.

List of abbreviations

AHS	Alberta Health Services
CADTH	Canadian Agency for Drugs and Technologies in Health
CBoC	Conference Board of Canada
CIHI	Canadian Institute of Health Information
C-TAM-TPB	Combined TAM and TPB
eHealth	Electronic health
EHR	Electronic health record
EUnetHTA	European Network for Health Technology Assessment
HCP	Healthcare Professional
HTAI	Health Technology Assessment and Innovation
IHE	Institute of Health Economics
IT	Information Technology
IHE	Institute of Health Economics
mHealth	Mobile Health
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Unified Theory of Acceptance and Use of Technology 2
WHO	World Health Organization

Preface

This thesis is an original work by Kynan Ly. The research project which comprised a portion of the thesis received research ethics approval from the University of Alberta Research Ethics Board 2 (REB 2), Project name “Health Technology Adoption”, Study ID Pro00088231, March 25, 2019. No part of this thesis has been previously published.

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Chapter 1: Introduction

Growing up I felt that parts of my identity were imparted by the land I grew up in. Similar to others living in Canada, our healthcare system or the idea of universal healthcare, became a concept that I was both proud of and supported. To little surprise, when Statistics Canada released an infographic titled "*Proud to be Canadian*" (2015), our healthcare system was ranked amongst the top for a source of Canadian pride. However, when the rose-tinted glasses are put aside, the Canadian healthcare system is struggling to keep pace with our rapidly changing world ("Canada's health-care system," 2018).

For Canadians, the healthcare system has been rarely seen outside the limelight of popular political discourse since the inception of the Canada Health Act (CHA). In provinces like Alberta, healthcare cost and healthcare delivery have long been discussed topics in the news media ("Alberta's health system needs," 2017; "Alberta spends loads," 2018; "BLOG," 2015). This continuous discourse about the rising cost of healthcare and the desire for better healthcare delivery and outcomes in Alberta prompts us to look at innovative solutions, most noticeably, health technology innovation to tackle them. This research examines how current health technology is by healthcare institutions and organizations in Alberta, Canada. I refer to the theoretical framework called Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, et al., 2003) and present a rationale for its inclusion in health technology assessment (HTA). This would provide healthcare institutions and organizations situated in Alberta a comprehensive overview on how healthcare professionals (HCP), clients, and other members of the healthcare system interact, accept, and adopt new health technologies. In this chapter, I will

introduce the background to healthcare in Canada and Alberta, HTAs and how they are conducted, and state the purpose of this research.

1.1 Canada's Healthcare System

Canada and its development of the modern day healthcare system can be traced back as early as 1957 with the *Hospital Insurance & Diagnostic Act* (Canada's Health Care System, 2011). Over the years, other events and legislations such as the *Medical Care Act* further refined Canada's healthcare system into what it is today. However, none are more influential than the *Canada Health Act* passed in 1984 (Minister of Justice, 2018) which outlines the distinct roles the federal, provincial, and territorial government play in the administration and delivery of healthcare to Canadians. Key responsibilities of the federal government include the setting and administration of national principles for the healthcare system and providing financial support to provinces and territories. The provincial and territorial governments are responsible for tasks such as meeting national principles set out by the *Canada Health Act*, and covering medically necessary doctor and hospital services. The separation of responsibilities between the different levels of government results in provinces and territories having different healthcare system infrastructure, and healthcare administration from one another. This is because although the *Canada Health Act* outlines requirements (public administration, comprehensiveness, universality, portability, and accessibility), provinces and territories have the autonomy to decide how these requirements are implemented and interpreted (with the federal government having the final say if these requirements are truly met) (Minister of Justice, 2018). Therefore, the Canadian healthcare system from an outside perspective may appear unified, but the reality is

that the care and services provided in one province or territory may differ from another. For example, resident in New Brunswick can present their Medicare card for billing insured physician services in any other province (except Quebec) and territories because of a prearranged agreement made between another ("Coverage and Claims – Outside New Brunswick (within Canada)," n.d.).

1.2 State of Canada and Alberta Healthcare Expenditure

The Canadian Institute of Health Information (CIHI) expected that in 2018 Canada's health expenditure reached 253.5 billion or 11.3% of Canada's gross domestic product. In comparison to previous years, 2018 projected cost was slightly higher ("National health expenditure trends," 2018). This is not uncommon, as Canada health expenditure has experienced continual growth over the last decade. The ever increasing health expenditure and its impact on the healthcare system has been acknowledged in reports released by a multitude of different governmental and institutional health bodies such as CIHI (Canadian Institute of Health Information, 2011), the Conference Board of Canada (CBoC) (Prada, Grimes & Sklokin, 2014), and Canadian Nurses Association (The costs and performance, 2013).

For the province of Alberta, its health expenses totaled $21.2 billion or 38% of the provinces $55.3 billion total expenditure in 2017 (Government of Alberta, 2018a). In comparison to Canada's overall health spending, Alberta is spending a larger portion of its budget on healthcare. Despite Alberta spending more per person than any other province in Canada (only spending less than the territories) ("National health expenditure trends," 2018), the Alberta

healthcare system and services are not considered top grade by CBoC. When ranked between 15 other countries and other Canadian provinces and territories by the CBoC, Alberta ranked 13th overall based on their ten health indicators (life expectancy, premature mortality, infant mortality, self-reported health status, mortality due to cancer, mortality due to heart disease and stroke, mortality due to respiratory diseases, mortality due to diabetes, mortality due to diseases of the nervous system, and suicides as the metric) ("Health - Provincial and Territorial Ranking", 2015). This places Alberta behind Canada's 8th place overall ranking and behind provinces like British Columbia who both ranked higher and spends less per person on health.

1.3 The Alberta Context

The focus on Alberta healthcare system over other healthcare systems in Canada can be attributed to a few reasons. One reason for choosing Alberta is because it stands out amongst other provinces. Alberta spends the most per person compared to other provinces while not having the best overall healthcare outcomes. Although numerous external factors may contribute to their overall performance (e.g., cultural or historical influences), Alberta stands to reap a lot of benefits from cost savings and improvements to healthcare outcomes from health technology innovations. Additionally, Alberta has one centralized regional health authority (Alberta Health Services or AHS) compared to other provinces like British Columbia which has five ("Health Authorities - Province of British Columbia," n.d.). This allows the research to tailor itself more towards a singular healthcare organizational structure, reducing the need to address varying different structures such as in the case of British Columbia. Finally, Alberta Health Services (Alberta's regional health authority) employs over 100,000 employees from diverse backgrounds

in both urban and rural locations (Alberta Health Services Annual Report 2018-2019, 2019). This diversity and scale of operation make Alberta an ideal fit for the theoretical framework, UTAUT, which focuses on how different end users (in this case AHS employees) accept and use technology.

Despite AHS being the single health authority in Alberta, when it comes to HTA and the adoption of innovative health technology it partners with "Ministry of Health, the universities, and provincial, national, and international agencies" (AHS Strategy for Clinical Health Research, Innovation and Analytics 2015-2020, 2018, p. 12). Some of these health organizations within AHS that conduct HTA are: the Innovation, Evidence and Impact team, Contracting, Procurement and Supply Chain Management, and individual program areas (See Figure 1. below for full listing) (Services, n.d.; Alberta Health Services Health Economics In AHS, 2018). Although there is a collaboration between these different groups, their resulting partnerships do not always look the same.

Figure 1. Alberta Health Services Innovation Centre of Expertise. From Health Economics In AHS by Alberta Health Services, 2018, https://www.albertahealthservices.ca/assets/info/res/if-res-htai-newsletter-2018-06-01.pdf

For AHS, HTAs play an important role in providing evidence based evidence regarding new health technologies. Whether it is to address a particular need in the system or to address the fact that "the time to adopt new discoveries into care is lengthy, often taking more than a decade (AHS Strategy for Clinical Health Research, Innovation and Analytics 2015-2020, 2018). This situates HTA as the forefront for innovation.

For this research, it is concerned with the evidence synthesis and assessment stage (stage 3) in AHS adoption cycle (See Figure 2. below) (Alberta Health Services Health Economics In AHS, 2018). As seen in Figure 2., it is at this stage that evidence gathering for HTA occurs in AHS and is the stage (stage 4) right before AHS decision makers and authority decide whether or not to adopt a new health technology.

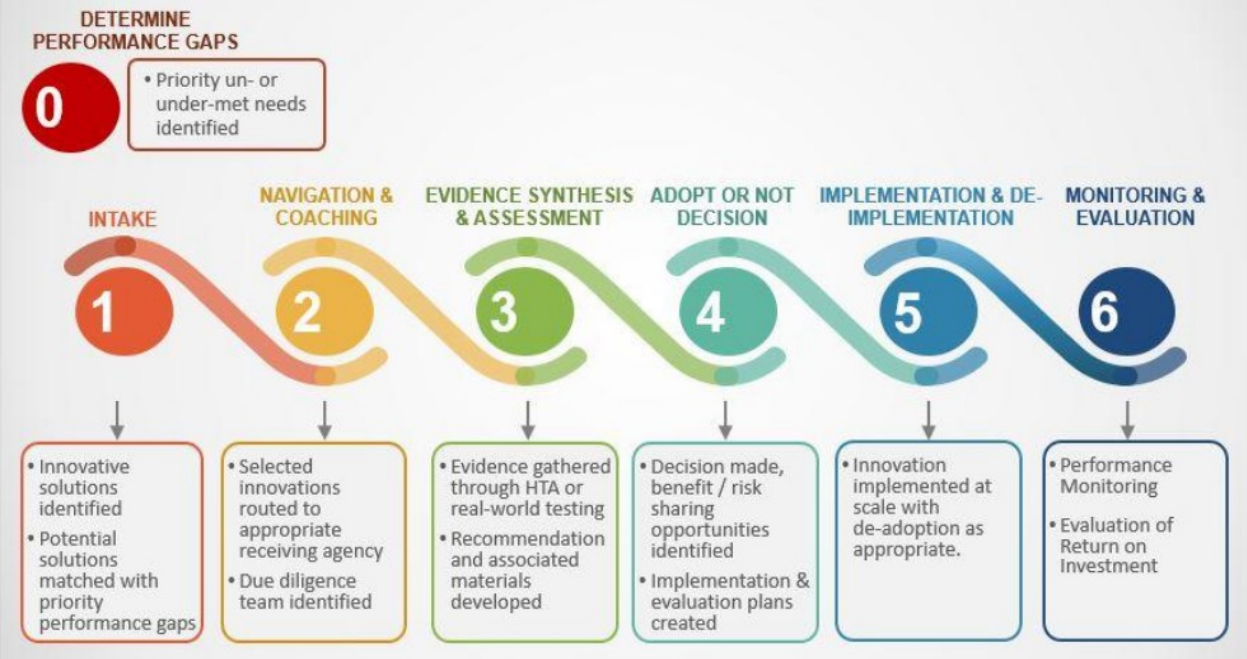

Figure 2. Alberta Health Services Innovation to Adoption Lifecycle. From Health Economics In AHS by Alberta Health Services, 2018, https://www.albertahealthservices.ca/assets/info/res/if-res-htai-newsletter-2018-06-01.pdf

1.4 Definition of Health Technology

Health technology is a broad term that can encompass both digital and non-digital innovations as seen in World Health Organization (WHO) definition of health technology:

> "application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives," (What is a health technology, n.d.).

However, for this research, this definition is too broad and encompasses topics such as vaccines. A subset of the definition is used in this research to refer only to only digital (hardware and software) procedures and technological systems developed to solve a health problem and improve the quality of life. Therefore, my operational definition of health technology and innovation differs from WHO definition by excluding non-digital procedures and systems, medicines, and vaccines. Examples of what constitutes health technology (for the purpose of this research) are: artificial intelligence, computer software designed for health related use, robotic surgery, electronic health records (EHR), mobile health (mhealth), electronic health (ehealth), and other types of digital health (Canada Health Infoway, n.d.).

1.5 Health Technology in Reducing Cost and Improving Healthcare Delivery

The incorporation of health technology innovation into the healthcare system has been commonly cited as both a possible source of cost reduction and improvement to healthcare delivery (Chaudhry et al., 2006; Buntin, Burke, Hoaglin, & Blumenthal, 2011). CBoC has stated in their report that the funding for improved information technology could renew its healthcare system to be amongst the best ("Health - Provincial and Territorial Ranking", 2015). The Government of Canada had released a notice that states "[adoption] and use of digital health technologies has the potential to make the delivery of health care more accessible, convenient and cost-effective" (Government of Alberta, 2018b). Although there is the associated upfront or short term cost in implementing these technologies, in the medium or long term there should be cost savings (Canadian Institute of Health Information, 2011). It is then not uncommon to see governments and institutions recommend the investment, utilization, and adoption of new health

technologies to address rising healthcare cost, improve efficiency, and healthcare outcome and delivery.

Research and literature surrounding the impact of health technology implementation have overall been positive. In a systematic review regarding the impact of health information technology in medical care, found that health information technology: increased delivery of care based on guidelines (particularly in the domain of preventive health), enhanced monitoring and surveillance activities, reduce medication errors, and decreased rates of utilization for potentially redundant or inappropriate care (Chaudhry et al., 2006). Another review conducted in 2011 reported that out of the 154 studies, 62% were positive (health information technology was associated with improvement in one or more aspects of care) and 92% were either positive or mixed positive (Buntin, Burke, Hoaglin, & Blumenthal, 2011). /other innovative health technologies that show promise in recent years, but require additional research before more widespread use and implementation can occur (Haux et al., 2016, Isern & Moreno, 2016).

1.6 Health Technology Assessment

The World Health Organization (WHO) defines HTA as a "systematic evaluation of properties, effects, and/or impacts of health technology" (*Health technology assessment of medical devices*, 2011, p. 8), WHO definition of HTA definition of health technology also refers to both non-digital health technology such as vaccines and digital health technology. For the purpose of this research, the definition of HTA presented by WHO will be using this research operational definition of health technology in place of theirs. The main purpose of HTA is: to

inform technology-related policies in healthcare, serve as a bridge between the integration of new health technology into the marketplace and clinical practice, and ensure that clinical decisions are evidence-based (Haas & Moskowitz, 2007, Barnett & Taylor, 2002). In the context of this research, HTA serves as one of the first formal contact points between the appraisal and adoption of new health technology and healthcare decisions and policies. Although healthcare decision and policy makers may be aware or interact with a particular technology before, it is in an HTA where the formal process of evaluation and integration with the healthcare system begins.

Generally, HTA contains elements such as: a technology's use and operations, safety and efficacy, potential unintended consequence, budget impact, management and maintenance, and other factors that may be relevant to the local practice context. However, there is no defined structure, requirements, or goals that are mandated in an HTA. This means that HTAs may be designed and made with a different purpose, structure, or context in mind. The lack of standardization can be misleading to the reader on the general goal or purpose of an HTA (Luce et al., 2010). This lack of standardization has some organizations such as the European Network for Health Technology Assessment (EUnetHTA) to define a structure for what a comprehensive HTA should look like called *HTA Core Model® (*HTA Core Model®*, n.d.)*.

In Canada, HTA can be conducted by a multitude of different organizations. The Canadian Agency for Drugs and Technologies in Health (CADTH) list a few of these organizations such as the Centre for Evaluation of Medicines (Ontario), and the Centre for Health Services and Policy Research, the University of British Columbia ("Search Canadian

HTA websites", n.d.). Unlike EUnetHTA which can be said to provide a framework for the European Union member states for HTA, Canada (and Canada-based organizations) does not have a single unified model for HTA. Despite the lack of agreement on a single model, it is believed that HTAs conducted in Canada has a positive influence on the health system (Martin, Polisena, Dendukuri, Rhainds, & Sampietro-Colom, 2016, LOCAL HEALTH TECHNOLOGY ASSESSMENT IN CANADA: CURRENT STATE AND NEXT STEPS, 2011).

In Alberta, organizations such as the Institute of Health Economics (IHE), Alberta Health, AHS, SCNs, and the Health Technology Assessment Unit work together (as well as on their own) to create HTAs (context-free HTA or a generalizable HTA, and context-sensitive HTA) (Putting HTA into Practice, 2012). Although there is no set standard for HTA in Alberta, these organizations generally follow a similar format (e.g., CADTH provides an outline of what they include in an HTA on the website). Comparing HTA between Alberta and EUnetHTA, generally they cover similar domains (e.g. cost-benefit, safety, legality), but may differ in the context because of contextual differences (e.g., different healthcare policies). (Alberta Health, 2017a; Alberta Health, 2017b; Alberta Health, 2017c; HTA Core Model®, n.d.; Canadian Agency for Drugs and Technologies in Health, 2015).

1.7 Significance of Research

New innovation of health technology can be seen as the solution to many problems currently faced by healthcare systems including rising cost of healthcare. Despite the affordances provided by new healthcare technology, these health technologies are useless if users do not

adopt the use them; therefore, a better understanding of the underlying factors that contribute to user adoption and acceptance of technology can help integrate these technologies into the system. This research aims to highlight and integrate an underrepresented and underutilized aspect of user adoption and acceptance of technology into HTA. To address this gap a theoretical framework outlined in the Unified Theory of Acceptance and Use of Technology (UTAUT), and aims to support healthcare organization in addressing aspects of user adoption, user use, and user acceptance of new health technology. This is done through the analysis and translation of UTAUT as well as case studies that better tailor it to the health sector. Consideration of this framework and its use in HTA would provide healthcare organization a more complete view on how the technology will be used, accepted, and adoption in their organization as well as providing them with the information needed to address future user adoption and acceptance issues.

Chapter 2: Unified Theory of Acceptance and Use of Technology

Research into the methodologies and reasoning behind individual-level adoption of technologies is one of the most mature streams of research within information system (IS) (Venkatesh, Davis, & Morris, 2007). Expansion of this research to address organization-level or group-level adoption of technology exposes new facets for analysis that explores what influences employees' productivity, output, and job performance (Sarker & Valacich, 2010). Research in these areas has resulted in a growing body of theoretical models that encompasses fields such as IS, psychology, and sociology, to examine technology adoption (Davis, 1989; Bandura, 1986). Over the years, different theoretical models have emerged to describe technology adoption such

Technology Acceptance Model (TAM and TAM2) (Davis, 1985; Venkatesh & Davis, 2000). In 2003, Venkatesh, Morris, Davis, and Davis, proposed a synthesis of these technology adoption models, the Unified Theory of Acceptance and Use of Technology (UTAUT).

2.1 What is the Unified Theory of Acceptance and Use of Technology (UTAUT)

Unified Theory of Acceptance and Use of Technology (UTAUT) synthesizes eight models of information technology (IT) acceptance research into a single unified model that explains user acceptance and usage of technology in an organization context. The models reviewed were: the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model, the Theory of Planned Behaviour (TPB), a combined Technology Acceptance Model and Theory of Planned Behaviour (C-TAM/TPB), the Model of Personal Computer Utilization, Innovation Diffusion Theory, and Social Cognitive Theory. The synthesis of these theories formulated four core determinants of intention and usage (performance expectancy, effort expectancy, social influence, facilitating conditions), and up to four moderators (gender, age, experience, voluntariness of use) of key relationships (See Figure 3.). It suggests that performance expectancy, effort expectancy, and social influences behavioural intentions, which then affects use behaviour. While facilitating conditions effects only use behaviour. Each construct is also impacted by the moderators which enhance or hinders their effectiveness. Application of UTAUT (in an organization context) was able to explain 70% of the variance in behavioural intention to use a technology and around 50% of the variance in technology use in a longitudinal field study of employee technology acceptance.

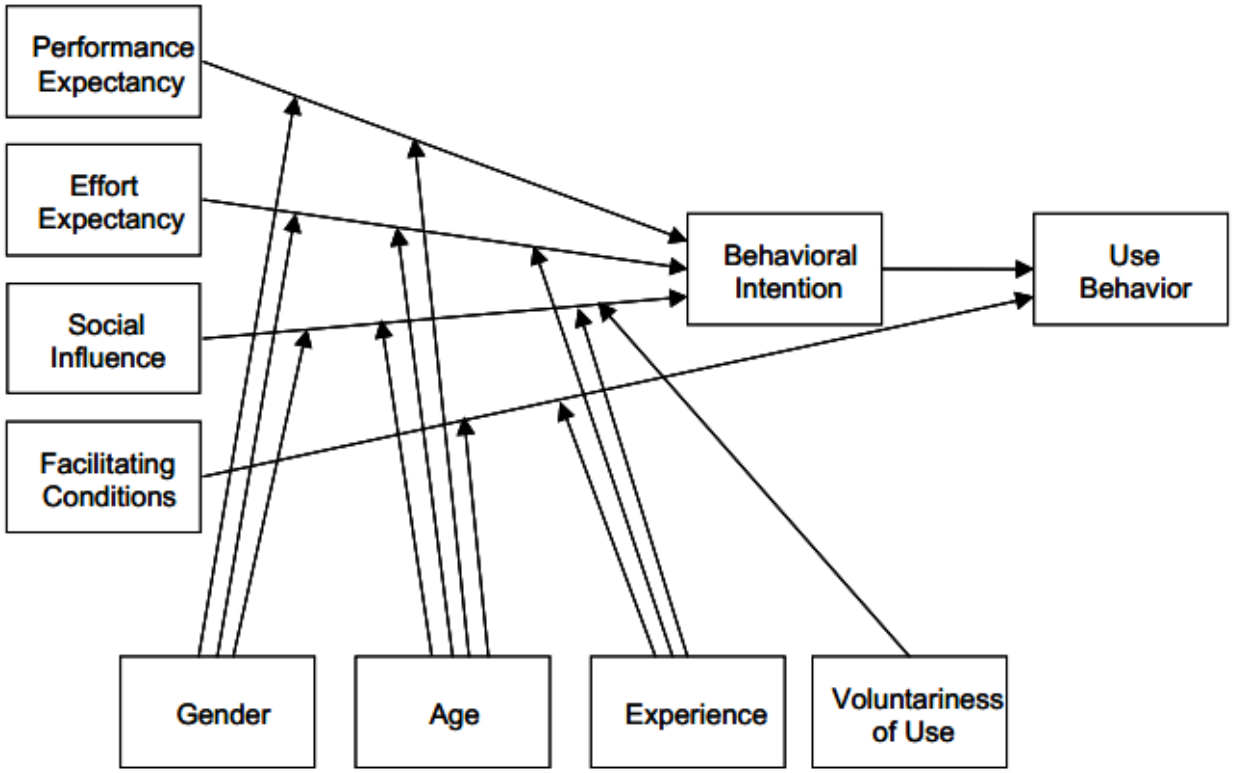

Figure 3. UTAUT Research Model. From Figure 3, by Venkatesh et al., 2003, User acceptance of information technology: Toward a unified view.

From the synthesis, it proposes that there were originally seven constructs that played a significant role as direct determinants of technology acceptance and use. However only performance expectancy, effort expectancy, social influence and facilitating conditions made the cut as the others (attitude towards technology, self-efficacy, and anxiety) are theorized not to be direct determinants of intention. The first construct, performance expectancy, is the degree in which one believes that the technology would improve their job performance. Effort expectancy refers to the ease associated with using the system, this does not necessarily mean that the technology is easy to use in practice, it could refer to a user's perception of ease of use. Social influence is one's perception of how others will view them for using the technology, some

examples are peer pressure or social consequence of using the technology. Finally, facilitating conditions refers to one's belief that there is organization, infrastructure, and/or technical support for the technology.

Additionally, UTAUT specifies that different moderators are not necessarily derived from UTAUT component theories but from other theories and their impact on the four core constructs. For example, gender is stated to be a moderator of performance expectancy. UTAUT gives the example that men tend to be more task-oriented and therefore performance expectancy may be more salient for men. These moderators then seek to temper the possible impact of the construct depending on circumstantial factors present in an organization.

2.1.1 Summary of UTAUT Component Theories

The component theories that make up UTAUT are theories in their own right and have a legacy within technology adoption literature (Venkatesh et al. 2003; Venkatesh et al. 2012). However, for the development of an HTA component that seeks to integrate a generalized theoretical framework into a more specialized healthcare context, an overview of each component theory and their impact on UTAUT allows this research to explore aspects of UTAUT roots that may have been discarded. Given that some constructs or relationships that were previously overlooked during the creation of UTAUT may be relevant to the healthcare context. Therefore, an understanding of what each component theory provides to the overall framework provides this research the flexibility to expand upon elements of UTAUT to better

tailor it towards the Alberta healthcare context (see Appendix B. for Venkatesh et al. (2003) original tables summarizing the impact and influence of UTAUT component theories).

Theory of Reasoned Action (TRA)

TRA proposed by Fishbein and Ajzen (1975), stands as one of the most fundamental and influential theories of human behaviour. It is used to predict how individuals will behave based on their pre-existing attitudes and behavioural intentions. It outlines two core concepts, one's attitude towards a behaviour (desirable or not desirable outcome) and subjective norms (the perception of others about one self). These two determinants on behavioural intention can help explain if someone will take a particular action. An example of this is if one evaluates a suggested behaviour as positive or has a positive attitude towards it and influential others have a positive perception of them if they perform the behaviour, it results in a higher chance they will do so.

Theory of Planned Behaviour (TPB)

Ajzen (1991) extends TRA by incorporating a new construct, perceived behavioural control, alongside attitude towards a behaviour and behavioural intentions found in TRA. This construct refers to the degree in which one believes he or she controls any given behaviour. It suggests that one will be more likely to perform a behaviour if one can do so successfully. It accounts for internal and external factors such as peer pressure or availability of IT support that an individual may encounter when deciding to conduct a behaviour.

Technology Acceptance Model (TAM / TAM2)

Tailored towards information system, TAM was designed to predict the acceptance and usage of technology on a job. An extension of TRA, it replaces many of TRA attitude construct with two different measures, ease of use and usefulness (Davis 1989). These aspects then would go onto impacting one's attitude towards using a technology and behavioural intention to use. The extension, TAM2 introduces subjective norm (a person's perception of those who are important to them wanting them to perform a particular behaviour or not) as having a significant direct effect on usage intentions (Venkatesh & Davis, 2000). However, subjective norm was just one of the three social influence processes that were proposed in TAM2 and not outlined as a core construct in UTAUT. "Voluntariness" and "image" are the other two social influence processes which were not incorporated into the UTAUT. Their exclusion from UTAUT is not discussed in Venkatesh et al. paper; however it is mentioned during their discussion of social influence. This research speculates that this could either be because subjective norm exert a significant direct effect on usage intention (Venkatesh & Davis, 2000) or UTAUT by taking only key aspects from each component theory, subjective norms, in comparison to the other two, played a large part in explaining technology acceptance and usage and was therefore chosen as a standout aspect. Given the limitations of synthesizing many different theories into one, this is understandable as the inclusion of every finding (or attributes that played a part in technology adoption and acceptance) would bog down UTAUT with too many elements for consideration.

Motivational Model

UTAUT uses Vallerand (1997) hierarchical model of motivation as its main theoretical framework. It outlines how intrinsic and extrinsic motivation represents a substantial portion of people's experiences when involved with activities. With extrinsic motivation referring to engaging in an activity in order to obtain something outside the activity (e.g., job promotion, better social standing), and intrinsic motivation is engaging in an activity out of pleasure or satisfaction. Although UTAUT outlines intrinsic and external motivations only, Vallerand states there is both a third motivation, Amotivation (relative absence of motivation), as well as different levels of motivation (global / personality, contextual / life domain, situational / state), each having their own moderators (e.g., social factors) and situations that influences them. This research speculates that given the context that UTAUT was trying to frame itself towards, the inclusion of the third motivation as well as the different levels of motivations would have resulted in additional complexity which would have reduced the generality of UTAUT. This is because in a controlled environment (workplace setting), the analysis of how each motivation level influences technology adoption of an employee may not be as relevant as the role of motivation (extrinsic and intrinsic).

Combined TAM and TPB (C-TAM-TPB)

A combination of TAM and TPB was proposed by Taylor and Todd (1995). It takes subjective norms and perceived behavioural control of TPB and adds them to TAM to provide a more complete test of the important determinants of IT usage on both inexperienced and

experienced IT users. The study was conducted to showcase how changes in user experience with a technology change over the course of a technology's lifecycle. It showcases that for those with different IT experience are influenced differently with variables within the model. UTAUT outlines all core constructs of TPB, but only listed one core concept in TAM excluding the single overlap between the two. It does not include perceived ease of use as a core construct, but given the definition presented, it is closely resembles perceived behavioural control.

Model of Personal Computer Utilization:

Derived from Triandis' (1977) theory of interpersonal behaviour (another theory that seeks to explain behaviour intention), Thompson et al. (1991) tailored the model for the IS context. Although Model of Personal Computer Utilization seeks to predict usage behaviour rather than intention, keeping with the theory's roots, the current research will examine the effect of these determinants on intention. Model of Personal Computer utilization outlines six core constructs: job-fit, complexity, long-term consequences, and affect towards use, social factors, and facilitating conditions. Job-fit refers to the individual's belief that the technology can enhance or improve their job performance (e.g., better efficiency, improving the quality of work). Complexity refers to an individual's perception of how relatively difficult a technology is to understand and use, with a lower adoption for those that are perceived as more complex. Long-term consequence refers to outcomes that have a reward in the future such as increase job flexibility when learning a piece of technology. Affect towards use is the feeling one experience when performing a particular act such as using a technology. Social factor refers to how one's behaviour is influenced by social norms, which depends on the context one receives from others

and what someone should do in a particular situation. Finally facilitating conditions are the objective factors that exist in an environment that can make a task easier, such as having IS support widely available. It is important to note Thompson et al. studied personal computer use in an optional setting, and made two modifications to Triandis' original theory. First, identify that perceived consequences had three distinct cognitive components; complexity, job fit, and long-term consequences, and exclude the construct habit from the analysis. Given the nature of their research goal which was to examine usage behaviour, Thompson et al. state that habit is similar to their research goal and thereby receptivity to include it. It is also mentioned by Thompson et al. that habit does play a role in technology adoption and acceptance but was excluded by the previously mentioned reason.

Innovation Diffusion Theory

Rogers Diffusion of Innovation Third Edition (1983) was used to explain the variables that determine the rate of adoption of innovation. UTAUT uses Moore and Benbasat (1991) model, which adapted the characteristics of innovation, presented by Rogers and refined them into a set of constructs that could be used to study individual technology adoption. It outlines six different constructs: relative advantage, ease of use, image, visibility, compatibility, results demonstrability, voluntariness of use. Relative advantage refers to whether or not an innovation is perceived as being better than its precursor. Ease of use is the perception one has about how easy or difficult it is to use the innovation. Image is the perception of that using the innovation can enhance or improve their image or status in a social system. Visibility refers to how often one can see others using the innovation or system in the organization. Compatibility is the degree

in which the innovation is perceived as being in line with pre-existing values, needs, and past experience of potential adopters. Results demonstrability refers to how demonstrable and visible the advantages are when using the innovation. Voluntariness of use is the degree in which the innovation is perceived as being voluntariness to use. Unlike UTAUT which has four core constructs, Moore and Benbasat list seven. Although there are overlap or close similarities with some of the UTAUT constructs, trialability or the degree to which an innovation can be experimented or tested with before adoption, has significantly less weight in an organizational setting and should be considered when examining a consumer perspective.

Social Cognitive Theory

UTAUT employs Compeau and Higgins' (1995) adapted model that is based on social cognitive theory by Bandura (1986). In addition, it notes that Compeau and Higgins model uses usage as a dependent variable, but analyzed the predictive validity of the model in the context of intention and usage. They outline five core constructs: Outcome expectation performance, outcome expectations personal, self-efficacy, affect, and anxiety. Outcome expectation performance and outcome expectation personal are similar in the sense that they are both concerned with the consequence of a behaviour. In the first case, it is concerned with the performance expectation regarding job-related outcomes, while the latter is personal or self-esteem and a sense of accomplishment. Self-efficacy is one's judgement of their own ability to accomplish a job or task with the technology. Affect is one's liking for a particular behaviour such as using the technology. Anxiety broadly refers to an anxious or emotional reaction when performing a behaviour. Similar to other component theories of UTAUT, a few constructs were

left out from Compeau and Higgins model such as others' use, encouragement by others, support, and use. The five mentions were found to have a significant impact, while the others were found to influence others and were less impactful.

2.2 UTAUT2

In 2012, Venkatesh et al. proposed UTAUT2 an extension of the original theory. The biggest difference between UTAUT and UTAUT2 is that UTAUT2 tailored itself towards a consumer use context. Despite the changed focus towards the consumers, UTAUT2 has also updated relationships, constructs, and moderators of UTAUT (See Figure 4) which will be used in later discussion of UTAUT translation. Although Canada's current healthcare system is viewed as reactive (MacIntosh, Rajakulendran, Khayat, Wise, 2014), a proactive healthcare may involve the use of health technology by both HCP and clients. In a future where there is a need for higher consumer engagement in their own health and healthcare (Snowdon, Leitch, & Shell, 2011) acknowledging the consumer's potential role in their health may be vital in the future evolution of the HTA format. Therefore although UTAUT2 may not be as applicable or tailored towards the correct context, UTAUT2 can play a large role in the future healthcare system that more readily involves clients in their own health and healthcare.

UTAUT2 contains additional constructs, moderators, alterations to some existing relationships between constructs and moderators. Some of the changes are to account for both new research within the field and allows the theory for a wider application in other contexts (consumer IT context). It adds three new constructs (hedonic motivation, price value, habit) and

removes voluntariness of use as a moderator. Hedonic motivation is the fun or pleasure one experience using the technology. Price value refers to the tradeoff between one's perceived benefits of the applications and the cost to use them. Finally, habit, which refers to the extent a user, performs a behaviour automatically because of learning. Similar to the moderator, experience, habit has a temporal aspect to it. Over time, one's experience with a technology increases with continual use, similar to how one develops habits performing a task over time. The increase in familiarity could result in uses of the technology to be automatic. Outside the previously mentioned changes, UTAUT2 also redefines relationships between constructs and moderators. Now all constructs influences behavioural intentions, while facilitating conditions and habits also influences use behaviour. These changes and modification both expand the scope and update previous relationships to better represent the end user and the new context.

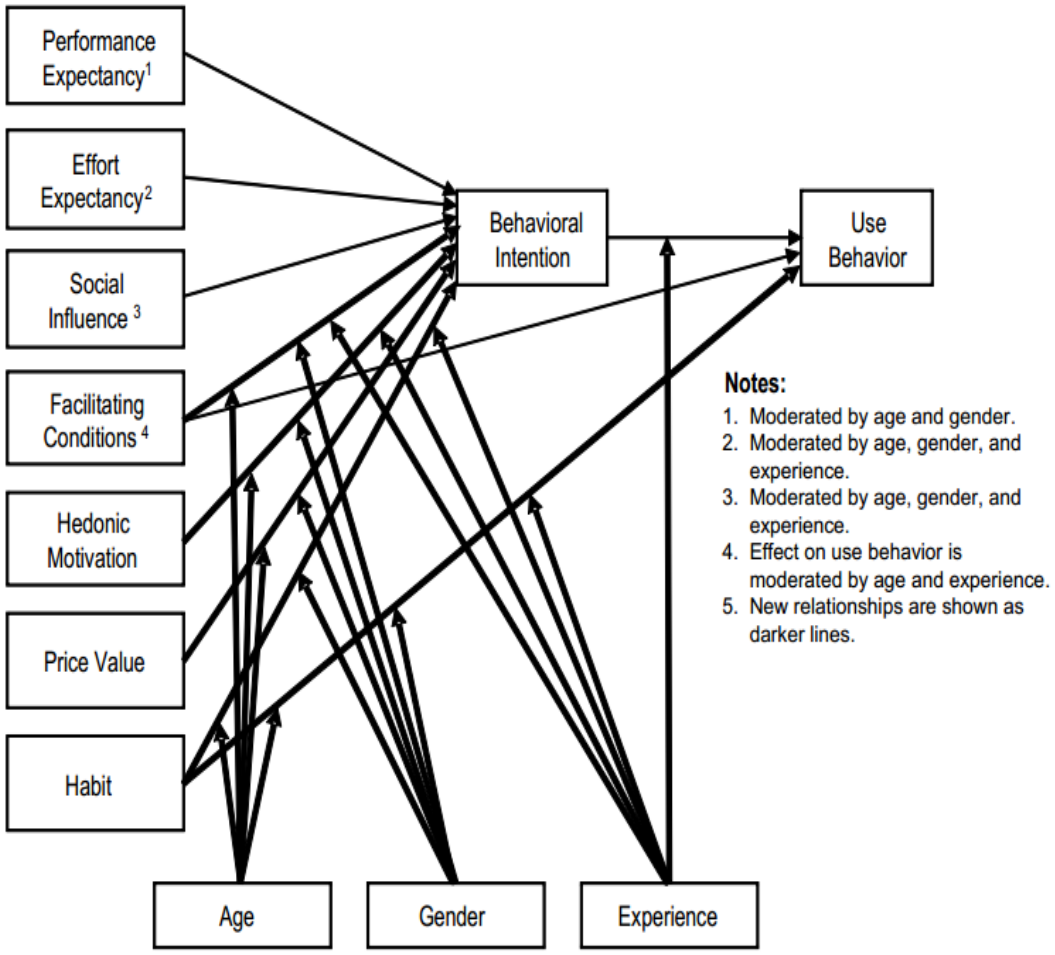

Figure 4. UTAUT2 Research Model. From Figure 4, by Venkatesh, Thong, & Xu, 2012, Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology.

2.3 UTAUT as a Framework for HTA

UTAUT and its synthesis of its eight component theories stand out amongst technology acceptance theories. Unlike other adoption and acceptance theories such as TAM, its strength is derived from the strength of its eight component theories with each having a legacy of research behind them (Venkatesh et al., 2003). However, this synthesis does have some inherent

weaknesses. First, a few of the theories used such as Innovation Diffusion Theory and Social Cognitive Theory are rooted in fields that are not necessarily closely related to information system or technology, and UTAUT employs adapted models of their original theories that were fitted to the IT context. For example, Compeau and Higgins modification of Social Cognitive Theory fitted the theory to examine computer use. Although Venkatesh et al. extends the model Compeau and Higgens present to encompass technology outside computers (2003), it does not necessarily mean that the model work as well for other technologies such as mobile smart phones or other IT context without further studies.

The main advantage UTAUT has for an HTA is it a generalized framework. UTAUT emphasizes the end user rather than the technology, allows it to be applied to any health technology or healthcare system structure. This allows the format of an HTA to be consistent between different HTA without the need for large modification to address different health technologies. Additionally, the affordance provided by having a degree of standardization allows UTAUT to stand out on its own. This prevents it from appearing as an optional add-on that is relevant in particular circumstances. Due to its generalizability, it allows UTAUT to be used in this research context (AHS healthcare system) without needing major modifications. Even UTAUT2, which has constructs such as habits that can be utilized in an HTA. Therefore for this research, UTAUT both adapts and translates well to the Alberta healthcare context.

UTAUT can explain variance in technology usage and acceptance for both consumers and organizations. However, given the complexity found in a large and diverse organization such as Alberta healthcare system, it may be difficult for a generalized framework to be able to handle

the nuances of the health system as well as account for large diverse user base. Despite these limitations, all of UTAUT constructs and relationships provide a framework that is easy to understand by others. For example, facilitating conditions from the perspective of an organization is a common factor that is looked at already. Training and IT support are familiar factors any organization faces. Without requiring as much specialized knowledge in one particular domain, the UTAUT framework provides a formalized structure to explore aspects of technology usage and acceptance.

2.4 Application of UTAUT for Health Technology

Since its inception, UTAUT has been used in numerous studies to evaluate user acceptance and usage of a variety of different technology. There have also been studies where UTAUT has seen alteration and modification that expand upon its original framework to better fit the context they are studying (Venkatesh, Thong, & Xu, 2016). However, this research benefits more from a larger emphasis placed on the original theory of UTAUT. This is because, as a first iteration of UTAUT translation into an HTA format, the inclusion and study of modification and alteration made to UTAUT can diverge the focus away from the core ideas laid out in UTAUT.

Healthcare is a complex system filled with its own nuances and challenges (Sturmberg, O'Halloran, & Martin, 2012). To then solely rely on UTAUT for the translation may result in an HTA translation that is out of touch with its audience. Whether it is because it fails to recognize the diversity of the workforce or beliefs of healthcare professional, the failure to recognize the

nuances of the field hinders the practicality of this research. Therefore the choice was made that this research would employ the use of case studies. These cases studies will look at different health technologies in different regions; this allows for a preliminary exploration of UTAUT with different health technologies in different countries. This will help supplement this research's translation of UTAUT, while still having the main focus being on UTAUT. The choice of including studies outside of Canada is to both showcase how UTAUT is applied and relevant regardless of the type of healthcare system and how researchers modify UTAUT to fit their context.

2.4.1 Examples of Health Technologies using UTAUT Model

Electronic Health Records

For this thesis, electronic medical record is interchangeable with electronic health records is and uses the Office of the Auditor General of Canada definition of electronic health record (EHR) as the "secure and private lifetime records that describe a person's health history and care" (Government of Canada, 2010). These electronic health records could range from "lab results, medication profiles, key clinical reports (e.g., hospital discharge summaries), diagnostic images (e.g., X-rays), and immunization history" (Canada Health Infoway, n.d.). EHR has been a prominent target for health technology adoption studies. The focus on EHR technologies is twofold. First, EHR systems can provide improvements to financial and operational performance of health care systems. These affordances could enable healthcare providers more efficient and effective means to communicate information across services (Canada Health Infoway, 2006,

2016) as well as reduce overall cost (Government of Canada, 2010). Second, investment and use of electronic records in the healthcare industry is behind other industries such as banking (Skinner 2003).

A study by Hennington and Janz (2007) mapped EHR to UTAUT framework and outlines different propositions. A key point is that it maps EHR from the perspective of American physician. It therefore is using the American healthcare model, where financial factors play a larger role. In the context of this research, financial impact is already addressed by other components in HTA, and thereby has less impact on HCP directly. In the study, it discusses an often written about barrier to EHR adoption is the misalignment of EHR processes with existing workflows. One example is that poor EHR implementation or design can result in errors made by the user which can impact patients' health (Koppel et al., 2005; Bria, 2006; Johnson and FitzHenry, 2006). These risks would then impact physicians' perception of how helpful the technology is and its ability to integrate with pre-existing workflows and therefore adoption and acceptance. Other more minor factors that can be generalized are the impact training has on a physician workload, clients' belief that a physician should use a particular health technology, and finally physician generational differences when interacting with technology (Browman, 2000; Miller and Sim 2004).

Highlights of the findings in Hennington and Janz exercise in mapping EHR adoption onto UTAUT are:

- Impact of integration of health technology into pre-existing workflows and workloads of HCP can impact adoption and acceptance
- Poor design or increase effort associated to accommodate new health technology impacts adoption and acceptance
- Lower quality of care provided during a transitional period impacts adoption and acceptance
- Public or client beliefs about health technology can influence HCP adoption and acceptance of said health technology
- Generational differences in the workforce can impact adoption and acceptance

Robotic-Assisted Surgery

Robotic-Assisted Surgery can refer to a broad set of different surgical operations that are assisted or use robotics. A common application of robotic-assisted surgery is to facilitate minimally invasive surgery such as laparoscopy and to assist surgeons to perform tasks that they previously could not using traditional open or laparoscopic techniques (Ho et. al., 2012). Unlike digital recording (EHR), which can be said to be an "old" technology, robotic-assisted surgery can be said to be on the cusp of what is new and innovative. BenMessaoud, Kharrazi, and MacDorman (2011) study, interviewed surgeons (users and non-users) to identify dominant constructs of UTAUT. Similar to the EHR example, this study contextualizes and modifies UTAUT (adds leadership and attitude towards using) to fit the health care context (Rawstorne, Jayasuriya, & Caputi, 2000), but differs in the fact that it uses open-ended questions to connect surgeon thoughts and beliefs to UTAUT rather than defining how each construct should be

framed. This provides a different angle for analysis as this study looks at the fundamentals of UTAUT and seeks to showcases which ones are most impactful or useful.

The study finds that the performance expectancy (perceived usefulness) was one of the most influential. That surgeons are drawn to robotic-assisted surgery due to enhanced functionality it provides (e.g., better visualization and dexterity). Other persuasive elements are the reliability of robotic (in performance expectancy), improved patient outcomes (extrinsic motivation), clients seeking out the newest or latest technology (subjective norms), technical or IT support (facilitating conditions). The two modifications (attitude towards using and leadership) have also seen a positive impact with positive attitudes having a large impact on their behaviour and leadership roles in training and proctoring other surgeons.

The distinction between non-users and users presented in this study provides a temporal scope to technology adoption. In the case of wide-spread or system wide adoption, the transitional period from being non-user to user is at the heart of technology adoption. For both users and non-users, perceived usefulness is both a facilitator of adoption and barriers.

Attitude towards using, and leadership modification to UTAUT are not necessarily new additions. In the conceptualization of UTAUT, attitude was a construct in UTAUT component theory. Leadership on the other hand, can be said to fall under facilitating conditions. In this case, it can be argued that having local leadership support in the work environment that promotes, proctors, or encourages the use of health technology can be facilitating conditions.

Highlights of the findings in BenMessaoud, Kharrazi, and MacDorman study connecting surgeon interviews with UTAUT are:

- Users and non-users are affected both positively and negatively by common constructs (e.g., perceived usefulness)
- Each construct (e.g., perceived usefulness) have varying influences on behaviour depending if they are a user or non-user
- Leadership influences behaviour and helps transition non-user to users
- Clients may seek out the latest in technologies which can influence health care professional adoption of new innovative technologies
- Perceived improvements to health delivery or outcomes are most influential for practitioners' adoption of new health technologies

Mobile Health (mHealth) Systems

Mobile Health Systems or mHealth systems have attracted more attention over recent years. There exist multiple definitions of mHealth, some refers it as mobile computing, medical sensors, communication technologies for healthcare (Jovanov & Zhan, 2004), while WHO (2011) defines it as medical and public health practice supported by mobile devices such as mobile phones, or patient monitoring devices. With no consistent definition of mHealth, it has been used to refer to a broad spectrum of mobile devices that support health care professional work like monitoring or detection system, healthcare management tools, and even tools to collect data to improve healthcare outcomes and status. Another difference between mHealth and

previously explored health technology is that mHealth technology is used by not only health care professionals or members of the healthcare industry, but also by clients.

Lee and Rho (2013) examined mHealth using UTAUT from the perspective of the South Korean healthcare system with users and non-users. Unlike the previous example that employed an American healthcare point of view, the inclusion of an example outside North America. The reason for the inclusion is because South Korean has a single-payer program (publicly and privately funded) that pays for privately provided healthcare. Despite the differences in Canada's and South Korea's healthcare system, fundamentally they both seek to provide universal health coverage and face similar health problems (Pen, & Tiessen, 2015). In the context of this study it explores user's acceptance of health technology supported by the South Korean government. The exploration of client acceptance and adoption of health technology situates the design of a new HTA to address future innovations that are provided by the healthcare system.

Building off different modifications made to UTAUT in other healthcare studies, Lee and Pho categorize the constructs of UTAUT differently. It adds four new constructs: accessibility (access to healthcare and health record regardless of time and space), communication (communication between healthcare professionals, service providers, etc.), intimacy (intimacy provided via health monitoring service), and service risk (uncertainty with mobile health monitoring).

The study finds that there exists a difference in perception of service benefits between user and non-user groups. It also finds that clients were less concerned about service risk such as

the cost and quality of service after they have used it. An interesting finding is that clients (both users and non-users) found that mHealth created a relationship between them and health care professional. This suggests that mHealth could be an alternative avenue for one to connect with clients. This study again outlines differences between age and gender and their perception of technology. It also discusses both the need for facilitating condition like service providers providing education, and guidelines for using their products and designing the technology to be usable with familiar devices of the client. Finally, it suggests that the technology should be designed in consideration of the clients' age.

Highlights found in Lee and Rho study examining client use of mHealth technology with UTAUT are:

- There exists a temporary uncertainty or hesitancy to use technology at that start that alleviate (to varying degrees) upon use.
- Facilitating conditions should account for generational and gender difference
- Technology design can be varied to account for generational and gender difference
- Some technologies can strengthen or create relationships between healthcare professionals and clients

Telemedicine

Telemedicine is defined through four elements by the WHO: its purpose is to provide clinical support, intended to overcome geographical barriers, involves the use of various types of

information and communication technologies, and improve health outcomes (2010). Telemedicine is similar to mHealth, and both are a subset of telehealth.

In the Kohnke, Cole, and Bush study, they define telemedicine as remote monitoring, real-time interactive services, and data capture of medical information that is electronically forwarded to a health care professional (2014). In this American study, the participants comprised of patients, health care professionals, and agency leadership personnel. Unlike previous examples, the authors made minor alterations to UTAUT by including additional moderators (role, attitude, anxiety, and self-efficacy), and their participants had a user-base that included health care professionals, administrative positions, and clients.

They found clients with high attitude (positive perception towards using the technology) and high self-efficacy (positive perception towards using the technology without independently) had a higher likelihood of using the technology and promoting it. Another finding was that the promotion of a "pay off" or that their efforts in using the technology will have a "reward" such as better health outcomes can improve self-efficacy and thereby increase adoption rates. The study also points out that that clinicians will not invest time into learning a technology they felt it was beyond their capability or not worth it. They also suggest the creation of programs that both recognize and reward users to learn and utilize the technology.

Highlights from Kohnke, Cole, and Bush study examining telemedicine technology with UTAUT are:

- Increasing healthcare professional self-efficacy can influence can have a positive influence their willingness to use and learn new health technology
- Leadership that invests time to showcase, demonstrate or raise awareness of the benefits of the health technology (e.g., improvements to patient health) can support health care professionals' adoption of health technology

Computer-based clinical decision support system

Computer-based clinical decision support systems are designed to support or enhance health professionals decision-making in a healthcare environment to improve overall health delivery. This and other similar technologies seek to augment HCP ability to provide client specific medical advice. This is done by providing features such as alerts, reminders, therapy critiquing and planning, amongst others (Coiera, 2003).

Sambasivan, Esmaeilzadeh, Kumar, and Nezakati (2012) examined CDSS in Malaysia. They looked at the adoption of computer-based clinical decision in both private and public hospitals with a population that was unfamiliar with the technology. Again using this study we can examine a different perspective of technology adoption from the views of a developing country. Unlike other studies, this one makes larger amount of modification to UTAUT (the introduction constructs such as level of physician involvement in decision making and perceived threat to autonomy). The reasoning behind these changes is tailoring UTAUT towards physicians' use of the technology. Using UTAUT as a base for their model, they chose to omit the constructs "facilitating conditions" and "subjective norms". The decision to exclude these

features is because facilitating conditions is relevant when performance expectancy and effort expectancy are present. Subjective norms were indicated to play an insignificant role due to self-autonomy of health professionals. It also has a larger focus on the initial intention to adopt technology, rather than the transition between user and non-users. Therefore there is a larger focus on adoption aspects of CDSS such as threats to professional autonomy, involvement in decision making, workflow, and healthcare outcomes.

Their findings suggest that perceived threat to professional autonomy lowers intention to use computer-based clinical decision. They also found that performance and effort expectancy had a positive impact on computer-based clinical decision adoption. Finally, physicians involved in decision making (e.g., planning, participation in development) had a positive influence on adoption.

A key difference between this example and the previous is the analysis of the "threat" of new health technology. Although the fear that new innovation replacing one's role, task, or job is not new, for health professionals, whose medical judgement plays a large part in their role, this "threat" can hinder technology adoption disproportionately between health professionals and other IT users.

Highlights from Sambasivan, Esmaeilzadeh, Kumar, and Nezakati study examining computer-based clinical decision support system technology with UTAUT can be generalized to:

- Involvement of health professionals in an administrative capacity when integrating and adopting new health technology can have a positive influence on adoption
- Uncertainty or threat of autonomy presented by health technology can negatively influence one's adoption of new health technology
- Uncertainty or threat of autonomy presented by new health technology can disportionately negatively impact health professionals and other IT users

Serious Games

Rios-Rincon, Liu, Daum, Miguel-Cruz, and Stroulia (2019) examined the use of serious games on tablets as a form of intervention for older adults with cognitive impairments. Video games are commonly associated as a leisure or recreational activity rather than activity done for your health. However recent studies showcase the benefits of video games as a form of cognitive intervention in older adults (Anguera, Boccanfuso, Rintoul, Al Hashimi, & Faraji, 2013; Nouchi, et al., 2012). What stands out in this study is that health technology is being used by both the clients (older adults) as well as health service providers; in this case, the researchers conducting the intervention sessions. This adds a different dynamic as now the health technology is being utilized differently by the two types of users. During the study I noted that recipients of the intervention the users of the serious games were concerns about aspects such as: choice of colour, size of play area, visual cues, and sound cues. The researchers, including myself, were interested in attributes such as: ability to change the level of difficulty, resuming a level when the application accidentally. Additionally, during the intervention, social influence, such as older adults complaining about the game influenced the older adult's enjoyment of the game. While

for the researchers, having the ability to communicate easily with IT support (facilitating conditions) to make necessary changes to the game quickly or solve technical issues made was a bigger concern.

Relevant highlights from Rios-Rincon, Liu, Daum, Miguel-Cruz, and Stroulia findings are:

- Depending on the type of users (or user group) a health technology can utilize differently which results in them being concerned with different attributes of the health technology
- Depending on the type of users (or user group), some of UTAUT constructs can play a larger or smaller role in influencing their intention to use the health technology

2.5 UTAUT for a Healthcare System

UTAUT and its application in a smaller context uncover the nuances it has at a user level. For this translation, this analysis at a smaller scope helps refine the constructs to be able to encapsulate a wide variety of technologies from an end user perspective. However, the analysis of UTAUT effectiveness from a larger scope enables this research to address macro level issues. The combination of both the micro and macro scope analysis of technology adoption and acceptance rounds out the HTA to be insightful for healthcare decision makers in understanding the technology adoption and acceptance at different organizational levels.

Individual, team, or facility resistance to technology adoption, use, and implementation is not health technology specific issues. Although there may be varying degrees of resistance from different parties such as healthcare professionals, support staff, and client, depending on the health technologies, this can be expanded to state that for any health technology there exist a general resistance to health technology (Ifinedo, 2012,, Lapointe, & Rivard, 2005; Timmons, 2003). For the Alberta context, this can be problematic as the implementation of new technological innovation that seeks to improve healthcare delivery can be delayed because of these resistances. This could reduce client satisfaction with the system by using out-of-date health technology (Taner & Antony, 2006), or reduces the effectiveness of healthcare access and use by Canadians who travel or move both between provinces and within (McDonald et al., 2005). Therefore the analysis of literature that examines UTAUT use on a more macro level can provide insight on issues that impact the macro level issues of health technology adoption.

2.6 UTAUT at a Macro Level

Canada

In a publication by Infindeo (2012), analysis of Canadian healthcare professionals' acceptance of health technology modifies UTAUT to include a "compatibility" construct to examine how well the technology fits with pre-existing values, experience, and needs. It reports similar findings as those found a micro scale, but it does echo that some healthcare professionals such as physicians and occupational therapists are impacted differently by some constructs such as social influence. In addition, it address allied healthcare professionals and that they are

influenced both by the views of other important personnel in their work context and their own autonomy in their work. This study brings forth a relationship previously not addressed, that allied health professionals are impacted by social influence depending on their own autonomy in the workplace. Although in reality the experience felt by allied health professionals are not isolated to just that user demographic, this study does showcase instances where autonomy plays a role in the impact of social influence. It also discusses the need for champions of new technology, and continual training, awareness and IT support past the initial stage of adoption. However, they make note that the findings in this study are not necessarily applicable or a full representation of the UTAUT effectiveness in the Canadian context. Despite this, these findings do fall in line with other studies mentioned as well as expand upon features that can be implemented.

Highlights in the Infindeo study examining technology adoption from a Canadain context using a modified UTAUT are:

- A technology's compatibility with current state (e.g., process, and workflow) can influence technology adoption and acceptance.
- Allied healthcare professionals can have varying degrees of acceptance of health technology based on their own autonomy and influence by important personnel.
- The duration or availability of training, and awareness program can influence technology adoption.
- Autonomy can moderate the impact of social influence on some user demographics in the healthcare system

Australia

Schaper and Pervan's (2006) examination of UTAUT in Australian context, explores the idea that organization culture has a role to play in technology adoption and acceptance. It discusses the idea that an organization that has a culture that is more accepting of new technologies can influence technology adoption positively. It frames that an organization that moves towards increased adaptability and autonomy can influence technology adoption. This adds an extra layer of complexity as the introduction of new health technology that can be used voluntarily across a health system rather than having it mandatory can impact technology adoption. For some health technologies this may be the case where only a few specialized facilities will have the resources needed to deploy them. While in other cases such as electronic health records, their use may be mandatory and there may be little flexibility on the part of the end user to be autonomous.

Highlights in Schaper and Pervan study examining technology adoption from an Australia context are:

- Organizational culture attitude towards new innovations can impact technology adoption and acceptance.
- Organizational culture stance on adaptability and employee autonomy (e.g. increase delegation) can impact technology adoption and acceptance.
- Changes in employee autonomy (e.g., increased representation) in workshops or meetings involving new technology can impact technology adoption and acceptance.

Thailand

Kijsanayotin, Pannarunothai, and Speedie (2009) expand the UTUAT to be more tailored towards Thailand's health sector. The authors report similar findings to those examining UTAUT at a micro level such as technology adoption is positively influenced by adequate facilitating conditions, and find validity of the UTAUT model in the context of their health field. One modification made to UTAUT is that it expands upon "IT use". It subdivides IT use into use frequency, administration use, care reports, and communication use. The idea that is presented is that a single health technology can be utilized differently or for different purposes. It could be possible that users find a particular utilization of health technology is simple while another is more difficult. This results in the ability to examine how different UTAUT constructs impact different types of IT use. Another aspect such as experience may play a large part in technology adoption as the study finds that experience had a stronger effect on technology use than did facilitating conditions and intention to use. Given that this study examined the experience people had with computers, which is common in Canada, our experience in more advanced technologies (e.g., robotic) may be similar to those in Thailand had with computers. This presents the idea that the demographic of a health system and their experience with any particular technology can impact technology adoption.

Highlights of the Kijsanayotin, Pannarunothai, and Speedie study examining technology adoption from a Thailand context are:

- A health technology can be multipurpose (e.g., being used for communication and administration) and users varying experience in its different purpose can impact technology adoption and acceptance
- User's previous experience with health technology can have a large impact on technology use

Case Study Notes

In these studies, they overall found UTAUT including those that made modifications to the original framework to be a useful framework for examining user adoption and acceptance of new health technology. For example in Kohnke, Cole, and Bush study (2014), they suggest that there exists a strong relationship exists between UTAUT, self-efficacy, and behavioral intention to use. While in Lee and Rho study (2013) findings suggested that after users used mobile health technology they seem less concerned about the service risk. Demonstrating that by using UTAUT, researchers were able to uncover challenges users face when it comes to adopting and accepting new health technology,

2.7 Extending UTAUT Scope for Alberta Healthcare system

As seen in the earlier macro examples, when looking at health technology adoption at a larger scope introduces new attributes for consideration. Looking back at the Alberta and AHS, there are additional factors that can influence technology adoption such as: geographical, cultural such as Alberta and AHS work culture, and healthcare system infrastructure.

Geography

In Alberta, Alberta Health Services is tasked with healthcare delivery in modern hospitals located in large urban cities, as well as smaller rural communities that may only have a single medical facility. This disparity between local infrastructure and geography can present different barriers to different types of health technologies. Take for example, technologies that is to be deployed across all healthcare facilities such as electronic health records. Urban locations may have more readily accessible IT support (facilitating conditions) as some healthcare facilities such as large hospitals may already have pre-existing IT departments or IT support services are within close proximity to locations that require them. While remote or more rural location may have to resort to online IT support or delayed responses. This disconnect between urban and remote locations would then impact that facilitating conditions (in this example) has on healthcare professionals, and other members of the healthcare system of their corresponding regions.

Other constructs like perceived ease of use can also be impacted by geographical distance. For example, in modern or more advanced hospitals similar health technologies already in place, or do not appear as "cutting edge" to the users there. This could result in particular technologies to be perceived easier to use to users in these locations compared to those in rural environment. Hospitals and medical facilities in the same urban environment can also experience this discrepancy in the integration of innovative health technology. For example, older hospitals

constructed in the 20th century may not be accommodated new health technology due to lack of space or infrastructure restraints, while newer hospitals are.

Culture

Technology adoption can be influenced by an organization's culture, but it could also be influenced by individual or societal cultural norms and beliefs (as seen in Infindeo 2012 study). Historically, Canada (and its provinces and territories) has been home to numerous ethnicities and cultural heritages. With one in five of its population foreign-born (Statistics Canada, n.d.), Canada and Alberta healthcare systems both serve and employ a diverse population that may hold different values from each other. Although it may be difficult to conceptualize or define exactly what Canadain culture is like, for this research and its scope, it is important to recognize that Canada has a diverse population with different views.

Huang, Choi, and Chengalur-Smith, (2010) suggest the idea that technology adoption can be influenced by cultural characteristics. It explores Hofstede's (1984; 2001; Hofstede, Hofstede, and Minkov, 2005) cultural dimension (uncertainty avoidance, power distance, masculinity, individualism, long-term orientation) and how they can impact technology adoption. Although their research proposal does not present results, there are parallels between their cultural dimensions and previous findings with individual technology adoption. For example a cultural dimension, individualism, ask if an individual likes to make job-related decisions themselves. As seen previously, physicians tend to prioritize their own autonomy when it comes to technology adoption and acceptance. On the other hand, there are some cultural dimensions, such as power,

that overlaps with the previously mentioned idea that different user demographics are impacted differently by social influence like the previously mentioned allied healthcare professionals consulting others for their decision making.

Culture, whether they are organizational or individual, can shape how we adopt and accept technology. For this research, it would be both beyond the scope of it to try to frame the Canadian or even Albertan cultural demographic and their corresponding impact, and it would be difficult and excessive for HTA researchers to possess or gather this type of information for an HTA. Despite that, the cultural dimensions mentioned earlier does help frame different factors that influence technology adoption.

Infrastructure

Expanding upon topics discussed in the geographic section, Alberta healthcare system serves a large population is spread across a large location. Compared to smaller scale adoptions and implementation of technologies such as those of a single hospital or clinic, a larger scale results in a higher need for logistics and support. This encompasses aspects such as IT support, transportation, supply chains, among other factors. Although this ties directly with facilitating conditions (e.g., workshops, and training), it also touches upon the readiness of the facilities to incorporate these new technologies.

Using the example of electronic health records (EHR), if a facility does not have the prerequisite technology in place like a tablet, then that facility needs to use additional resources

to acquire them before they can adopt electronic health records. Additionally, other aspects such as training can also be affected as users may only have access to it at certain times, or places due to these limitations. This both adds an additional level of complexity to adoption, and can also impact the technology adoption later down the road. A previously mentioned barrier to technology adoption was changes in the workflow. Continuing the previous example, the changes need to require the necessary resources and technologies to adoption EHR could change pre-existing workflows (before the introduction of EHR), which is then subjected to another possible change when electronic health records are finally introduced. Therefore, the state of pre-existing infrastructure can impact the adoption further down the line, although it may seem like a separate entity.

Chapter 3: From Theory to Application

A common and difficult task to ask of theory is "what do we do with this?" In other words, how do we contextualize, apply, and transition theory to be utilized in the "real world"? As seen in earlier chapters and examples, UTAUT has found success in explaining variance in user behaviour intention and use behaviour. Therefore all that is left is to translate this theoretical framework into an HTA. There are challenges with translation of UTAUT into an HTA. One challenge is representation, and that is because criteria, question, statement, or acknowledgments that are not present in an HTA is not represented to health authorities and decision makers (Cookson & Mirelman, 2017). Contemporary HTA sections such as economic evaluation, are slated to be a staple of both modern and future HTA. That is not to say what is current a staple of HTA will be a staple forever, as HTA continue to evolve over time (Jonsson, 2009; Briggs, &

Gray 1999; Richardson, & Schlander, 2019). With the nature of HTA changing and evolving over time (Weinstein, & et al., 2003; Thokala, & Duenas 2012), there is not a rigid structure or standard that needs to necessarily be followed.

To better ground this research attempts to adhere to the following criteria when translating UTAUT into an HTA format:

1. Provide health authorities and decision makers an HTA that focuses on technology adoption and acceptance as outlined in UTAUT constructs and moderators
2. Ensure its generalizable and applicable to any health technology
3. Focus on the aspect of UTAUT that can be addressed efficiently (or practical) first, then explore how other aspects can be expanded further
4. Provide healthcare authorities and decision makers a preview of possible technology implementation strategy, and challenges at an earlier stage of AHS technology adoption cycle (evidence synthesis and assessment stage)
5. Tackle technology adoption and acceptance from an organizational or high level perspective
6. Provide insight on the disconnect between health technology adoption decisions made at the macro level and their use by the workforce on the micro level

3.1 UTAUT and UTAUT2

UTAUT, to a lesser extent UTAUT2, is the core for a new HTA framework. When one examines UTAUT and its component theories, such as Diffusion of Innovation Theory, there are many aspects of the component theories that were later "reintroduced" as additional constructs or moderators for UTAUT when reviewing the case studies in the previous chapter. This "reintroduction" indicators could be because these moderators or constructs, such as attitude, and self-efficacy, are either not as significant to (broader) technology adoption compared to other constructs (e.g., social influence), added too much complexity, or not generalizable or applicable to the (organizational) context UTAUT was focused on. Although these other indicators do play a role in technology adoption and acceptance, they will be utilized to help round out the HTA.

UTAUT as a Core Framework

Looking to UTAUT to provide the core foundational attributes of a new HTA section, performance and effort expectancy will have a heavier emphasis. This is not to discredit the importance of social influence, and facilitating conditions, but rather because the formerly mentioned constructs had a larger impact compared to the latter in the literature. Additionally, the underlying principle of these two constructs can more easily be conceptualized in written form. Overall, UTAUT constructs serve as the core but I will emphasize effort and performance expectancy more than social influence, and facilitating conditions.

UTAUT's heavier emphasis on "perception" or "perceived opinion or stance" stands apart from traditional HTA metrics. Unlike other metrics (e.g., economic evaluations), researchers must gain this data by consulting with the end users. This makes UTAUT a metric that manufacturers or researchers cannot necessarily provide solely on their own, but only from reaching out to the end users.

Limitation of using UTAUT informed HTA is that data collection may be more difficult for some parties than others. Given that Alberta Health Services (AHS) are not the sole creator of HTA, other parties (e.g., CADTH) can conduct their own, or partner with AHS to conduct HTA. Therefore, discrepancies between access to data, evidence, and resources may impact one's ability to conduct this HTA. For internal body conducting HTA, having access to employee information (e.g., sending out a survey to them, access to representatives or facilities) may come easily, while for others it may prove more difficult. The impact of this factor varies with each HTA and organizations, but is important to note if UTAUT based HTA is to be introduced.

Despite some of the shortcomings of using UTAUT as a core, it does provide healthcare decision and policy makers a key advantage; the ability to make informed decisions about health technology by exploring users' perception of new health technologies and their perceived thoughts around them. This situates this from being overshadowed or competing for the same knowledge domains pre-existing HTA address.

UTAUT Moderators

Given that moderators are indirect influences on UTAUT constructs and their impact on technology adoption as a whole, they allow researchers to further expand upon their analysis if they wish. Take gender for example there exists a lot of research that explores the complexity of gender, gender roles, and gender in the workplace (Heilman, 2012). Therefore, researchers should utilize moderators to help explain how each construct are impacted differently based on these moderators (e.g., these age demographics are more subjectable to facilitating conditions). In the case of the moderators such as "voluntariness of use" may still be applicable despite it being removed in UTAUT2. Therefore, moderators present an opportunity to expand the analysis.

Moderators in this case can be expanded to fit the scope of the HTA. Using the example of experience as a moderator, and electronic health records as a technology, a survey could be sent out to employees asking about their experience with tablets (computers, and other electronic platforms) to determine their level of comfort or experience in using it. This could be as simple as their experience with the technology's platform (e.g., computer use) or experiences with digital record keeping.

Given the variety of different moderators presented in UTAUT, it is also possible for researchers to focus on one moderator over another depending on the technology or purpose behind the HTA. Therefore it is important to remember that researcher can both utilize moderators to different extents and selectively choose which one they may want to prioritize

depending on the health technology being studied. Overall, moderators presented in UTAUT (and UTAUT2) can both expand upon analysis, by allowing researchers to utilize them to the degree that fit their scope.

UTAUT Constructs

UTAUT constructs will serve as the core of a new HTA. However, out of all the constructs, social influence and cost possess an additional dimension that should be noted. While UTAUT itself does not state that all users are all influenced by social influence (it can vary from person to person), experiences of social influence in the healthcare context are unique. As seen in the previous chapter, the impact of social influence in the healthcare field is disproportionate. Physicians and other more specialized healthcare professionals are seen to be only slightly or not at all influenced by the social influence of their peers. This can be attributed to their trust in their own autonomy (e.g., their personal ability and capability to make medical judgement). On the other hand, other types of healthcare professionals such as allied healthcare professionals are more subjected to social influence by those in leadership or expertise position. This divides the workforce; there are those who are more affected by social influence and those who are not. This division highlights a unique aspect of the healthcare context that differentiates it from others.

Therefore to better portray this division, it is suggested to use an additional grouping method that classifies users into either “Independent” or “Other”. Those that belong to “Independent” would be those who are characterized by greater levels of “autonomy” or ones with a stronger belief in their own judgement, application, or delivery of care. Typical examples

are physician or other specialized health professionals. Those that do fit that description would be classified as “Other”. Given that the level of “autonomy” is the key differences between these two groups, researchers can define a particular level of “autonomy” to be the guideline that separates the two groups. This could be accomplished in multiple ways such as using broad assumptions and observation. One example of a broad assumption is stating that surgeons who are tasked with making medical judgement in the field would have high levels of autonomy. Another method could be through the use of surveys where you ask the user “how often do you independently make your own medical judgement in your workplace”. As Kohnke, Cole, and Bush mentioned, using research evidence such as informative workshops, can be a more effective method for a particular demographic (e.g., physicians or those with higher levels of autonomy) than another. This kind of knowledge helps healthcare decision makers’ plan effective training and adoption strategy for the right audience. This is done through the acknowledgement of the impact of autonomy on social influence.

This addition to measuring and analyzing social influence was chosen for two reasons. First, it allows researchers to estimate how many individuals belong in each group. This estimation helps gauge how big of an impact social influence will have with a health technology. Second, it allows researchers to showcase different solutions to address these constructs such as suggesting informative workshops that are more tailored and effective for each group. This translation instead plays around the idea that there exist those would are more susceptible to social influence than others. It tailors itself towards the health sector by examining the impact of autonomy when it comes to social influence, and what strategy that works for them (e.g.,

informative workshops for those with higher autonomy, and stronger leadership roles for the others).

Perceived performance expectancy and effort expectancy has been found to be two of the more prominent factors that influence technology adoption. Although they are distinct construct, they are similar in that both examine one's perceived expectation just from two different angles. One examines the perceived usefulness of a technology to complete a task or reach a goal (is worth using). While the other examines the perceived effort needed to utilize it (is it more trouble than it is worth).

For some health technologies, users may never have seen, heard, or interacted with them before; therefore it may not be as effective to ask the whole user base what their opinions about a particular health technology when the vast majorities have not interacted with it before. A possible solution is to create a representative group to test out the new technology (similar to a trial run of the health technology) and use their results as a representative sample of the user base. This has its own risk, as some parties may have the capability to undertake the task, while others may not. Researchers will have to weigh the pros and cons of using such methods.

An alternative is to gather data from pre-existing users of said technology, or obtain feedback from users of the technology elsewhere (e.g., other facilities that utilize the technology). Unless the technology is making its first appearance, there are likely other organizations or users within AHS that have come into contact with a similar technology. This

may be a more practical approach than gathering a sample set of users to try out the new health technology.

In the case of brand new technologies, questions can also be put forward to the developers of the health technology, with the goal uncovering features built into the technology that makes it more user friendly or research they have done themselves (e.g., focus group testing). This option however, may not be as informative as gathering data from the field and has two main limitations. The first being that just because the technology has a particular feature that makes it more intuitive, it is hard to tell how the user (in the field) will use it. It would however, display the extents in which a developer has undergone to tailor their technology to the user base. The second limitation is if the HTA is examining a group or a broad categorization of health technology (e.g., robotic surgery). It becomes difficult to accurately determine what type of features will consistently be in all of them (as it varies from developers and companies). In those cases, examples of different features can be collected (e.g., common features they all possess) to represent what the technology as a whole has to offer.

Overall data collection for performance and effort expectancy is challenging, not because the analysis is difficult, but rather the potential scarcity of the information because a health technology is “so new”. This could result in substituting data with alternative ones (e.g., developer internal testing). This is not ideal as these two construct benefit the most from data taken directly from the users in the field. These alternative solutions should not dissuade researchers to collect this data directly from the users despite their lack of use of familiarity with the new health technology. As this data can still be used to gauge the users perceived thoughts on

a health technology. Researchers should be aware of this data can be volatile and subject to change once users are either introduced or become more familiar with the technology.

Facilitating conditions, compared to the previous three constructs, allows users to answer questions about their current perception of what resources (e.g., IT support or training) are available to them. This can also be interpreted as "does one believe they are set up for success". What are the underlying supports that are available to the end users? For example, if a particular technology requires a computer, the availability of computers within a health facility can be used to explore how often it can be utilized in the field. Another take on the question is to ask if the current IT infrastructure is sufficient to host such a technology. Would current IT be able to handle the increased load, or would a third party support system is relied upon? These types of questions aim to both address facilitating conditions (e.g., local availability of IT support) available, as well as explore the practicality of implementing such a technology into the healthcare system.

The overall translation of UTAUT constructs from the theory to a more tangible HTA is reliant on the types of questions put forward. UTAUT continually asks for the user's opinions and thoughts on a topic, whether it be about the usefulness of a tool, or the impact of peer pressure. This results in surveys, questionnaires, or representative groups interviews (and other similar formats) being the prime tool for data collection. From there, the analysis of this data requires researchers (and statisticians) to explore what aspect of UTAUT that the users are most impacted by and how they can be addressed. This in turn provides healthcare authorities and

decision makers a more realistic picture of possible troubles and tribulations that come with the technology's adoption and implementation.

Limitations on UTAUT translation

What does this mean for UTAUT and its translation to an HTA? At face value (focusing purely on UTAUT), the UTAUT theory does not analyze the types of data that are typically found in traditional HTAs. It instead explores what the user feels and thinks about a health technology. Given the nature of the data (user's opinions and perceptions), it is trying to collect and analyze, it requires researchers to understand what each construct and moderator provides. This places ownership of both how the data in framed and analyze on the researchers. As researchers collect the data for this HTA, the type of questions put forward, or how they are asked can produce different results. Asking questions such as "are you comfortable using computers in the workplace" or "how often do you use a computer in the workplace" are similar but different types of question. One provides more insight on how one perceives using a technology is, while the other looks more closely at its actual use. Both can be used to answer effort expectancy (in this example), but researchers can infer different things from both.

Other challenges such as conducting data collection on a whole workforce or user base can be impractical and tedious (e.g., low response rate). The consideration of varied data collection methods (e.g., contacting manufacturers, focus groups) makes finding a "perfect" one challenging as researchers weigh them against each other.

UTAUT2 Translation and Use

At first glance, UTAUT2 should have been the main focus of this research. Given that it is the evolution of UTAUT after years of modifications, use, and research. However, unlike the original, UTAUT2 shifted its focus towards the consumer context. Compared to the original context of UTAUT (organization focus), UTAUT2 is directed towards a different audience. Therefore this research uses both the changed research model outlined in UTAUT2 (e.g. updated UTAUT relationships) as well as uses it as an extension to support UTAUT as a core.

Two of the new constructs, hedonic motivation (fun or pleasure derived from using a technology) (Brown, & Venkatesh, 2005) and price value (Venkatesh, Thong & Xu, 2012). These constructs overall would play a minimal role. This is because hedonic motivation can be less applicable depending on the type of technology being reviewed. Given that HTA are conducted at a very early stage of the adoption cycle, it is possible that the technology hasn't been used by any of the potential end user yet. Therefore it is difficult to accurately tell if a user enjoys using a technology without them being able to try it. That is not to say that hedonic motivation can't be used as an indicator of user adoption (Usability of locator technology among home care clients at risk for wandering Evaluation Report, 2015), it is just that compared to UTAUT original four constructs, hedonic motivation is less applicable in some scenarios. The same can be said with price value, when the end user is not necessarily paying out of their own pockets for a health technology it matters less to them if it had cost 10 or 100 dollars. Other factors such as usability or contained features may play a more prominent role to the end users compared to its price value. Researchers can still utilize these construct in their analysis, but

should keep in mind some of their limitations and how applicable they are to the health technology being reviewed.

The last introduced construct, habits, which is defined as the extent to which a user perform a behaviour(s) automatically (Venkatesh, Thong & Xu, 2012) is somewhat related to the moderator experience. The literature states two key distinctions between the two. First experience is required to have a habit, and the second one's experience over time can result in different habits forming.

This construct touches upon a previously discussed barrier for adoption "interruption to workflow". Given that workflow can be argued to a set of habits done some form of sequence. Over time as users become more accustomed to a set of work tasks assigned to them, these tasks then become routine and some even automatic. An example of a habit could be a user writing up a medical report after administering each medication. Therefore when new health technology impedes upon pre-existing workflows or "habits" a user has, it makes adoption and use of the new technology more difficult. Therefore understanding how new health technology interacts with pre-existing habits or workflows could be beneficial to a new HTA.

Now this construct can be used in conjunction with experience to explore to explore both the impact of introducing a new health technology into the workflow, and how its use relates to some pre-existing habits. This can be done by inquiring the user base on when and how they use a technology, if some technology is similar to the new one, or understanding the job

requirements of the user base. The overall goal should be to examine if this technology interrupts previous workflows or habits.

A limitation to this is the fact that not everyone shares the same "habits" as each user (with their own experiences) may have different habits. Therefore, to help reduce variability, there should be less emphasis on precise details and a larger focus on "motions". "Motions" here refers to a collection of user's actions such as work schedule, set amount of tasks or clinical pathway or other similar forms such as care pathway, or critical pathway (Rotter et al., 2010). After establishing an understanding of how users go about their work, we can examine how this new technology will "ideally" integrate into them. This type of inquiry may change depending on the type of technology being considered, but examples questions could be asking the users "when they see themselves using this technology" or "do you see yourself constantly interacting with the technology during a task". The main purpose behind these questions is to discover both how often a user thinks they will be using a technology and how distributive it may be to their "motions". This is done to showcase how disruptive a technology is to a user's "motions", which may result in the need for additional strategies or longer integration periods.

Overall, habits can be more widely used in a new HTA to examine a barrier (interruption to workflow) that was sited in previous literature while the other two constructs can be utilized given the applicability.

UTAUT2 and Future Prospects

As healthcare and delivery grows and evolves in the future, new health technologies are becoming available in the consumer market. Therefore HTA designed to examine consumer health technology can better utilize UTAUT2 constructs as they may be more relevant in these particular studies. For this research it is beyond its scope, but it is important to mention it as a possible future expansion of this research as HTA researchers begin tackling consumer health technologies (Services, 2014).

Other Aspects of Adoption

UTAUT, and to a lesser extent UTAUT2, is able to address common issues and challenges users faced when it came to technology adoption and acceptance found in previous chapters. There are still minor points, that due to their infrequent citation or outside the scope of the AHS context, that was disregarded. For example, consumers' opinion on whether or not health professionals are using the latest technology could influence users' opinion of a technology. In this example, this may not be as applicable for AHS compared to United States where there may be more direct competition between healthcare providers.

Expansions and Add-ons

Although this research presents a more generalizable translation of UTAUT into an HTA, there is room for additional constructs that were previously overlooked in certain cases.

The most obvious expansion is to examine price value or hedonic motivation and their impact on user adoption and acceptance. Branching off from those two, constructs such as anxiety may be applicable or very relevant. For example, there may be instances where healthcare professionals (HCP) may experience some level of anxiety when using new health technology in assisting in a high risk operation. In these cases where HCPs are relying on technology to assist them in tasks that are more high risk or vital anxiety may play a large part in the adoption and acceptance of it. Additionally, there may be different user groups that are concerned with one particular application of the health technology (Similar to the Serious Games example described in Chapter 2.4.1), which may justify analyzing how these different user groups use the health technology. An example case of when this might happen in Alberta is when an HTA is made in collaboration with SCNs to examine collaborative health technology like mobile health. In these cases, it will be up to the HTA researchers to decide if these additions or inclusion should be used.

Another point of expansion is the addition of other metrics such as the ones mentioned earlier about geography, culture, and infrastructure. These aspects can be used to help supplement the analysis done on UTAUT constructs. Whether it explaining how urban or rural locations may be influenced differently, or how work cultures impact a particular demographic

over another. Geography, culture, and infrastructure help add an additional dimension for analysis for researchers looking to expand the scope of their research.

3.2 Health Technology Assessment Design

Data Collection

Researchers or those conducting HTA are presented with a lot of different options in designing an HTA around UTAUT. A simple and effective application would be to employ a survey. This would be sent users on the frontline or management/leadership roles overseeing users, a representative sample, or to the entire user base. Depending on the type of health technology, frequency of use, and scope, one of these options may be more practical than the others. It is important to note that user may be hesitant to give their opinion if they are personally associated with it; therefore it is recommended that the users are anatomized or referred only by job titles. The main goal of this survey is to address each of the core principles of UTAUT as well as collect additional information about user demographics to address how different user groups are influenced differently (see Appendix A). Additionally, depending on the sample size and scope of the analysis, a statistician should be consulted to determine how many equivalent questions are required for each construct is required for statistical significance.

This research does not present a set of definitive questions that should be included in a survey for each construct, but rather presents examples set of questions (as seen in Appendix A). This is because firstly, not every health technology is the same in its use, application, and design.

Therefore, some questions may be more applicable to one health technology than another. Secondly, the types of questions asked should be tailored towards the users that would be using the new technology. Given that not all users will be utilizing a technology equally, some attributes of its use, design, or implementation may differ between user groups like with the previously mentioned physicians and allied healthcare professionals or how different health organizations may prioritize different attributes of a health technology.

This research additionally, does not ask for a particular type of response to these questions. For similar reasons as before, this freedom allows researchers to better utilities UTAUT. Despite that, a scale (e.g., from 1 to 10) can be effective in gathering the user perceived thoughts and perspective on a particular topic; both for its simplicity (for users to answers) and the ability to conduct quantitative analysis and obtain statistically significant results. Given that qualitative responses (written response) may require more resources (for analysis) than their quantitative counterparts. Alternative data collection methods such as focus groups or only surveying a representative sample can also be used. If alternative forms of data collection and analysis are used, it is important to remember the idea each UTAUT construct is trying to explore (see Appendix A for examples) and that the end user is the focus.

In summary, although this research recommends the use of surveys and scales (for quantitative analysis), it is not a requirement. Other forms of data collection methods can present their own advantages and disadvantages. It is therefore up to the researchers to choose what data collection methods work best for their HTA and provides them the data to address the core concepts of UTAUT.

Analysis

The analysis of data to answer the different categories of UTAUT is varied. The goal of this HTA is not to provide in-depth finding of how users will accept and adopt health technology given that HTA is situated at a preliminary stage, but rather to present preliminary results to showcase to healthcare authorities and decision makers.

Therefore results or findings should not be a summary of the raw data collected, but rather inferences about the data along the lines of "a large percentage of physicians feel that this new technology greatly interrupts their clinical pathway" or "a majority of users do not feel that this technology would benefit their work". The example underlines the perceived notions users have with a health technology, identifies where resistance to its adoption and acceptance can be located, and identifies what attribute of UTAUT that needs to be addressed. Additionally it allows HTA researchers to suggest how these issues can be addressed through the suggestion of effective strategy that may help remedy some of the resistance.

This information, in the overall picture, can then be weighed against other similar health technologies, in the case of a comparison between competing models, to see if one particular technology is the right fit. In other cases, this information can help direct future efforts in training, implementation towards issues that the users care about. In conclusion, the analysis of this data should be tailored towards the type of HTA being conducted as well as highlight contention between users and new health technology in order to make more informed choices.

Design and Layout

There are many different ways to go around designing the study to gather data from the users. Depending on the scope, a cross-sectional approach where analysis is done on a population or representative subset at different points in time or surveys sent out to users can be used. This allows researchers to conduct a smaller scale analysis of user adoption and acceptance of a new health technology and extrapolate these finding to the larger population. From there, different statistical methods can be deployed to vet the findings reliability (Cronbach's alpha), investigate the relationship of predictor variables to outcomes variables (logistic regression), relationship between different items (partial least squares regression), test independence (Chi-square), or represent relationship between unobserved construct and observable variable (structural equation modeling) amongst others (AlAwadhi, and Morris, 2008; Im, Hong, and Kang, 2011; Liu, Miguel Cruz, Rios Rincon, Buttar, Ranson, and Geotzen, 2015). A statistician or those with enough experience should be consulted to determine what the best method to use is.

There are two different ways one presents the information to HTA readers; the first is to lay out the findings corresponding to each construct and moderator. This allows HTAs readers to identify what findings belong to what overarching theme (construct), and how moderators impact them. The second is to present the findings based on how they can be addressed, such as grouping all findings that share a similar strategy together. The method recommended is to use a question and reply approach with each construct having its own section where a question is answered with findings from the analysis as well as potential strategies. This allows for the HTA

readers to better identify the core concerns of the users in a manner that allows the HTA readers to see what types of questions were being asked of the users and how they responded.

Expectation for this HTA

This HTA is not meant to be an extensive look at user adoption and acceptance of technology. Given that HTA exists at the early stages of technology procurement or acquisition, it is impractical to do in depth study of a health technology before it is even implemented (among other limitations mentioned earlier). This serves as a preliminary analysis of user acceptance and adoption of new health technology. It should give a "first look" at how the users of this technology adopt and accept new technology. Therefore these findings may not be as predictive of user adoption and acceptance of technology compared to those done at later stages of technology adoption.

This is because this HTA conducts a preliminary analysis, and research of a user acceptance and adoption of new health technology that is typically found at later stages of the adoption cycle earlier. It would not be uncommon, but rather expected that this research about user adoption and acceptance of new health technology will be expanded upon later if the technology passes the evidence synthesis and assessment stage.

3.3 Conclusion

With each passing day, new health innovative technology are being developed, deployed, and integrated into health institutions around the world. However, not all new health technologies are accepted by the users, and therefore impeding their adoption into the health system. This research helps remedy some of the contention or disconnect between the users and new health technology at the evidence synthesis and assessment stage in Alberta Health Services (AHS). To do this, Venkatesh et al., Unified Theory of Acceptance and Use of Technology (UTAUT) were used as the theoretical core for a new health technology assessment (HTA). Despite the significance of their findings in the original context, the analysis of one theory in a vacuum limits the applicability of the theories for the healthcare context. Therefore, the examination of the component theories of UTAUT (Theory of Reasoned Action, the Technology Acceptance Model, the Motivational Model, the Theory of Planned Behaviour, a combined TBP/TAM, the Model of PC Utilization, Innovation Diffusion Theory, and Social Cognitive Theory) was used to better understand both the origin of UTAUT but also present aspect that was excluded from it. Additionally the inclusion of other literature that applied UTAUT in healthcare context and with health technology was made to uncover the nuisances of the healthcare context. From the literature, the core constructs of UTAUT (performance expectancy, effort expectancy, social influence, and facilitating conditions), habit from UTAUT2, and other minor additions (e.g., autonomy) to address the healthcare context were analyzed.

The compilation and analysis of both the theory as written, and modification made by other researchers in the literature, was turned into an outline (see Appendix A) that showcases

how UTAUT can be translated. Although this research presents different alterations on how UTAUT core concepts can be tackled by HTA researchers in the Alberta context, they are just recommendations and would require additional validation in practice.

Future research and application of findings is needed to validate both the overall impact this translation has for AHS as well as the design choices. This may include future moderations that increase the depth that some topics, the inclusion of addition metrics, or the introduction of other theoretical frameworks from other theories. For example, possible expansions of the framework presented in this research can be taken from the component theories of UTAUT (e.g., Diffusion of Innovation adoption groups) or from other technology adoption theories. More work is required to test this framework as well as to adapt it to other healthcare contexts.

This research serves as a preliminary adaptation of UTAUT into the HTA format. It finds that UTAUT is both comprehensive as a framework to analyze user adoption and acceptance of technology in the health sector and provide a useful and effective look at the different factors influencing them. By bringing the issues of user adoption and acceptance to the forefront allows healthcare authorities and decision makers to better understand the relationship between the user and how new innovative health technology are adopted and accepted.

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Appendix A

The following series of examples are designed with the assumption that a survey format will be used for data collection and analysis. Additionally these questions are designed to be answered using a numeric rating scale (the following examples are using a likert scale as the default response method). Finally "***health technology***" will be used as a placeholder for health technology and "***task***" as the placeholder for the role/purpose the health technology supports, augments, or conducts. One important aspect to note here is that "price value" and "hedonic motivation" are left out, this is not because they are not important as indicators of user's technology adoption and acceptance but rather because given the nature of HTA (and the stage of technology adoption), these two construct have a more limited applicability as mentioned in Chapter 3.1.

Some of the listed example questions may not be applicable to your health technology and that is to be expected. Therefore feel free to employ a subset, alter, or refine any of the following examples. However the fundamental purpose of each question should be to adhere to the core principles of each section (which is described in their own sections). Depending on the type of research done (quantitative), equivalents question may be required to mediate variability. This may require consulting with a statistician (or those with the skill) to discover how many are needed. Lastly, some of the questions may feel like they belong in more than one category that is also expected as some questions can be used to answer more than one construct.

Data Collection

- **Demographic Questions**
  - **Purpose:** To help categorize the data (both to showcase how different user demographic react to new health technology as well as categorizes based on "autonomy"). It is also recommended that to increase response rates and user confidence in sharing their opinions and thoughts is to have the surveyors remain anonymous (outside aspects such as job title, or age-range). Some of these questions here can be used to gather information about moderators (e.g., gender)
    - Job Title
    - Age Range
    - Type of Health Facility (e.g. Hospital)
    - Sex

- **Performance Expectancy Sample Questions.**
  - **Purpose:** The purpose of these questions is to find out if users believe that the ***health technology*** will benefit them (e.g., care delivered, job performance).
    - To what extent do you believe that the ***health technology*** is needed to perform the ***task***?
    - To what extent do you believe that the ***health technology*** benefits the care you deliver?
    - To what extent do you think that the ***health technology*** will make your job easier?
    - Do you believe that the ***task*** will benefit by introducing the ***health technology***?
    - Do you believe that using the ***health technology*** is better (e.g., safer) than the current way the ***task*** is performed?

- **Effort Expectancy Sample Questions.**
  - **Purpose:** The purpose of these questions is to find out if users believe that the ***health technology*** is worth the amount of effort to use.
    - To what extent do you think that the ***health technology*** will be easy to learn?
    - To what extent do you think that the ***health technology*** will make your job easier?
    - To what extent do you think that the ***health technology*** is worth it (to learn and deploy) onto your unit?
    - Do you believe that incorporating the ***health technology*** into your work schedule will be simple?
    - Do you see yourself using the ***health technology*** over the current way the ***task*** is performed because it is simpler?
    - Do you see yourself learning how to use the ***health technology*** easily?

- **Social Influence Sample Questions.**
  - **Purpose:** To find out how social aspects impact the users use of ***health technology***. This may include peer pressure, their discussion around it, or their attitude towards it. The inclusion of some more "personal" perception of the ***health technology*** is because one's opinion of a topic may be shared with others and thereby affects other people's opinions. Additionally, some of the following examples help gauge a user's personal "autonomy" in the workplace.
    - To what extent do you see yourself helping others with learning the ***health technology***?
    - To what extent do you see yourself using a ***health technology*** because you heard good things about it?

- To what extent do you research about the health technology you use in your daily work?
- Do you feel pressured to use the latest technology introduced into your unit?
- Do you feel more pressure from management or your peers when it comes to using or not using the ***health technology***?
- Do you feel comfortable relying on the ***health technology*** results when performing the ***task***?
- Have you heard more positive than negative things about the ***health technology***?
- Would you turn to your peers or higher management to learn more about the ***health technology***?

- **Facilitating Conditions Sample Questions**
  - **Purpose:** To find out how what type of facilitating conditions the users believe there is for the ***health technology***. Some of these data (e.g., IT support, and computer usage) can be gathered from environmental scan or other means. What are included below are sample questions that may not be gained from the previously mentioned methods.
    - To what extent do you struggle with finding technical support for technologies in your unit?
    - To what extent do you feel that your team is accepting of new technology?
    - Do you feel that your unit is ready (both staff and location) to introduce the ***health technology***?
    - Do you feel that there is enough support (technical and administrative) currently in place for the ***health technology***?
    - Do you feel that the current Alberta Health Services training is effective in teaching employees new technologies?
    - Do you feel that you have time to learn about the ***health technology***?

- **Habit Sample Questions**
  - **Purpose:** To find out how disruptive the introduction of the ***health technology*** can be the pre-existing task, schedules, or workflow.
    - Do you have a defined way in doing the ***task*** that it seems automatic?
    - Do you tend to use a similar ***health technology*** in your work shift often?
    - Would you say that your unit has a "go to method" for doing the ***task***?
    - To what extent do you feel that the ***health technology*** integrates into your work schedule?
    - To what extent do you feel that the ***health technology*** will change how you do the ***task***?

- **Moderators Sample Questions**
  - **Purpose:** To supplement the analysis of the different construct presented earlier. Unlike the previous sections, these questions have the most variability as researcher can expand upon these questions based on the scope of their research. The main moderators examined here is "Experience" as others two (age, gender) can be done in the demographic section seen earlier.
    - Do you feel comfortable typing on tablet (e.g., IPad)?
    - Do you feel experienced in troubleshooting problems on the computer?
    - How experienced would you say you are with a smartphone?
    - How experienced would you say you are with communicating with IT support about computer problems

Appendix B

The following are the original tables that explore UTAUT component theories taken from Venkatesh, Morris, Davis, and Davis, User Acceptance of Information Technology: Toward a Unified View. Table 1. Define the core constructs of the component theories and defines them (in the context of their particular theory). Table 2. Describe if the moderators are present in the component theories. This research also goes over these in Chapter 2 in Summary of UTAUT Component Theories, while also exploring additional aspects that were either glossed over or not present in the following tables.

Table 1. Models and Theories of Individual Acceptance

Theory of Reasoned Action (TRA)	**Core Constructs**	**Definitions**
Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behavior. It has been used to predict a wide range of behaviors (see Sheppard et al. 1988 for a review). Davis et al. (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviors.	Attitude Toward Behavior	"an individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein and Ajzen 1975, p. 216).
	Subjective Norm	"the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen 1975, p. 302).
Technology Acceptance Model (TAM)		
TAM is tailored to IS contexts, and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to better explain intention parsimoniously. TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000). TAM has been widely applied to a diverse set of technologies and users.	Perceived Usefulness	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320).
	Perceived Ease of Use	"the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320).
	Subjective Norm	Adapted from TRA/TPB. Included in TAM2 only.
Motivational Model (MM)		
A significant body of research in psychology has supported general motivation theory as an explanation for behavior. Several studies have examined motivational theory and adapted it for specific contexts. Vallerand (1997) presents an excellent review of the fundamental tenets of this theoretical base. Within the information systems domain, Davis et al. (1992) applied motivational theory to understand new technology adoption and use (see also Venkatesh and Speier 1999).	Extrinsic Motivation	The perception that users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al. 1992, p. 1112).
	Intrinsic Motivation	The perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p. 1112).

Table 1. Models and Theories of Individual Acceptance (Continued)		
Theory of Planned Behavior (TPB)	**Core Constructs**	**Definitions**
TPB extended TRA by adding the construct of perceived behavioral control. In TPB, perceived behavioral control is theorized to be an additional determinant of intention and behavior. Ajzen (1991) presented a review of several studies that successfully used TPB to predict intention and behavior in a wide variety of settings. TPB has been successfully applied to the understanding of individual acceptance and usage of many different technologies (Harrison et al. 1997; Mathieson 1991; Taylor and Todd 1995b). A related model is the Decomposed Theory of Planned Behavior (DTPB). In terms of predicting intention, DTPB is identical to TPB. In contrast to TPB but similar to TAM, DTPB "decomposes" attitude, subjective norm, and perceived behavioral control into its the underlying belief structure within technology adoption contexts.	Attitude Toward Behavior	Adapted from TRA.
	Subjective Norm	Adapted from TRA.
	Perceived Behavioral Control	"the perceived ease or difficulty of performing the behavior" (Ajzen 1991, p. 188). In the context of IS research, "perceptions of internal and external constraints on behavior" (Taylor and Todd 1995b, p. 149).
Combined TAM and TPB (C-TAM-TPB)		
This model combines the predictors of TPB with perceived usefulness from TAM to provide a hybrid model (Taylor and Todd 1995a).	Attitude Toward Behavior	Adapted from TRA/TPB.
	Subjective Norm	Adapted from TRA/TPB.
	Perceived Behavioral Control	Adapted from TRA/TPB.
	Perceived Usefulness	Adapted from TAM.

Table 1. Models and Theories of Individual Acceptance (Continued)		
Innovation Diffusion Theory (IDT)	**Core Constructs**	**Definitions**
Grounded in sociology, IDT (Rogers 1995) has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organizational innovation (Tornatzky and Klein 1982). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics (see also Agarwal and Prasad 1997, 1998; Karahanna et al. 1999; Plouffe et al. 2001).	Relative Advantage	"the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p. 195).
	Ease of Use	"the degree to which an innovation is perceived as being difficult to use" (Moore and Benbasat 1991, p. 195).
	Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p. 195).
	Visibility	The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat 1991).
	Compatibility	"the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p. 195).
	Results Demonstrability	"the tangibility of the results of using the innovation, including their observability and communicability" (Moore and Benbasat 1991, p. 203).
	Voluntariness of Use	"the degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore and Benbasat 1991, p. 195).

Table 2. Role of Moderators in Existing Models				
Model	**Experience**	**Voluntariness**	**Gender**	**Age**
Theory of Reasoned Action	Experience was not explicitly included in the original TRA. However, the role of experience was empirically examined using a cross-sectional analysis by Davis et al. (1989). No change in the salience of determinants was found. In contrast, Karahanna et al. (1999) found that attitude was more important with increasing experience, while subjective norm became less important with increasing experience.	Voluntariness was not included in the original TRA. Although not tested, Hartwick and Barki (1994) suggested that subjective norm was more important when system use was perceived to be less voluntary.	N/A	N/A
Technology Acceptance Model (and TAM2)	Experience was not explicitly included in the original TAM. Davis et al. (1989) and Szajna (1996), among others, have provided empirical evidence showing that ease of use becomes nonsignificant with increased experience.	Voluntariness was not explicitly included in the original TAM. Within TAM2, subjective norm was salient only in mandatory settings and even then only in cases of limited experience with the system (i.e., a three-way interaction).	Gender was not included in the original TAM. Empirical evidence demonstrated that perceived usefulness was more salient for men while perceived ease of use was more salient for women (Venkatesh and Morris 2000). The effect of subjective norm was more salient for women in the early stages of experience (i.e., a three-way interaction).	N/A
Motivational Model	N/A	N/A	N/A	N/A

Table 2. Role of Moderators in Existing Models (Continued)				
Model	**Experience**	**Voluntariness**	**Gender**	**Age**
Model of PC Utilization	Thompson et al. (1994) found that complexity, affect toward use, social factors, and facilitating conditions were all more salient with less experience. On the other hand, concern about long-term consequences became increasingly important with increasing levels of experience.	N/A	N/A	N/A
Innovation Diffusion Theory	Karahanna et al. (1999) conducted a between-subjects comparison to study the impact of innovation characteristics on adoption (no/low experience) and usage behavior (greater experience) and found differences in the predictors of adoption vs. usage behavior. The results showed that for adoption, the significant predictors were relative advantage, ease of use, trialability, results demonstrability, and visibility. In contrast, for usage, only relative advantage and image were significant.	Voluntariness was not tested as a moderator, but was shown to have a direct effect on intention.	N/A	N/A
Social Cognitive Theory	N/A	N/A	N/A	N/A

Table 2. Role of Moderators in Existing Models (Continued)				
Model	**Experience**	**Voluntariness**	**Gender**	**Age**
Theory of Planned Behavior	Experience was not explicitly included in the original TPB or DTPB. It has been incorporated into TPB via follow-on studies (e.g., Morris and Venkatesh 2000). Empirical evidence has demonstrated that experience moderates the relationship between subjective norm and behavioral intention, such that subjective norm becomes less important with increasing levels of experience. This is similar to the suggestion of Karahanna et al. (1999) in the context of TRA.	Voluntariness was not included in the original TPB or DTPB. As noted in the discussion regarding TRA, although not tested, subjective norm was suggested to be more important when system use was perceived to be less voluntary (Hartwick and Barki 1994).	Venkatesh et al. (2000) found that attitude was more salient for men. Both subjective norm and perceived behavioral control were more salient for women in early stages of experience (i.e., three-way interactions).	Morris and Venkatesh (2000) found that attitude was more salient for younger workers while perceived behavioral control was more salient for older workers. Subjective norm was more salient to older women (i.e., a three-way interaction).
Combined TAM-TPB	Experience was incorporated into this model in a between-subjects design (experienced and inexperienced users). Perceived usefulness, attitude toward behavior, and perceived behavioral control were all more salient with increasing experience while subjective norm became less salient with increasing experience (Taylor and Todd 1995a).	N/A	N/A	N/A