Healthcare Technology Adoption: A Social-Organisational Perspective

Dissertation submitted in partial fulfilment of the requirements for the degree of

Master of Science in Industrial Organisational Psychology

at the University of Canterbury

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February 2024

Abstract

The medical technology industry, valued at almost a trillion dollars annually, holds significant societal and individual impacts, where advancements are crucial for improving healthcare outcomes. However, the adoption of new healthcare technologies has a success rate of only 30-60%, highlighting a substantial challenge. This is particularly important given the current strain on healthcare because of underfunding, overworking, and an ageing workforce. It is evident from previous research that sufficient healthcare technology plays a pivotal role in addressing this problem. Moreover, previous frameworks pay little attention to socio-organisational factors. Therefore, the current research aims to explore how socio-organisational factors impact healthcare technology adoption. A sequential mixed methods exploratory design constituted of two phases was employed. Firstly, archival data was thematically analysed to explore general barriers and enablers of healthcare technology adoption. Secondly, a quantitative survey was administered to healthcare professionals to which regression and t-test analyses were performed. Data was collected on organisational and social aspects of HCT adoption, including relevant relationships, communication, and innovation culture. Moreover, enablers such as patient outcomes, usability, co-design, and workload accommodations were assessed as well. Results from thematic analysis found seven themes, these were: relationships, the nature of clinical work, the psychology of clinicians, culture, communication, training, and technology characteristics. Qualitative analyses gleaned further insight, proving relationships as a key predictor of technology adoption success. Results also revealed differences in importance between hardware and software regarding communication and training. This thesis highlights the necessity of encompassing socio-organizational factors in HCT adoption studies. For practitioners it demonstrates the importance of considering relationships, co-design, and targeting effective communication and training at specific modalities of technology.

Acknowledgements

I would like to acknowledge everyone who supported me during this research. Firstly, a big sincere thank you to my supervisors Jen and Sanna who were just incredible. I want to also thank Kat for her unwavering compassion toward her students. There was a lot of talk about how difficult and arduous this degree is. But the entire teaching team made it feel as though there was always support if and when you needed it. I guess that's one benefit of being taught by well-being experts! I would also like to thank my fellow cohort of students; you guys are all amazing and I wouldn't have wanted to do this with anyone else. Each of you brought a different perspective to every lecture which made for interesting discussions all the time, and great entertainment at other times. I also want to thank my parents and sister for their continued support and love, I love you guys and thank you for allowing me to freeload at the house for a bit. Last but not least, I want to thank my partner in crime Madeline for always being there. I love you.

Table of Contents

List of Tables

Introduction

Digital technology-enabled healthcare, or ‘Smart’-healthcare, has potential benefits, including better patient care, clinical time-management (Jacob et al., 2019), disease self-management (Mosa et al., 2014), remote monitoring, and decreased workload for clinicians (Kotronoulas et al., 2017). However, adoption rates for healthcare technologies remain a challenge. According to reports, new healthcare technology benefits only a range of 30% to 60% of patients (Grol, 2001; Schuster et al., 2005). Various frameworks have been employed to understand the issue of the low rate of technology acceptance which include The Technology Acceptance Model (Davis, 1989), The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and The Theory of Planned Behaviour (Schifter & Ajzen, 1985), among others. However, these frameworks overlook social and organisational factors and are narrowly focused on usability aspects, such as perceived ease of use and perceived usefulness (e.g., Davis, 1989).

Healthcare technology adoption is a significant and relevant issue as it forefronts the need to ease the workload of clinicians and reduce patients' time spent in beds in the context of underfunding (Bagshaw et al., 2022), overworking (Manoharan, 2022), and an ageing workforce in healthcare in Aotearoa New Zealand (Ministry of Health, 2016). This research agrees with others (e.g., Renukappa et al., 2021), that adequate healthcare technology is one, achievable, method of mitigating this stress on healthcare systems. As such, this research aims to understand socio-organisational enablers and barriers in relation to healthcare technology adoption.

Healthcare Technology

Healthcare technology typically involves a service model that allows individuals to access healthcare services at any time and from any location, using electronic devices such as

laptops, tablets, or smartphones (Renukappa et al., 2022). This kind of health technology resembles mobile health technology or mHealth which is any healthcare provided by mobile or other wireless technology for managing or improving patient health (World Health Organisation, 2011; Holman, 2018). Application of mHealth technologies range from healthcare apps to continuous glucose monitors (Hartz, 2016; Böhm et al., 2020) and video consultations or telemedicine (Tawfik & Anya, 2015), with the most recent and well-known form of mHealth being covid tracking applications and services (Cao et al., 2022; Adetunji et al., 2022).

For the sake of clarity, healthcare technology (HCT henceforth) not only involves mHealth or health information systems such as patient management systems, but also specific hardware operated by clinics and hospitals to improve patient health, and clinical procedures, and monitor the biological status of patients. These include technologies like X-ray machines, surgical and socially assistive robots (Khan & Anwar, 2020), and electrocardiograms. The hardware-software divide is not absolute, as HCT is generally both, lending to the information and material needs of healthcare providers. For example, technologies such as Silhouette Wound Imaging come with the hardware to carry out diagnostic activities while providing software that links to a wide database of wound images and uses these to help with diagnosis and treatment plans (Patel et al., 2019). This highlights the complexity of HCT and illustrates how intertwined hardware and software typically are.

Technology Adoption

As highlighted by Robert et al. (2009), technology adoption in organisations has been classified, organised, and perceived in various ways. For example, Hage and Aiken (1967) describe the process as having four phases; evaluation, initiation, implementation, and routinization, whereas Zaltman et al. (1973) describe adoption as knowledge awareness,

attitude formation, decision, initial implementation, and sustained implementation. Further, Van de Ven et al. (2000) suggest the initiation, development, implementation, and termination stages. Therefore, there are different stages to the overall adoption process, from being presented with a technological innovation to the continued use of the innovation through to the termination of use. This thesis does not discriminate between the phases described by other research but takes adoption to mean the entire process.

Most literature on HCT adoption revolves around IT or service model-type technology (e.g., Robert et al., 2009; Tubaishat, 2018). The research landscape is abundant with adoption research looking at how electronic health records or new digital patient management systems are adopted. Specifically, research has focused on the antecedents, drivers, and motivators for adoption (Lin et al., 2012; Najaftorkaman & Ghapanchi, 2014; Almeida et al., 2017), adoption effects or impacts on performance (Bhattacherjee et al., 2006; Laurenza et al., 2018), quality of care (Menachemi et al., 2008; Agha, 2014), and cost-effectiveness (Jena & Philipson, 2013). Locating research specifically dedicated to hardware in the context of HCT proves challenging, however, possibly due to the proprietary nature of hardware and the tendency for such research to be conducted internally. This scarcity may also arise from the highly specialized nature of hardware research, making it less likely to surface in broader searches related to HCT. For instance, a targeted search for a particular type of X-ray machine may be necessary to uncover factors influencing its adoption.

Benefits of HCT

The benefits of healthcare technology are wide-ranging and assist with better patient care (Lau et al., 2007), clinical time-management and efficiency (Ventola, 2014; Jacob et al., 2019), disease self-management, remote monitoring, (Istepanian et al., 2014), connecting patients with clinicians (Kotronoulas et al., 2018; Haleem et al., 2021), and reducing

workload of clinicians (Kotronoulas et al., 2017). To put things into perspective, the sales of connected health and wellness devices reached 73 million worldwide in 2016 and significantly surged to 160 million devices in 2020 (Grand View Research, 2019). Furthermore, hundreds of new health-related apps are uploaded to websites every day with 500,000 apps available in 2021 (IQVIA Institute, 2021). Despite demonstrated advantages, the adoption of healthcare technologies in clinical settings remains suboptimal. Healthcare organisations are slower than other sectors to adopt information technology (England et al., 2000), clinical guidelines wane after dissemination (Grol, 2001), and many introduced technologies fail to reach patients (Schuster et al., 2005). However, some argue that the slow adoption rate is a wise approach because of the heterogeneity of patient groups, suggesting the adoption process needs to be careful and flexible (Christensen & Remler, 2009). This thesis disagrees with this sentiment considering the precipice of overworking and understaffing most healthcare professionals find themselves on. Enhanced understanding of the existing impediments and facilitators is therefore critical for bolstering adoption rates.

Barriers and Enablers

Healthcare technology adoption faces a range of barriers and enablers. Barriers can arise due to technical, financial, social, or organisational issues, such as lack of funding (Boonstra & Broekhuis, 2010), data privacy (Gagnon et al., 2016), lack of trust in technology (Dhagarra et al., 2020), technology related anxiety (Talukder et al., 2020), and resistance to change (Tsai et al., 2019). On the other hand, enablers facilitate the adoption and implementation of healthcare technologies and include improved health outcomes, co-design (Gagné, 2000; Cucciniello et al., 2016), dedicated resources (Taylor et al., 2015), and the promise of increased efficiency and quality of healthcare delivery (Schneider et al., 2016). Financial barriers such as start-up and ongoing costs and uncertain return on investment, are frequently highlighted by clinicians as critical barriers, however, they are not the focus of this

thesis because they have already been covered extensively (e.g., Boonstra & Broekhuis, 2010). It is important to keep a general rule of thumb in mind, that a lack of a single enabler can shift it into a barrier. For example, going from high workflow to low workflow fit will undoubtedly turn this phenomenon into a barrier.

Technology-specific enablers for HCT adoption can include low cost, low expected effort, and ease of use (Bhatta et al., 2015; Gagnon et al., 2016), which is related to simplicity, convenience, and how easy the technology is to learn (Kavandi & Jaana, 2020). Barriers to adoption can include a mismatch of technological skill and complexity of the technology being implemented (Ludwick & Doucette, 2009), limitations of the technology (DesRoches et al., 2008), and lack of reliability (Randeree, 2007). Because time is a critical factor for clinicians and healthcare organisations, it is no surprise that it is a major barrier to technology adoption. Organisational factors like learning how to use the technology mean workflow is interrupted or slowed (Boonstra & Broekhuis, 2010) and can put stress on clinicians by increasing unnecessary time spent learning the technology (Pizziferri et al., 2005). Efficient and effective training can help overcome this barrier and is a key organisational enabler (Giraldo et al., 2018). Other organisational enablers can include patient-related factors such as comfort with and preference for the technology (Gagnon et al., 2016; Mileski et al., 2017), access to care (Choi et al., 2019), education, and health literacy (Jimbo et al., 2013). Clinician-centred factors such as leadership support (Catan et al., 2015; Mileski et al., 2017), job security (Brewster et al., 2014), workflow fit (Gagnon et al., 2016; Choi et al., 2019), and clear guidelines and policy embedding the technology (Bhatta et al., 2015; Mileski et al., 2017) can enable adoption. Furthermore, perceptions and attitudes towards the technology (MacNeill et al., 2014), appraisal of clinical evidence for the technology (Mileski et al., 2017), awareness of the technology (de Vries et al., 2017), and feelings of competence with technology (Bhatta et al., 2015; Gagnon et al., 2016) are also

important factors which influence HCT adoption. Important to note is that social and organisational factors tend to overlap due to the social nature of organisations.

Social facilitators and barriers to HCT adoption include culture or climate, social influence, endorsement, and observability (Tushman & O'Reilly, 1997; Jacob et al., 2020). Organisational culture can be hard to define, Gershon et al. (2004) cited 54 varying definitions of organisational climate. However, broadly focused, culture is the norms, values, and fundamental assumptions shared by the people which make up an organisation. These shared norms, values, and assumptions are subsequently imparted to incoming members of the organisation and influence how current members of the organisation relate to one another and their workplace (Helfrich et al., 2007). Openness to innovation, psychological safety, and the assumption that novel technology is aimed at creating better outcomes for patients are among some of the cultural enablers present. Social influence is the degree to which a person thinks others important to them believe they should use HCT (Venkatesh et al., 2003). For example, if a clinician perceives a certain person to hold importance, their adoption behaviours may influence the clinician to adopt. Relatedly, whether the attitudes of people in leadership positions are for or against innovation can drastically affect the innovation and adoption behaviour of organisation members and is a major social enabler alongside social influence (Rogers, 1995). Likewise, endorsement of HCT from clinicians can play a pivotal role in patient engagement with HCT (Thomson & McCabe, 2018). Finally, observability is the degree to which the results or outcomes of the technology are observable (Rogers, 2005). The need for clinicians to observe the benefits of the technology, to witness sufficient evidence that it works and is better than existing practices and further, for that information to be diffused has positive effects on HCT adoption.

Focusing on Social and Organisational Factors

A socio-organisational lens is required to understand the complexities of healthcare technology adoption. This section reviews the relevant factors of this lens which have been examined in the literature. Again, it should be noted, that social and organisational factors occasionally overlap because of the social nature of organisations.

Beginning at the start of the implementation process, co-design is the process of stakeholder participation in the development and selection of HCT. Co-design can promote acceptance of change, and give clinicians a sense of ownership (Gagné, 2000; Fuchs & Prouska, 2014). This means communication about the technology must be effective and different disciplines need to communicate with each other. Effective teamwork is more likely in well-organized practices that prioritize uninterrupted time for meetings, open communication, and interprofessional respect (Pullon, et al., 2009). Co-design in the context of healthcare typically involves stakeholder participation in the design phase of a technology. Stakeholders can be end-users, organisational leaders, and other people with a vested interest in the product. End-users are typically clinicians or patients, but usually both as HCT is generally administered by clinicians to patients. However, in the case of health information technologies like patient management systems or digital health records clinicians are the sole end-users.

When novel HCT is introduced clinicians more than likely, unknowingly, influence the opinions and attitudes of other clinicians by speaking informally about new technologies. These interpersonal conversations are unlikely to be explicit attempts to persuade others to use novel HCT yet prove powerful in shaping their attitudes through social learning, social influence, and conformity (Fulk, 1993; Holden, 2012). Social learning is a fundamental concept in the field of behavioural psychology and serves as a core component of social

cognitive theory (Straub, 2009), which initially originated as social learning theory (Bandura, 1977). Social learning is how individuals acquire new behaviours and knowledge by observing, modelling, and imitating others in their social environment (Rogers et al., 2014). Specifically, observing others' successful or unsuccessful adoption of technology can influence individuals to consider or not consider adoption themselves through modelling (Straub, 2009). Applied in healthcare organisations, social learning relates to sharing patients, informal teaching and learning, and mentoring. However, only a few studies have looked at social learning within healthcare settings (see Grol et al., 2007) and no studies were found to have researched social learning regarding HCT in clinical settings.

An ongoing process regarding HCT implementation is a perceived lack of support from supervisors and co-workers which can have devastating effects on evaluations of change, making it difficult to speak up, trust the technology, and participate in the change associated with technology adoption (Fuchs & Prouska, 2014). Additionally, organisation size plays a role because larger organisations typically have greater resources which can lead to greater endorsement of innovations. Moreover, as suggested earlier, effective leadership is crucial in facilitating successful organisational change (Ford et al., 2021). One of the key roles of leadership is to model and foster a culture that is conducive to adoption, which includes promoting psychological safety and accountability, making workload accommodations, and creating a culture of learning (Wong et al., 2021). This involves providing a safe space that allows for mistakes to be made, learned from, and disseminated throughout the organisation (Kucharska & Bedford, 2020). Finally, organisational culture is considered the cornerstone of innovation and is vital to the adoption of healthcare technology (Tushman & O'Reilly, 1997).

Considering the complexities of healthcare technology adoption, a socio-organisational perspective is crucial to understanding how the adoption of healthcare technology works. Factors such as co-design, effective communication, teamwork, social learning, supervisor and co-worker support, leadership, organisational size, and culture significantly impact adoption. Understanding these factors is vital for successful healthcare technology implementation and improving patient care and is the focus of this research.

Current frameworks

The notion that a person's intention to perform a behaviour is the most important predictor of their actions, is a widely accepted concept in several psychological models. Fishbein's theory of reasoned action (Fishbein & Ajzen, 1975), Ajzen's theory of planned behaviour (1985), and Triandis's attitude-behaviour theory (1979), all support this proposition. These theories posit that individuals tend to carry out their intended actions and avoid actions they do not intend to perform. However, research has found behavioural intentions are not sole predictors of human behaviour, because they fail to account for a substantial amount of behavioural variance (Sheeran, 2002). Other frameworks aimed at explaining technology adoption in clinical contexts include the diffusion of innovation (DOI) theory (Rogers, 1995) which posits that people can be categorized into innovators, early adopters, early majority, late majority, and laggards. DOI is used in approximately 16% of research exploring the adoption of mHealth tools, whereas TAM or extensions of TAM are used in approximately 34% (Jacob et al., 2020). As alluded to, these models have been expanded and modified to suit different research and contexts and the magnitude of variability within and throughout these frameworks suggests there might not be a ‘one-size fits all’ model. In their review of these frameworks in explaining technology adoption and acceptance of clinicians, Jacob et al. (2020), reveal the incongruence between the theories

explaining technology adoption, their incompatibility, and their inappropriateness for explaining the socio-organisational environment clinicians reside in.

When taken as a whole, these frameworks show a gap in the focus of examining HCT adoption. TAM, UTAUT, and DOI are the most used frameworks to understand technology adoption in healthcare (Jacob et al., 2020). However, TAM examines perceived usefulness, attitudes, and perceived ease of use (Davis, 1989), UTAUT examines (technology) expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003), and DOI focuses on relative advantage, compatibility, and observability (Miller, 2015). Considering the social and organisational factors explored in the previous section, there is a glaring gap in what should be examined when attempting to understand how technology is adopted in healthcare settings. Although UTAUT considers social influence, there are major social factors like co-design (Fuchs & Prouska, 2014), psychological safety (Baer & Frese, 2003) and social learning (Grol et al., 2007) that influence adoption. Moreover, organisational factors are overlooked by these popular frameworks, culture (Robert et al., 2009), supervisor support (Gagnon et al., 2012), and leadership support for innovation (Woods et al., 2004; Ford et al., 2021) have been shown to impact adoption and should be examined as well. These criticisms are not new, others have called for a more nuanced, wider, and more considered view of technology adoption breaking away from traditional individualistic cognitive-behavioural approaches (e.g., Greenhalgh et al., 2017).

Wong et al. (2021) attempt to fill these gaps with their TECH-ism framework which understands technology adoption as an experience of organisational change. TECH-ism considers the context of technology adoption in healthcare settings, from the outset – HCT is being introduced to an organisation constituted of people working together. Building on the diffusion of innovations framework (Miller, 2015), TECH-ism posits that there is a pitfall

between the early adopters and the early majority that many technologies and organisations fail to overcome. The aim of the framework is not to explain or predict the technology adoption of clinicians but to assist healthcare decision-makers in identifying, socialising, and managing the socio-organisational factors present (e.g., co-development, communication, workload accommodations, etc.). This thesis takes inspiration from this work.

Summary

There have been close to 10,000 papers published on general technology adoption since 1973 and journals are observing over 1000 documents published every year (Xu et al., 2021). As mentioned earlier, there are many frameworks and theories that attempt to explain and understand healthcare technology adoption. However, as previously indicated, these frameworks undergo frequent modifications and extensions to accommodate diverse situational contexts and provide limited insights into the relevant social and organisational factors explored in this review, except for the technology-organisation-environment framework and UTAUT which consider organisational factors and social factors respectively (Gangwar et al., 2015). Furthermore, many of these frameworks are employed in organisational settings and social contexts, raising the inquiry of why this is the case.

This research hopes to contribute to the deficit of focus on social and organisational factors by exploring concepts such as technology-related anxiety, relationships of organisational team members, organisational culture, and positive leadership. Moreover, industrial and organisational psychology can lend itself to the issue of poor adoption. Concepts and theories such as behavioural intention (e.g., Triandis, 1979; Rogers, 1983), social learning (Straub, 2009), co-design (Gagné, 2000), and perceived organisational, co-worker, and supervisor support (Fuchs & Prouska, 2020), could be instrumental in understanding the issue of technology adoption. It is clear healthcare technology is vital to

providing patients and clinical users with the tools to improve and maintain health. However, as evidenced by the literature, most HCT is poorly adopted, much of the patient population does not see the benefits of it, and adherence to clinical guidelines often tapper off after dissemination (Grol, 2001; Schuster et al., 2005; Silgo et al., 2017). Therefore, a special focus on social and organisational factors that contribute to technology adoption and how they relate to one another is needed. The research questions are as follows:

RQ1: What are the general barriers and enablers of HCT adoption?

RQ2: What are the socio-organisational factors important for HCT adoption?

RQ3: What is the relationship between the perceived importance of socio-organisational factors and HCT adoption?

To achieve these aims, the research adopts a sequential exploratory mixed-methods design to enhance the depth and rigour of findings by enabling a comprehensive analysis and giving participants a greater voice (Coyle & Williams, 2000; Shorten & Smith, 2017). The approach consists of two phases: the initial phase employs quantitative analysis to identify general barriers and enablers of HCT adoption. The subsequent phase further refines these findings through qualitative analysis, focusing on a detailed exploration of the identified factors. This method allows for a thorough comparison and integration of data across both phases, ensuring a coherent flow of insights and a structured investigation of thematic barriers and enablers (Coyle & Williams, 2000).

Study 1 Methods

Reflexivity

Aligned with the conventional Braun and Clarke methodology (2006), this section will briefly examine some reflections arising during the research process. While I maintain an attempt at impartiality, it is essential to acknowledge potential biases due to my partner's role as a midwife and close connections with individuals in physiotherapy and nursing. This exposure may influence my interpretation of certain findings and my insight into the healthcare system in New Zealand, particularly the midwifery profession, is shaped by personal observations. However, interactions with various healthcare professionals throughout this thesis journey have provided insights into shared challenges, such as under-resourcing, experienced across professions.

Occasional exposure to news updates and my parent's involvement in the trade union movement affords me a glimpse into the struggles faced by nurses, doctors, and midwives advocating for improved working conditions, fair compensation, and increased support from employers and the government. At the study's outset, I held neutral sentiments toward healthcare professionals, the healthcare system, and healthcare organizations, likely influenced by positive personal experiences within the New Zealand and United Kingdom healthcare systems. However, exposure to negative experiences shared by others during this research and engagement in related research projects has evoked empathy and altered my perspective.

Towards the research's conclusion, my views have evolved. Through the narratives of healthcare professionals and patients, a growing sympathy has emerged for those grappling with a healthcare system approaching a crisis point. The constraints of under-resourcing and overworking appear to hinder clinicians from delivering the quality of care they aspire to

provide. The challenge of recruiting willing participants for the quantitative survey, despite having existing interview data, led me to consider the time constraints and exhaustion faced by clinicians, emphasizing the demanding nature of their work. Despite clinicians' dedication to doing their best with available resources, there exists a tension where patient expectations sometimes exceed the achievable level of care. Increased awareness of clinicians' working conditions has fostered a deeper appreciation for their efforts, extending beyond news reports and protests to a more nuanced understanding of their daily challenges.

Participants and procedures

A reflexive thematic analysis was conducted on existing semi-structured interview data which was focused on discovering the general barriers and enablers of HCT adoption. Eight interviews were conducted in 2021 by researchers at the University of Canterbury. I was provided access to the interviews by way of ethics amendment (see Appendix A). Interviews ran from approximately 25 minutes up to 1:02 hours with an average interview time of 34 minutes. Firstly, participants were asked to read information (see Appendix B) and sign consent (see Appendix C) forms before the interview. However, if this was not possible, the interviewer would read it with the participant at the beginning of the interview. See appendix D for the interview script. Participants were recruited through convenience sampling and snowball sampling. They were mostly male (75%) and had an average tenure of 5.5 years (Range: 2.5 – 10+). Participants had a variety of roles which were: process improvement specialist, service improvement manager, professional clinical leader, registered nurse, hospital operations manager, and radiation oncologist.

Table 1

Participant Descriptives Table for Study 1

Name	Randy	Marlon	Jessie	John	Penny	Tom	Clay	David

Role	Process improvement specialist	Service improvement manager	Professional Clinical Leader	Process improvement specialist	Registered nurse	Registered nurse	Hospital Operations Manager	Radiation oncologist
Gender	M	M	F	M	F	M	M	M
Tenure	Unknown	2.5 years	Unknown	7 years	3 years	6 years	5 years	10+ years
Technology	Patient management system	Workflow improvement tool.	Cough reflex test	Digital referral system	Electronic medical records	Patient management system	Workflow improvement tool	Business communication platform

Participants were asked to explain their role and tenure with their current position and how long they have been in the healthcare sector. Once an understanding of their role was established, participants were asked about a time when new technology was introduced to their workplace, what it was, how it was introduced, and what the initial reactions from staff were. Then participants were asked what barriers and enablers they perceive for HCT adoption about the specific technology and in general. Other questions concerning decision-making processes (who is involved, approval and implementation steps and how long implementation takes), and general perceptions of technology uptake (risk, openness to technology, and confidence around new technology) were asked if there was time. The names of participants have been changed to protect their identity. For a complete list of questions and interview flow see Appendix D.

Analysis

Following Braun and Clarke's (2006) thematic analysis methodology, the first author initially immersed themselves in the data to establish a comprehensive familiarity through listening and reading interview transcripts multiple times. Subsequently, separate coding from the first and second authors was conducted over several weeks which was undertaken with a focus on identifying general barriers and enablers to technology adoption in healthcare. Both authors came together after several weeks to sense-check each other’s extracted themes.

Following this, a zooming-out process by the first author was employed to identify general themes encompassing the existing thematic codes. The themes then underwent refinement over several weeks by the first author and subsequently sense-checked by the second author.

Study 1 Results

In this section, the results of the thematic analysis are presented by sequentially reporting on each theme. At the beginning of each theme section a table is given as an overview and guide of the themes and theme components.

Theme 1: The double-edged sword of relationships. (DESOR)

Table 2

Double-edged Sword of relationships Theme Description and Samples.

Main theme	Description	
The double-edged sword of relationships.	About how relationships at multiple levels (Inter-team, inter-organisation, leader-follower, and clinician-patient) can be both effective and a hindrance to adoption.	
Sub themes		Sample
Co-design	About the positive impact designing, implementing, and communication between developers, clinicians, patients, and other stakeholders has on HCT adoption.	"But we knew that in order for the technologies to be adopted, we had to have complete buy in from the doctors. So, we had several of the doctors working on the project with us." - John
Conflict	About the (mostly) negative impact conflict can have on HCT adoption.	"… [junior staff] say this is ridiculous why we're still doing it manually. But then you almost have this other layer of generation that is the opposite to that was pretty much saying to we've always done it this way. Why would we do so and so you're now stuck in between the two generations…" - Marlon

The double edge sword of relationships

The double-edged sword of relationships pertains to the interconnections among clinical staff, encompassing relationships within teams, among individuals, within organisations, and extending to governmental spheres typically through policy formulation or funding allocation. This theme embodies a dichotomy: when these relationships manifest positively, they tend to produce favourable effects on the adoption of HCT. Conversely, negative associations exert an adverse influence on technology adoption. In effect, the quality of relationships plays a dual role, either facilitating or hindering the adoption of technology in healthcare organisations. On an individual level, clinicians establish working relationships among themselves and with other people from different departments or organisations – sometimes going beyond working relationships. Expanding to a small group scale, teams form relationships with other teams – such as the interaction between an IT team and an intensive care unit (ICU) team, or the interplay between administrative and clinical teams. Zooming out to an organisational scale, healthcare institutions, such as hospitals or clinics, maintain associations not only with each other but also with various external entities, such as governmental bodies, funding agencies, and other allied healthcare services. Some of these relationships have a greater impact on technology adoption than others. For example, funding agencies need a sound business case to get technology through the door. As exampled by Clay: "*[implementers] have to identify the need for improvement and have to prove very clear layout from the current state and future state, what difference it will make, and to make sure it is financially viable and robust"*. A few key relationships were noted by participants:

- Clinician – Clinician
- Clinician team – I.T Department
- Healthcare organisation – Governmental bodies

- Technology developer – Clinician
- Clinician – Patient

These are the key relationships that can impede or facilitate HCT adoption. Clinician-to-clinician relationships can impede technology adoption through feelings of expertise which trump the proposed efficacy of technology "*they genuinely believe that they knew better because they had years of experience*" – Jessie. However, they can facilitate it through honest and open, feedback as exampled by Jessie, "…*People would challenge each other in a hopefully reasonably respectful way to as part of a part of an observed clinical practice. and that that would sort of get those last few non-compliant staff over the line*". Here we can see that respect between clinicians can facilitate HCT adoption.

While honest and respectful relationships can facilitate adoption, conflict between clinicians can impede it. Conflict can arise when clinicians champion or use technology when others feel they can perform their role without it. Clinician to I.T. department relationships are also important especially if the technology is software based. Hostile or absent relationships mean that feedback is left unattended, and frustration emerges as software that could improve health outcomes is misused, underutilised, or ignored. For example, Randy explains: "…*we just do not have proper or true interdisciplinary activity on things like the introduction of a new platform*…" He goes on to explain: "…*the technology space it's still victim to that is siloed thinking."* Therefore, the lack of a positive relationship between disciplines is hindering HCT adoption.

Conflict

There is also a conflict of interest between different parties such as clinicians and executives, IT professionals, patients, and other clinicians. There are instances of medical devices which are introduced to an organisation which are used by some clinicians but not others. This can create tension and occasionally lead to conflict between parties. For example,

there were instances of clinician conflict which are underpinned by the experience of clinicians. As illustrated by Jessie: "*You would have your quite bolshie staff who had been there maybe three or four years challenging somebody with [over] 20 years of experience and that didn't go down so well*." When technology is introduced, their colleagues who are new to the role *and* are in favour of the technology sometimes come into conflict with older, more experienced clinicians.

This is based on the dynamics of power, perceived expertise, and the hierarchical structure of roles in healthcare. Occasionally, healthy debate or feedback about technology occurs, however, relationships can become strained or awkward when clinicians feel their expertise or experience is questioned as highlighted by Jessie: "*So, there was a period of time I'd say probably about one to two years, where there was a bit of awkwardness around those who were adopting it and those who weren't.*" Therefore, technology adoption behaviour itself could be a mediating factor in the quality of relationships between staff.

Organisational relationships

The dynamic between an organisation and its members warrants focus, particularly regarding the potential discord between clinicians and the organisation due to contentious policies or leadership decisions. For instance, a participant highlighted an organisational policy that imposed a cap on administrative funding, resulting in a situation where clinical staff were burdened with compensating for this shortfall. This was highlighted by Randy here: "*If you cut it off at the bottom like that, then you just force your higher paid workforce to do admin work they hate, it's ridiculous waste of money and no one can make any sense of policy, but there you have it*.". According to this participant, this led to a sense of resentment among clinicians, as it diverged from their primary professional focus. They found themselves unintentionally shouldering additional administrative responsibilities, causing

dissatisfaction and a sense of misalignment with their core clinical roles. This may impede HCT adoption through feeling overwhelmed with role saturation or becoming adversarial with decision-makers who may introduce the technology.

Co-design

If conflict is the shadow, co-design is the light. Relationships can enhance technology adoption when implementing or designing HCT. It seems critical that users are involved in the design and development process to facilitate HCT adoption. When doctors and nurses had input in the design and introduction of technology, outcomes seemed to be better in terms of acceptance, the technology being fit for purpose, and workflow. The relationship between developers and clinicians, it seems, should remain intimate.

"*Things like the introduction of the new platform became an IT project right, it did not become an interdisciplinary project that involved… end users in a meaningful way*..." – Randy.

Sometimes when introducing new technology, it seems that the position and capacity of team members can play a role in technology adoption. For instance, IT departments are heavily involved in rolling out, developing, and maintaining new software in hospitals and clinics. This is mentioned as a poor approach to technology integration due to their lack of work experience in clinical settings and the need to view technology integration as a change management exercise. As exampled by Randy here: "*It was approached as an IT project… but it was in fact a change management exercise*.", Jessie here: "*With any introduction of new technology, the change management process has to happen, alongside it otherwise it's just gonna fail*.", and Clay here: "…*to get buy in from staff and provide the proper change management is equally important [as financial risk]*.". Therefore, the approach innovators take is a critical early decision and a lack of clinical experience, not communicating with

clinicians, and failing to establish change management practices a substantial barrier to HCT adoption.

It was clear from Randy, Jessie, and Clay, that this lack of clinical experience means the software which is used by clinicians is not fit for purpose or is poorly thought out. This could mean notes are handled more than once, information is duplicated across different systems, or information input is poorly optimized. There seems to be little in the way of feedback systems for clinicians to work with IT departments to fix or update any issues they regularly observe with the system. However, this was not always the case, and one interviewee mused about the past (15+ years) when doctors would *engage* with technicians and developers and provide input into the development of technology: "…*and the doctors would drop into the workshop and say hey you know what's happening with this stuff. You have this kind of relationship at a customer level*…" – Randy. This relationship seems to be lost or at least diminished which has seemed to reduce the quality of design and function of HCT according to participants. Other participants also saw this need for clinical voices in the development and implementation as critical for the success and adoption of HCT: "*But we knew that in order for the technologies to be adopted, we had to have complete buy-in from the doctors. So, we had several of the doctors working on the project with us*." – John. Thus, a close positive relationship between clinicians, developers, and IT departments can enhance the adoption of HCT through quality subject matter expertise which can lead to fewer troubles further on in the implementation phase and potentially lead to greater success of HCT adoption.

Theme 2: The nature of clinical work (NOCW)

Table 3

The Nature of Clinical Work Theme Description and Samples

Main theme	Description	
Nature of Clinical Work	This theme is about how the NOCW impacts the adoption of novel technology. It's about the pace of work, current issues in healthcare, basic healthcare drives and the need to consider workflow and load.	
Sub themes		Sample
Workflow	Existing ways of working can become an impediment to HCT adoption if the development/introduction of technology does not consider the current workflow.	"It's not the well, so it's not that they didn't call for [the technology]. It's just that a lot of the times it doesn't actually fit the way that they work." – John.
Pace of Work	The pace of work in clinical settings is rapid – clinicians are overworked and understaffed. This means introducing novelty to the working environment can be tricky. This rapid pace is juxtaposed with the rigidity and slow pace of governance and organisational change stemming from multiple facts about the NOCW.	"The reality is obviously, how, as an industry also moves very quick, very slowly in terms of the actual systems will move quickly into their equipment and medical and research and all of that, but the actual IT systems and clinical is very slow, especially in public sector." – Marlon

Nature of clinical work

Clinical settings often face resource constraints, leading to overworked and burnt-out staff members. Despite these limitations, clinicians remain committed to providing high-quality care. However, these constraints impact the adoption of HCT in several ways. One significant factor, often tied to the element of time, is the need for evidence that HCT is effective, safe, and does not disrupt care for patients, as illustrated by Clay: "*[about how long the process of HCT takes] It depends obviously on complexity of the project and evidence of the project…"* and Jessie: "*So yes, of course, if I want some new technology i'm going to have*

to prove that there's an evidence base behind it". The reality is that clinical spaces are not always ideal, with limited staff, resources, and time available. Therefore, technology adoption in clinical settings must be carefully considered to ensure it aligns with the primary objective of delivering effective, timely, and safe care. As evidenced by David here: "…*a lot of the successful business cases for new technology have been based on reduction of risk, the fact that it will make treatments safer*" and Jessie: "*…unfortunately, in a district health board it is cost benefit, So if you can prove that a person is going to reduce the length of hospital stay, then they might [consider the technology]".* As such, timeliness, safety, efficiency, and efficacy become important enablers for HCT adoption.

The standard healthcare workplace structure and design can also hinder HCT. Hierarchical structures tend to concentrate decision-making power in the hands of experienced staff, potentially impeding the input of newer members. Additionally, challenges may arise in communicating integration processes for new technology due to complex scheduling and rostering arrangements. Finally, time constraints exampled in this quote from Penny: "*I think we may have had one education session, but because I worked at [the]time, I never made it to that.*", further exacerbate the situation, making it challenging for clinicians to undergo training or learn new technologies effectively forcing staff to undergo extra-curricular training or foregoing training altogether.

Workflow

In the context of adopting HCT, existing workflows play a crucial role. Many times, clinicians know best, about what they need from a piece of technology because they know exactly how it should fit into their workflow and what it should do as exampled by David: *"[A surgeon] wanted to try and improve the records for his own patients in his department and then since then it's been adopted by the by the whole the whole hospital*". This is an example of ground up development from clinicians fitting the technology to their context.

The impact of workflow is also exemplified in the shift from paper to digital records. When digital records and patient management systems were introduced, resistance from clinical staff was evident. While clinicians recognized the potential benefits of digital records, such as improved access and security, they often fixated on the drawbacks of change such as when Penny stated: "*[about the technology] it's not one for each patient or workspace or anything like that, and then you've got to remember your password… I would just rather have carried on writing on a bit of paper frankly because it's quicker and easier.*". Complaints about lugging a laptop to the bedside or the need to remember passwords were common. However, technology issues are not uniform across healthcare organisations, Penny went on to say: *…in town and Christchurch hospital, they have to do this for each workstation, so its not much of an issue there.".* This suggests that resources have a substantial impact on the adoption of HCT.

These concerns were valid, but it is essential to recognize that overcoming these challenges brought several advantages. Digital records reduced the risk of lost records, enhanced information sharing among health professionals, improved data detail, and allowed clinicians to identify patient health trends. For example, Clay mentioned this about digital health records: "*When I get home, I can remotely access a computer and, basically, I can look…a patient up… like blood pressure, it would take 10 minutes, it was all portable, light, so I can access remotely from home… a pretty good technology*". Therefore, while some clinicians find certain technology cumbersome, others find great value in it. However, the transition from paper to digital records also highlights a critical point: new technology must align with existing workflows to be effective. For example, John said: "*It's not the well, so it's not that they didn't call for [the technology]. It's just that a lot of the times it doesn't actually fit the way that they work.*" Therefore, in the realm of HCT, the alignment of technology with the natural flow of work is a critical enabling factor.

If a HCT seamlessly integrates into the workflow and does not disrupt it, it is far more likely to be embraced by clinicians. However, when the adoption of HCT contradicts the established workflow, resistance is more likely. Workflow concerns highlight the importance of open, transparent, and effective communication between technology users, such as clinicians, and developers. As exampled by Marlon here: "*I guess the biggest enablers would be to do user testing with the client and understanding what the client's context is, or their environments. Because a lot of it is actually driven by behaviour and the environment that clients are in*.". When clinicians and developers work collaboratively to ensure that new technology complements the existing workflow, it paves the way for a smoother adoption process.

Pace of work

One prominent sentiment that emerged from discussions about barriers to HCT adoption was the challenge of reconciling the pace of work with the pace of governance. This issue is rooted in several driving factors that shape the adoption process.

First and foremost, healthcare agencies prioritize providing safe and effective care to patients. This emphasis on patient safety means that any new technology introduced must adhere to rigorous risk standards established by existing policies and regulations as explained by Marlon here: "*…especially in health organizations, you find that everything is driven by risk and compliance. So, it's almost like we need to have all of these things to meet our risk and compliance regulations. When the reality is some of [the technology] is never used.* And David here: "*In radiotherapy specifically there's a very strong culture of careful commissioning of new equipment and calibration so on to minimize risk*". Furthermore, compatibility with the current technology infrastructure within healthcare systems is essential, often necessitating extensive testing and validation. This process can be time-consuming, particularly for software technology such as patient management systems, which

may take many years to integrate effectively. For example, Marlon explained: "*And the other problem that I've seen a lot as well is duplication on information being entered. So, if you're running two or three different multiple systems… you're entering [information] almost three different times, like patient's name, or the data around conditions. Like duplication of information is insane, you'll be surprised. Then you will essentially have all these different databases holding all this information for the same patient, which is again, not connecting to each other*." This may provide some insight into resistance to novel technology – if a new system or technology is introduced it may be seen by clinicians as time wasted or more work.

Paradoxically, the pace of clinical work is often extremely fast, driven by the urgency of treating time-critical illnesses and injuries. Clinicians must make swift and decisive decisions, while external pressures from governing bodies focus on reducing patient wait times, time spent in beds, and treatment delays. For example, John states: "*There's a lot of targets that we've got for the Ministry of Health around faster cancer treatments… the referrals on the paper forms was identified as a time waster… Basically, those six days were not useful for the patient at all. In so it started off as a time-saving initiative*." Balancing these two contrasting demands presents a complex challenge in HCT adoption.

The analysis reveals the meticulous nature of clinicians in their work – risk was mentioned 30 separate times in the interviews. This emphasis on caution is further accentuated by the stringent risk management and compliance requirements imposed by most healthcare systems. The necessity for maintaining patient safety and data integrity underscores the importance of adhering to proven methods and adopting new technologies cautiously. However, the pace of clinicians' workday rubs against such governance providing a knotted tension and a key barrier.

Theme 3: The psychology of clinicians

Table 4

The Psychology of Clinicians Theme Description and Samples

Main theme	Description	
The Psychology of Clinicians	The feelings, attitudes, biases, and cognition of clinicians about technology adoption.	
Sub themes		Sample
Fear	This sub-theme pertains to the fear clinicians may feel when dealing with novel technology.	"[about reluctance to adoption] I think there's a few things so. One of them is fear. Yeah, I think a lot of it is just around fear of change, possibly but also fear of getting it wrong, fear of departing with what's familiar." - Jessie
Change	This sub-theme is about the psychological mechanisms behind change, which seem to be triggered when faced with novel HCT.	"I think a lot of it is just around fear of fear of change, possibly but also fear of getting it wrong fear of making a mistake, sticking with what's familiar… that's probably one of the bigger ones, and another one is time, realistically." – Jessie
Cognitive load	This is about how cognitive load plays a role in influencing clinicians' willingness to adopt and learn novel HCT.	"There is so much that these people have in the heads worrying about patients worrying about what's gonna happen next, and all these other things that we just need to try to reduce the worries as much as possible." - John
Technophobia	Technophobia refers to the fear of technology and in this instance, the fear which older clinicians may face when using novel HCT.	"I work with a lot of older nurses, and I feel like they have a very, very hard time adopting new technologies." – Penelope

The Psychology of Clinicians

As the interviews were examined, a pervading theme was noticed – the psychology of clinicians. This refers to their thoughts, feelings, and behaviours. This theme consistently relates to and persists through, the different themes explored in this thesis. Instances, where personality differences among decision-makers and clinicians became hurdles in adopting HCT, were noted as impactful in some areas. For example, Jessie noted: "*It was that was a really difficult time and there was there was some challenges there, and you know, I guess, this is where individual team personalities can be problematic*.". Additionally, some interviewees also expressed feeling or witnessing fear or unease about new technology. Relatedly, notions of technophobia came up during these discussions, however, it was not clear whether they were founded. Finally, uncertainty about whether a piece of technology actually worked caused apprehension and anxiety among clinicians making apparent, the need for evidence of efficacy. This theme sheds light on how the mindset of healthcare staff can influence the integration of technology into their work.

Fear of new technology

The fear and anxiety of some staff when it came to using the technology was apparent. Would the technology be safe? Would it help this patient? Would it help this patient better than what we were doing before? Will I be able to use the technology correctly? – these were some fears turned barriers that came through in the thematic analysis. For example, Jessie explained: "*I think a lot of [resistance] is just around fear of… fear of change, possibly but also fear of getting it wrong fear of making a mistake, sticking with what's familiar… that's probably one of the bigger ones, and another one is time, realistically.*". Based on this, trust in technology becomes apparent as a key motivator in using novel technology and from that, the need for explicit evidence that the technology is safe and works. Not surprising considering the cost of mistakes of poor practice in healthcare.

Personalities impacting adoption.

What was surprising is the impact personality and ego had on the uptake of technology – harken, for a moment, back to the conflict within the double-edged sword of relationships. Throughout the interviews, there were a variety of complaints and concerns about how other staff were behaving when it came to the adoption of technology. This involved instances such as disregarding clinical guidelines due to perceptions of one's ability and experience as superior to evidence, disregarding evidence to suit pre-conceptions, and changing the trajectory of policy or uptake due to a change in *who* is in the role. Randy explains here: "*We've had a couple of years where just because of who you are, you're affecting how the organisation works for good or bad.*". Disregarding, undermining, or otherwise questioning evidence came through in the interviews. This is likely connected to the concerns for patient safety flowing into anxiety around novel HCT. Another reason supported by the data is that clinicians feel their expertise is superior to the evidence presented. Jessie explains here: "*Through part of that was the fact that it, you know they didn't feel the research had been peer reviewed adequately and part of that was that they genuinely believe that they knew better because they had years of experience and that their years of experience were being ignored in this process of changing*.". Whether each instance of this is true or false, clinicians felt their expertise was being questioned which could be a frightening concept to some more senior clinicians considering the hierarchical structure. As such, enabling better HCT implementation could mean communicating between clinicians about their concerns and anxieties with novel technology.

Change and Cognitive Load

Anxiety and apprehension with novel technology came through in the interviews, yet it was not necessarily technological anxiety that was at the heart of this barrier. Hesitation towards technological change rests on the fear of *change* itself. As Jessie explained: "*I think a*

lot of [resistance] is just around fear of… fear of change". Unlike some domains of work, people who work in healthcare tend to stay in healthcare for their entire career whether staying within their discipline or moving to more administrative or leadership roles. Therefore, change can be frightening when it disrupts or shatters existing, embedded, and enduring ways of working.

As alluded to in the first quote from Jessie, and in the NOCW, *time* plays a critical role in the uptake of HCT. It does this by limiting the hours clinicians have to learn, train, or play with novel technology. Often, the first time clinicians use a piece of technology is when they are working, and the technology needs to be used. This places cognitive strain on a workforce who ordinarily, already have a high cognitive load. As such, frustration at new technology is normal and anxiety when novel technology is placed in front of them is understandable. This anxiety is exemplified by Marlon talking about the transition from paper to digital records here: "…*And now it almost creates an anxiety in the user, that they have to fill out all the time to actually figure out, where's the pen in terms of the process*?" However, these are barriers which could be mitigated.

Importantly, encouraging the use of novel HCT one time is not enough, some participants noted their perseverance in getting clinicians to try it. For example, Jessie explains that "*People feel uncomfortable with [technology], and you have to you know re-offer training all the time and they have to remind them that it's you know not that hard to pull it out of the cupboard and have a go with it*." This likely speaks to the cognitive load barrier, with clinicians unable to remember to use the technology, or it may be that it is not seen as important or beneficial in the short term because of the time it takes to learn and understand.

Technophobia

Connected to the anxiety and fear of technology is the notion of technophobia ostensibly presented in older clinicians. Individuals raised during the information age are perceived to encounter fewer technological challenges compared to those born in earlier generations. Exampled by Penny: "*I work with a lot of older nurses, and I feel like they have a very, very hard time adopting new technologies*." And Randy here: "*So, you had combination of tabs and shortcut keys and mouse, and a digital native may have found that quite straightforward… They found they could handle it in a year that was the learning curve*." There was some contention on this point because some interviewees dismissed this notion and believed that older generations were just as capable of accepting new technology. While others saw this as a real impediment to technology uptake.

Theme 4: Culture and communication

Table 5

Culture and Communication Theme Description and Samples

Main theme	Description	
Culture and communication	About the impact of organisational culture on adoption, the effects of transparency, psychological safety, accountability, and fostering a learning culture. Additionally, it is about communication surrounding technology implementation, training, efficacy, and technology characteristics. And the difficulty around communication with different branches of a large healthcare organisation.	
Sub themes		Sample
Transparency	This sub-theme is about the transparency of communication between leadership and staff, and developers and organisation members. We found it was often a	"My manager would tell me, there is a new there's a new product coming, then we would receive information, then… we would need to do, training on it...

	lack of transparency that led to confusion, angst, or frustration with HCT.	but yeah I don't really know who approves it." – Penelope
Clarity and frequency	This sub-theme relates to the issue clinicians face around the clarity and frequency of communication in the healthcare system. It is about getting the right message to the right people the right number of times.	"The biggest issue at the DHB as a whole is actually reaching all the layers of the organization for any communications channel, to the point where, you know, being here for three years, almost say whoever figures out how to reach every single person within the DHB via any channel of communication, and actually clearly communicate a message … Will win a Nobel prize I guarantee you." – John
Feedback	This is about valuable feedback from clinicians and users to technology developers and implementers. And the need for these feedback channels.	"And I went through about half a dozen iterations with the doctors just getting the feedback while we were prototyping these things, just to make sure that we were actually achieving the needs really. And by the time we got to the prototyping phases, that basically released itself." – John
Social learning	This sub-theme is about how the NOCW often leads to clinicians teaching and learning from each other regarding HCT.	"So, then you just teach each other, basically, and pick it up" - Penelope

Culture of Learning and Accountability

The culture of an organisation and whether it is orientated towards innovation and ready for change is critical to the adoption of HCT. Jessie explains that: "…*team culture, I think, is critical to adopting any change and be at technology or otherwise, I think. Yeah, you have to accept that*.". The cultivation of a learning culture revolves around instilling the values of continual learning, embracing innovation, sharing knowledge, and fostering ongoing skill development. Leadership figures play a pivotal role in promoting and upholding this culture within the workplace, while those in leadership positions embody, encourage, and

make these principles salient. This environment significantly facilitates technology adoption within healthcare organisations by affording clinicians the freedom to learn through their technological errors. It encourages openness and transparency about these mistakes, enabling thorough discussions on how they occurred and strategies to prevent their recurrence in the future.

Moreover, a culture of learning intertwines with a culture of accountability. Accountability involves not only acknowledging mistakes but also being forthcoming about their origins, regardless of the individual responsible. For example, Jessie, a professional clinical leader tells us about her style of leadership: "*My personal leadership style is to be really honest when I make mistakes, because I think that that can be really helpful for other people's learning*". This emphasis on accountability holds particular significance in the realm of technology adoption. Because, when leaders commit errors, this information becomes known among most clinicians, serving as a learning opportunity and a means to potentially avert similar mistakes in the future. Consequently, the risk of isolated errors accumulating without discussion, ultimately exacerbating into more significant issues, is mitigated through proactive acknowledgment and open dialogue in a timely fashion *when* it happens.

Transparency

Transparency was an important process that arose in the data. Transparency from leaders, transparency during the implementation process, and transparency from clinicians using the technology. As transparency is understood as part of accountability and learning culture (E.g., being honest with mistakes), it also stands on its own as an important factor. An example of the absence of transparency from Penny: "*My manager would tell me, there is a new there's a new product coming, then we would receive information, then… we would need to do, training on it... but yeah I don't really know who approves it."* It is important for learning and accountability for knowing what not to do, what may go wrong, and how

colleagues delt with problems. Moreover, it is directly important for technology implementation for similar reasons.

Clarity and frequency of communication

Reiterating the importance of communication, clarity stands out as a crucial aspect. This refers to the transparency and comprehensibility of a message, gauging its effective understanding by the intended recipients. The hindrance to clarity often arises when there is a deficiency in communication regarding a technology rollout, such as relying solely on methods like email or posting notices on staff room bulletin boards. This is exemplified by John's declaration here: "*The biggest issue is… reaching all the layers of the organisation for any communications channel to the point where… whoever figures out how to reach every single person within the DHB… and clearly communicates a message… Will win a novel prize I guarantee you*." To optimize clarity, messages should be succinct, straightforward, and easily digestible, minimizing the time clinicians need to invest in comprehension. As John points out above, reaching all layers of an organisation is a difficult task and healthcare organisations specifically can have unique challenges such as shift workers, busy staff, and a sometimes chaotic workplace.

Conversely, clarity can be bolstered by utilizing a diverse array of communication channels frequently. However, a delicate balance is necessary to avoid overwhelming clinicians with an excess of information. In addressing this challenge, some healthcare organisations implement an in-house communication service. This service allows clinicians to receive pertinent messages on critical updates or discussions, ensuring the right information reaches the right individuals without inundating them with unnecessary information. The objective is not to inundate every clinician with exhaustive information but to precisely convey relevant information to specific recipients.

"*…The trouble is that…at the hospital uses notifications to communicate, so I can't just turn them off and yet I'm constantly sort of every few minutes I have a little window pop up say, and it may be a conversation related to or completely unrelated to what my work is so it's a distraction*" – David.

Feedback on tech

During the interviews, it was clear that understanding the needs of clinicians, their environmental needs, and the needs of the systems they work with was particularly important to the uptake and adoption of HCT. One achievable way participants pointed to, to understand these aspects was feedback which is exampled by John here: "*I went through about half a dozen iterations with the doctors just getting the feedback all the time, while we were prototyping these things, just to make sure that we were actually achieving the needs really*." This means engaging with clinicians to figure out for developers, change management, and leadership, what concerns clinicians have with certain HCTs or improvements which could be made to enhance uptake or use.

Theme 5: Training

Table 6

Training Theme Description and Samples

Main theme	Description	
Training	This theme is about the capacity, willingness, and feasibility of clinicians to learn how to use HCT.	
Sub themes		Sample
Time	This sub-theme is about the lack of time clinicians possess to complete formal training.	"We all feel that we don't have enough time, I suppose, like many different professions and so there's resentment if we have to spend time to get to learn something" – David
Social learning	This sub-theme is about the seemingly ubiquitous standard	"So then it's just you just teach each other, basically and pick it up and you

	of learning how to use technology from fellow clinicians.	find that when you've done something wrong the wrong way like it we didn't really have a very good introduction to it at all it's just… that's what we do and we just help each other, and you know you can get through it, but it's probably not smoothest way and it's quite time consuming" - Penelope
Learning and use autonomy	This sub-theme is about the resulting situation most clinicians find themselves in when it comes to learning novel HCT. They need to be able to learn and use HCT at their own pace, in their own manner.	"As I continue to work with operational teams to see what they're doing with Microsoft teams by themselves undirected by anyone and unhindered by anyone… some of the process work is really, really good… then [clinicians] only need to be shown a few kind of examples of what it can do, and [clinicians] go 'oh that's really interesting'." - Randy

Training

This theme reflects one of the more concrete barriers and enablers of HCT adoption. Namely, the discrepancy between how much time is needed to learn to use novel technology, and the amount of time available to clinicians. This theme has many links to other themes discussed in this paper and was almost subsumed into 'the nature of clinical work'. However, I reasoned that it was unique enough to warrant its own theme and was mentioned by six of the eight participants. This theme explains the unfortunate reality of why social learning underpins clinical learning of HCT. Additionally, the NOCW, (e.g., shift work, rostering systems, and emergencies.) proves to be difficult in arranging comprehensive training sessions or even communicating information about training to clinicians. Regardless of its connections, time and training itself proves to be a barrier and potential enabler to technology adoption in healthcare.

Training provided by healthcare organisations is observed in the data as online and offered in person. The latter could potentially be more beneficial to clinicians because they

may be provided with the technology itself, to practice with it. However, online training modules provide the benefit of being flexible and with time constraints being an obstacle, seems appropriate for some clinicians. These are provided live or as recorded videos, usually with accompanying documents and learning exercises that count towards professional development. As Penny explains: *"[about where they do training] our learning website where we do all of our courses, it's usually on there".* David's viewpoint accentuated the relationship between the intuitiveness of technology and clinicians' training needs here: *"And I think the thing about the tablets was it was very intuitive so we don't really need any training, it was just like using a normal pencil on a on a piece of paper, and so we could just outline things, and it was, I think the fact that it was very intuitive was what made it so successful".* Specifically, the incorporation of tablets with touch screen capabilities meant minimal training, owing to the small functional disparity between traditional pencil-and-paper methods and tablet form completion. Comparatively, the introduction of workstations with mouse and keyboard, prompted clinicians to seek familiar elements, raising questions about where the pencil is in the process. This observation highlights the substantial influence of technological design on seamless integration into clinical workflows, underscoring the significance of intuitive interfaces in mitigating training demands and saving time.

Time

The lack of time clinicians had to train with novel pieces of technology was an apparent barrier to HCT adoption. Moreover, the current state of training (e.g., social learning, autonomous, and lack of formal training) means it becomes time-consuming to learn 'on the job', the time organisations think they may be saving by minimizing training sessions flows into the role and clinical tasks. As Randy highlights: "*They found they could handle [the software] in a year but that's the learning curve…*". Here we see the time it can take to learn new software. While this has been cited by participants as an enabler in some cases, this

form of on-site training can induce undue stress and anxiety hindering HCT adoption. Moreover, teaching each other means clinicians need to take time out of their primary roles to help other clinicians understand how to use a piece of technology further exacerbating work demands and placing undue stress on clinicians. Furthermore, clinicians may only find out they have been doing something wrong with the technology when another clinician points it out, potentially leading to an increase in fear of using novel HCT.

As Penny highlights, this kind of learning and introduction to technology can be time-consuming, burdensome, and unwieldy: *"So then it's just you just teach each other, basically and pick it up and you find that when you've done something wrong the wrong way like it we didn't really have a very good introduction to it at all it's just… that's what we do and we just help each other, and you know you can get through it, but it's probably not smoothest way and it's quite time consuming".* The result of having limited time and opportunities to complete training on HCT meant that clinicians felt they were underprepared when faced with some HCT. Finally, David mentioned that feelings of resentment were common because when they needed to complete training, it isolated them from their professional workload: "*We all feel that we don't have enough time, I suppose, like many different professions and so there's resentment if we have to spend time to get to learn something"* . Therefore, further investigation is needed to understand where the majority of resistance is coming from – the nature of work or clinicians themselves?

Social Learning

A noteworthy aspect of training is the situation most clinicians find themselves in, namely, that inadequate time for training in new technology leads to a necessary social learning culture. Social learning is observed as clinicians informally learn tips and techniques from other clinicians using technology. Penny explains why here: "*You just get told [tech implementation] is going to happen, and I think we may have had one education session, but*

because I worked at the time, I never made it to that. So, then it's just you just teach each other…". Poor training time allocation means that clinicians need to learn from each other how to use novel technology.

Learning and use autonomy

Learning and use autonomy as an aspect of training and time is about affording clinicians the space, grace, and time to learn how to use technology on their own. This was a barrier and an enabler of HCT adoption, it means allowing clinicians to learn at their own pace and work out kinks or tricks with the technology. Jessie reflects on the introduction of a novel piece of HCT: *"…quite a lot more experiential learning I guess happened as a result of using [the technology]."*. Although, as with social learning, it seems to be the result of a lack of time allocated for hands-on, person-to-person training. Learning and use autonomy also can become important for figuring out how novel HCT can be integrated into current workflows by clinicians themselves, sometimes unintended by developers. For example, Randy tells us: *"As I continue to work with operational teams to see what they're doing with Microsoft teams by themselves undirected by anyone and unhindered by anyone… some of the process work is really, really good… then [clinicians] only need to be shown a few kind of examples of what it can do, and [clinicians] go 'oh that's really interesting'."*. This is a positive example of giving clinicians the autonomy to use a piece of software to meet their ends through self-direction and creativity. However, this laissez-faire approach to technological training ostensibly increases the risk of errors, mistakes, and short-cuts.

Theme 6: Technology Characteristics

Table 7

Technology Characteristics Theme Description and Samples

Main theme	Description	Sample

Technology characteristics	This theme is about usability, ease of use, and other characteristics that improve or hinder HCT adoption.	"So as an example, there was a referral system, which, probably about five years or so ago, one of the, one of the surgeons I was working with, was asked to test and he absolutely savaged it because it just he was struggling to log on to us. And he's an intelligent person, and he just thought that this was getting in the way of him to actually do his job. With the thing is, with all of the technology, we just need to keep it simple" - John

This theme receives comparatively less emphasis than others as it falls outside the socio-organisational focus of this thesis. Additionally, the impact of technology characteristics on adoption has been extensively explored in existing research (Kijsanayotin et al., 2009; Liu et al., 2015; De Veer et al., 2015). However, it does warrant a theme in this analysis because participants discussed the need for specific technology characteristics when considering the enablers and barriers of HCT adoption. For example, Randy tells us: "*yeah, it's not made visible within the [health information technology] system where the opportunities to understand If equity issues that arise or could arise, or to be able to prevent it [are not visible]. Now we'll get there, but it's just not quick or easy or adaptive*.". Here we can observe that an opportunity to use software to further health outcomes for patients is not being met due to the complexity of the software. On the other hand, John makes this statement about replacing referral systems: "*they [had] a dictation system which they [typed it out] then they have to automatically approve the letter that literally gets printed out and sent to the receiving department. Now, that was taking an average of about six days, which was basically a communication from one office to another office. And so, we were replacing it with something which was, which was easy for them to use*.". This examples how the ease of use of a technology can enhance healthcare practices and if not present, can hinder it.

Study 1 Discussion

The double-edged sword of relationships.

The double-edged sword of relationship theme illuminates the web of relationships that permeate healthcare organisations, spinning from individual clinician interactions to broader organisational and governmental connections. On an individual level, clinician-to-clinician relationships showcase both impediments and enablers, where conflicts arising from perceived expertise may impede facilitation. The relationships between clinicians can also be strained from championing interventions such as technology introduction if negativity is expressed to the champion by other clinicians (McCormack et al., 2013a). This suggests that championing new technology may come at a social cost for some clinicians. Relationships with the IT department emerge as critical, impacting the feedback on software-based technology while, conflict of interest among different stakeholders, such as clinicians, executives, IT departments, and patients, adds an additional layer of complexity.

The interviews revealed conflicts arising from contentious policies and leadership decisions, influencing the overall environment for technology adoption. Notably, the co-design approach and clinician involvement in technology development stand out as positive influences on HCT adoption. Research suggests that feedback and end-user participation in the development of new technology are fundamental to the success and alignment of the technology in and with the workplace (Ghulam Sarwar Shah & Robinson, 2006; Bernstein et al., 2007; Kushniruk, & Nøhr, 2016). However, a shift from collaborative interdisciplinary projects to IT-centric approaches has led to misalignment and inefficiencies cementing the lost connection between clinical experience and technology design which has potentially resulted in muted technology and noisy clinicians. To shift from an IT-centred implementation to a change management or user-focused implementation healthcare

organisations must understand that technology should fit the work environment and conform to user needs, not the other way around.

Culture and communication.

The thematic analysis underscores the importance of an innovation-oriented organisational culture and leadership in the adoption of HCT. Jessie's insights highlight the critical role of a learning culture that embraces continuous improvement, innovation, and skill development—values that are significantly shaped by leadership (Schein, 2010). Leaders not only embody these principles but also actively promote them, creating an environment conducive to learning from mistakes and fostering transparency (Kucharska & Bedford, 2020). This leadership style, emphasizing honesty and accountability, facilitates an open dialogue about errors, potentially enhancing the technology adoption process (Bennis et al., 2008). Moreover, the analysis points to the necessity of clear and consistent communication to overcome barriers presented by organisational complexity and to ensure effective technology implementation. Communication is an integral part of Kotter's (1996) eight step process for leading change. Specifically, ensuring clear and compelling communication about innovations and change mean the process will likely cause less effort in the long-term. Therefore, engaging clinicians through feedback and tailoring training to align with organisational goals are identified as essential strategies for smoothing the adoption and integration of HCT into clinical practice. Ultimately, the success of HCT adoption is linked to a supportive organisational culture that prioritizes innovation, learning, and accountability, underpinned by effective leadership and transparent communication.

Nature of clinical work.

There may be a misunderstanding in how researchers approach healthcare organisations which explains how models discussed in the literature review do not conform to

different contexts and a one-size-fits-all all approach is misguided. Kernick (2002) explores the complexity of healthcare organisations and suggests that *models* are too stringent to be applied to healthcare organisations because they should be viewed as ecosystems rather than static rational machines. For example, changing the quality of workflow, training, or introducing novel HCT will have unintended consequences that flow into the rest of the ecosystem. This notion is supported by Harrison et al. (2007) who find that the interaction between introducing HCT to a healthcare organisation and its workflows, culture, social interactions, and other technologies can create unwanted or unintended consequences. For example, when nurses facing substantial workloads encounter complex software that requires the use of multiple screens for medication administration, a common response is to postpone the documentation of medication administration until the end of their shifts (Harrison et al., 2007). This unofficial practice can result in inaccuracies in recording medication timings and quantities, unnecessary duplication of prescriptions, decreased efficiency in communication between physicians and nurses, and compromised effectiveness of safety checks integrated into the software (Koppel et al., 2005). This illustrates the complexity of the NOCW, the difficulties in introducing technology successfully, and the importance of understanding the ecosystem of the healthcare organisation.

One finding from the thematic analysis was the need for HCT to align with the workflow of clinicians. There is a plethora of research aimed at understanding how HCT can be integrated into healthcare organisation workflows (e.g., Lawler et al., 2011; Carayon et al., 2015; Bayramzadeh & Aghaei, 2021). Findings from human factors research reflect the findings in study one. For example, poor technology implementation can disrupt staff and impede patient care, and inefficient implementation disrupts workflow and effective teamwork, and can increase risk to patients (Bayramzadeh & Aghaei, 2021). HCT implementers and developers need to be aware of the context in which the technology is

embedded. One example of the disunity between HCT and workflow comes from Istanbul, where there is a culture of writing notes on paper towels (a readily available tool) because the electronic health records are unable to keep up with the workflow (Gonzales et al., 2015). This illustrates how HCT needs to be able to fit with the clinical pace of work. To do this, as outlined in the previous section, co-design principles and effective communication are key during the development and implementation stages.

The pace of work also came through in the findings and the paradoxical context of having a fast-paced work environment with an extremely slow governance system. With the recent COVID-19 pandemic, healthcare workers had to adopt new ways of working with patients which included technologies such as telehealth. For example, in Canada, telehealth (video consultation) jumped from 4% to 60% of primary care visits during the pandemics beginning (Glauser, 2020). This shows a rapid acceptance of technology while under immense pressure and increased workload. However, the rapid acceptance of telehealth was immediately necessary and involuntary. In other words, clinicians could not resist it. Technologies such as new patient management systems and condition testing technologies are different. The implementation of non-immediate HCT generally requires many years (Clark et al., 2019) and from our findings can exceed 10 years. Therefore, clinicians may see some novel HCT as unimportant, too difficult to learn, or merely unaware it exists due to their busy work environment and high cognitive load.

Training

From the results of the thematic analysis training presents itself within the nature of clinical work as underutilised due to poor time availability, the nature of shift work, and trouble with communicating effectively to the wider clinician population. The challenging theme of training proves to be a critical barrier in HCT adoption. The persistent discrepancy

between clinicians' learning needs and limited time availability is intricately woven into various elements, including the NOCW, cognitive load, and social learning. The emphasis on training methods underscores the vital role of intuitive technology design (Lehane, 2019), while the autonomy in learning and use presents a dual aspect as both a barrier and an enabler.

The autonomy in learning and use might produce downstream anxiety and stress for users. Informal learning increases the risk of stress in the work environment as well as making relationships disharmonious (Kazi, 2008). This on-the-job learning approach, while occasionally beneficial, introduces stress, highlighting the nuanced and multifaceted nature of the themes explored in this thesis. Formal training has the benefit of having specific desired outcomes that can be tailored to a workflow which means that trained clinicians should know how a certain technology can enhance *their* work (Chen & Klimoski, 2007). Moreover, formal training can be used to strategically align the desired outcomes of the training with organisational goals (Noe & Ellingson, 2017). For example, if a hospital desired to collect data for a specific condition, it could tailor training with their patient management systems for clinicians. However, informal learning and autonomy of use tend to be status quo across many organisations (Bear et al., 2008) and as discussed in the results, role saturation is becoming an issue for clinicians exacerbated by continuously introducing novel technology (Straub, 2009). Therefore, clinicians can quickly become overwhelmed with novel HCT especially if they are learning informally. As such, finding time to train formally should be a priority of healthcare organisations.

In cases where persistent feelings of being overwhelmed endure, technostress – a concept introduced by Brod (1984) – emerges as a condition of adaptation stemming from an incapacity to cope with new computer technologies. This concept may elucidate why clinicians experience a sense of overwhelm in the context of HCT. Technostress is

exacerbated by external stressors, including physical, psychosocial, and organisational stressors (Sethi, 1985). Considering the context of underfunding, overworking, and high stress, healthcare workers are extremely susceptible to technostress furthering the case for allocated formal training time.

Psychology of clinicians

During the late 20th century, researchers such as Kling (1996), Brod (1984), and Frankenhaeuser & Johansson (1986) directed attention to the potential adverse effects of workplace computerization. This concern reflected apprehensions regarding how technology could, a) encroach upon work processes, b) pose risks to the well-being of workers, and c) potentially lead to the displacement of workers altogether. Interestingly, during this period, a study on the computerization of hospitals found that six themes emerged when nurses were asked what it was about computerization affected them the most (Adaskin et al., 1994). These were 1. Time-frame, 2. Choice of software, 3. Communication, 4. The change process, 5. Training, and 6. Leadership. Over three decades, it appears that the requirements of clinicians have exhibited relatively little change.

Fear of change and fear of general technology (technophobia) were present in the results and align with current research, although fear of being replaced was not an issue in the findings which arise elsewhere (Koivunen & Saranto, 2018). Anxiety towards novel HCT was a large contributor to the psychology of clinicians and is supported by the literature (Kjerulff et al., 1992). Interestingly however, Kjerulff et al. (1992) clinicians who experienced higher levels of technological anxiety exhibited less favourable attitudes toward computers, reported heightened stress in their work environment, demonstrated lower levels of job satisfaction, and expressed fewer positive sentiments toward the physicians they worked with. From this comparative study, it is difficult to determine what direction the cause is. It could be that

lower levels of satisfaction with work, heightened stress from work, and poor relationships with their peers are causing the anxiety towards technology. Therefore, this notion is explored in study two.

Study 2

Introduction and Rational

This study employs a survey research methodology to examine the interplay, empirically, between perceptions of the importance of socio-organisational factors and other variables influencing the attitudes and themes explored and found in study one. Survey research is instrumental in elucidating the prevalence, distribution, and interrelationships of psychosocial and organisational variables deployed in this research (Kerlinger & Lee, 2000). The research questions answered in this study are:

RQ2 = What are the socio-organisational factors important for HCT adoption?

RQ3 = What is the relationship between the perceived importance of socio-organisational factors and HCT adoption?

Importantly, the assessment of HCT adoption attitudes and intentions involves two distinct self-report measures: self-reported importance which is how factors important for adoption are operationalised for RQ2 (e.g., *Please rate how important these factors are in determining whether or not you use new medical technology: I was involved in the selection of the technology*) and perceptions concerning the workplace environment (e.g., *Thinking about your current organisation in general; My organisation has been successful in implementing new technologies*). Survey methodology is aptly suited for situations where perceptual measures more accurately capture real-world dynamics than objective measures (Melone,

1990; Rahman et al., 2016). As such, this survey methodology dovetails seamlessly with study one's thematic analysis, which was grounded in a critical reality approach.

The items present in the survey reflect the findings from study one. For example, the identification of the training theme and subsequent enablers and barriers surrounding training meant questions asking participants to rate the importance of training effectiveness were included. Likewise, lack of time was identified as a substantial barrier. Therefore, participants were asked how important it is that they have sufficient time to learn how to use the technology. The purpose of the importance questions was to gather data on the views of clinicians as to what barriers and enablers they see as most important in determining whether they use new HCT and to answer research question two.

Considering the first study, mixed methods lend itself to the overall research project by helping to increase the rigour and richness of findings overall by affording participants more voice, a deeper look at the data, and the ability to compare and contrast across study one and two (Coyle & Williams, 2000; Shorten & Smith, 2017). Furthermore, this thesis employs a sequential mixed methods exploratory design, which is constituted of two phases. The first phase where the quantitative analysis provided the grounds (general barriers and enablers of HCT adoption) for the second quantitative phase where a more precise focus on the identified barriers and enablers was employed by narrowing down barriers and enablers into items and then into composites or factors reflecting the themes. The emphasis is on the flow of information gathered between studies.

Study 2 Methods

Participants

Participants were recruited using snowball and convenience sampling methods over four months during 2023 (see Appendix F for survey advertisement) using word of mouth and

social media platforms (Facebook, LinkedIn, and Health Informatics New Zealand). In total 118 participants responded to the survey with 90 participants completing the entire survey. The average age was 38 (*SD* = 12.43, Range: 22 – 72 years). The sample was 76% female, 22% male, 1% other, and 1% preferred not to say. Participants job roles were 26.5% nurses, 12% doctors, 10.8% physiotherapists, 6% midwives, and 44.7% were other various healthcare professionals. The average tenure for the current positions of each participant was 6 years (*SD* = 7.64, Range = .5 – 32). All analyses were performed using Jamovi statistical software (version 2.3.28).

Procedure

The survey was created with Qualtrics, see Appendix E for the information letter and Appendix G for the materials used in the survey. We administered eighteen questions to gauge how important the socio-organisational factors and their components, identified in the first study, were perceived to be in determining whether participants used new HCT. Each question was prefaced with the prompt; “Please rate how *important* these factors are in determining whether or not you use new medical technology:”. Each response scale was a 5-point Likert scale with 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, and 5 = Extremely important. Additionally, another two workplace environment items aimed at feelings of anxiety towards new HCT, and perceptions of respective organisation implementation success were asked.

The six themes were operationalized into factors by the authors by deductively choosing the best item-theme fit to ensure content validity. This was done by creating composites in Jamovi based on chosen items. However, many of the factors’ internal validity were not adequate; culture and communication (a = .41), NOCW (a = .44), clinician perspectives (a = .50), and technology characteristics (a = .40). Therefore, it was decided to

use single items based on face validity to represent these factors instead (Fisher et al., 2016). Therefore, culture and communication were separated from a single composite into two distinct factors – culture *and* communication. The two factors which displayed adequate internal validity (DESOR and training) remained as composites.

Measures

The factor compositions can be found in Table 8 immediately after this section and are highlighted if they are based on importance items or work environment items (I = importance, W = work environment). A higher rating on DESOR, culture, communication, NOCW, technology characteristics, and training means that participants perceived these factors to be important in determining whether they use novel HCT. A higher rating on clinician perspectives means healthcare professionals are less anxious about new HCT. A higher rating on successful adoption means healthcare professionals perceive their workplace to be successful at implementing novel HCT.

Double-edged sword of relationships (DESOR)

The double-edged sword of relationships was assessed using four items. Each item was generated by the authors. Cronbach's alpha for this composite was $\alpha = .77$.

Culture

Culture was assessed using one item which was generated from the Study 1 interview data.

Communication

Communication was assessed using one item. The item was modified from Matheson's (1991) subjective norm measure about novel technology use.

The nature of clinical work (NOCW)

The nature of clinical work was assessed using one item which was developed from Study 1 interview results.

Training

The training factor was assessed using three items. One item was adapted from Schmidt's (2007) training satisfaction scale and the other two were crafted by the authors using interview results. Cronbach's alpha for this composite was $\alpha = .67$.

Technology characteristics

Technology characteristics was assessed using a single item which was crafted by the authors from interview data.

Clinician perspectives

Clinician perspectives were assessed using one item which was adapted from Holt et al's. (2007) readiness for organisational change scale. Note that clinician perspectives are not present in RQ2 (What are the socio-organisational factors are important for HCT adoption?) because the items comprising this factor are not importance ratings.

Successful adoption

Successful adoption of HCT was assessed using a single item. This item was adapted from Dabić et al's (2019) innovation culture scale.

Table 8

Construct Item Composition and References

Construct	Items	Reference
The double-edged sword of relationships (I)	"I was involved in the selection of the technology."	
	"I was involved in the development of the technology."	
	"My patients' whānau like the technology."	
	"My patients like the technology."	
Nature of clinical work (I)	"The technology improves my patients' outcomes."	
Culture (I)	"My supervisors consistently support the use of the technology."	
Communication (I)	"There is effective communication about the technology roll-out."	
Training (I)	"The training to use the technology is effective."	Schmidt, 2007
	"There is sufficient time to learn how to use the technology."	NIOSH, 2021
	"There is sufficient time to integrate technology into work processes."	NIOSH, 2021
Technology characteristics (I)	"The technology is easy to use."	
Clinician perspectives (W)	"I feel anxious when I work with new technologies."	
Successful adoption (W)	"My organisation has been successful in implementing new technologies."	Dabić et al. (2019)

Analyses

Research Question 2: What are the socio-organisational factors important for HCT adoption?

Each composite mean was taken as the importance rating of the corresponding factor and a descriptive analysis was performed. However, a more detailed descriptive analysis of the means was performed at the item level to discover which items in particular were perceived as important for HCT use.

Research Question 3: What is the relationship between perceived importance of socio-organisational factors and HCT adoption?

To answer research question three (what is the relationship between perceived importance of socio-organisational factors and HCT adoption?) the factors discovered in Study 1 were analysed to discover their relationship with successful technology adoption. Specifically, two regressions were performed. Firstly, simple descriptives and correlation analyses were performed. Secondly, a hierarchical regression was performed with technology characteristics and clinician perspectives in the first block with DESOR, NOCW, culture, communication, and training in the second block. Successful adoption was the dependent variable.

In addition, I have previously discussed how the impact of the nature of work and training context affects the stress and technostress of clinicians. I have made the case that these factors impact the anxiety, fear, and potential technophobia found in clinicians. Importantly, anxiety, fear, and technophobia impact negatively on clinician intention to use and adopt technology (Kjerulff et al., 1992; Koivunen & Saranto, 2018). Therefore, a multiple regression aimed at answering if the socio-organisational factors predicted clinician perspectives was performed with DESOR, NOCW, culture, communication, and training as predictors with clinician perspectives as the dependent variable.

Study 2 Results

Research question 2: What are the socio-organisational factors important for HCT adoption?

The variables in Table 8 are the importance descriptives surrounding whether participants find these factors important in determining novel HCT use. Table 8 also provides the factors used in the analysis, their means, standard deviations, and correlations, note that

*p = < .05, **p = < .01, and ***p = <.001. The double-edged sword of relationships was moderately positively correlated with successful adoption and was significant at p = .005.

Table 9

Descriptive and Correlation Table of Constructs Used in RQ2

	Variables	*M*	*SD*	1	2	3	4	5	6	7
1	DESOR	2.77	0.90							
2	NOCW	4.50	0.76	.290**						
3	Culture	3.97	0.96	.283**	.253*					
4	Communication	4.10	0.92	.239*	.132	.379***				
5	Training	4.21	0.64	.233*	.286**	.360***	.592***			
6	Technology characteristics	4.24	0.77	.175	.324**	.248*	.196	.445**		
7	Clinician perspectives	3.57	1.19	-.04	-.157	-.221*	-.122	-.268*	-.237*	
8	Successful adoption	3.55	1.07	.309**	.162	.183	.198	.114	.251*	-.162

** = p<.05; ** = p<.01; *** = p<.001*

Firstly, the factor that was perceived to be the most important in determining whether health professionals use novel technology was the nature of clinical work. Whereas the perceived least important for determining technology use was the double-edged sword of relationships. Technology characteristics, communication, and training were also perceived to be important for determining novel technology adoption.

Secondly, a closer look at the items shows the most important enabler for health professionals was whether the technology improves patient outcomes with the least important being that they were involved in the selection of the technology. The item with the most variation from clinicians was on whether the patient's whānau liked the technology with being involved in the selection process, being involved in the development process, cost-

effectiveness, and patients liking the technology all having similar standard deviations. The item with the least variation was physical access to the technology.

Research Question 3: What is the relationship between perceived importance of socio-organisational factors and HCT adoption?

To test if perceptions of importance for socio-organisational factors determining HCT use predicted clinician perspectives a multiple regression was conducted (Table 9) with DESOR, NOCW, culture, communication, and training as the predictors. Durbin-Watson test for autocorrelation indicates that there is no serious violation, $d = 1.67$, $p = .100$ (Field, 2009). All variables had a VIF value of < 2.5 indicating no collinearity (Johnston et al., 2018). Q-Q plot showed a normal distribution of residual errors, and the fitted residual plot was randomly scattered. Overall, the results showed the model was approaching significance with the DESOR (which was significant) trending the model towards significance. Moreover, the DESOR accounted for a moderate amount of variance explained by the model.

Table 10

Multiple Regression Analysis For Socio-Organisational Factors Predicting Clinician Perspectives

	Clinician perspectives	
	B (SE)	(*p*)
Intercept	1.62 (.93)	.085
DESOR	.28 (.14)	.044
NOCW	.13 (.16)	.434
Culture	.12 (.14)	.395
Communication	.20 (.16)	.236
Training	-.17 (.24)	.471
Overall F	$F(5,77) = 2.26$, $p = .057$	
Adjusted R^2	.07, $p = .057$	

To test the additional predictions, a hierarchical regression was conducted with two blocks. The first block consisted of technology characteristics and clinician perspectives as the predictors. The second block contained the perceived importance of socio-organisational factors determining adoption with successful implementation as the dependent variable.

All variables had a VIF value of < 2.5 indicating that no considerable collinearity exists in the model (Johnston et al., 2018). The standardized residual plot showed a normal distribution of residual errors. However, the fitted residual plot was not randomly scattered suggesting a violation of the assumption of linearity. Durbin-Watson test for autocorrelation indicates that there is no serious autocorrelation, $d = 1.67$, $p = .070$ (Field, 2009).

Overall, the results showed in Table 10 that the first model was significant. Technology characteristics accounted for very little of the variance in successful adoption. However, when the socio-organisational factors were included, the second model showed a modest improvement becoming significant and accounting for more variance. Overall, when technology characteristics and clinician perspectives were included in the model, it explained 6% of the variance, including socio-organisational factors the second model accounted for 17% of the variance. The second model is significant, partly because DESOR is trending. Moreover, the change in R^2 was significant with a 12% increase in variance accounted for.

Table 11

Hierarchical Regression Analysis, Socio-Organisational Factors Predicting Adoption Success

	Successful adoption			
Predictors	*B (SE)*	β	*t*	*p*
Step 1				
Tech characteristics	.28 (.16)	.21	1.90	.06
Clinician perspectives	-.08 (.09)	-.08	-.81	.419
$R^2 = .06$, $F(2, 80) = 2.54$, $p = .085$				
Step 2				
NOCW	.07 (.16)	.05	.45	.657
Culture	.09 (.14)	.08	.69	.493
Communication	.25 (.17)	.21	1.55	.124
Training	-.38 (.25)	-.23	-1.49	.138
DESOR	.27 (.13)	.23	2.02	.046
$R^2 = .17$, $F(7, 75) = 2.23$, $p = .041$				
$\Delta R^2 = .12$, $F(5, 75) = 2.04$, $p = .083$				

Post hoc analysis

Post hoc analysis was conducted because the background literature suggests that perceptions towards specific modalities of technology can vary (Bishop et al., 2005) and HCT perceptions vary within the category of HCT itself (Low et al., 2021; Sezgin & Yıldırım, 2014) which means clinician attitudes will vary across the types of different technologies (i.e., clinicians may feel different about health information technology compared to hardware like glucose monitors). We asked participants to inform us which specific piece of technology they were thinking of when answering the questions. 63 participants answered this question, 33 were thinking about software and clinician-facing technology (e.g., digital health records, patient management systems, etc.) and 30 were thinking about specific hardware devices (e.g., continuous glucose monitors, breathing regulators, ultrasound machines, etc.).

Post hoc analyses were conducted after the authors read the open-ended questions and considered the background literature. There was potential for comparisons to be made between hardware and software. The post hoc question, which flows on from RQ2, was whether socio-organisational factors differed in perceived importance if participants were thinking about hardware or software when answering survey questions. A two-tailed independent samples *t*-test was conducted to answer the question of whether the perceived importance of socio-organisational factors differed for hardware and software.

RQ3 was not suitable for post hoc analyses because we would have preferred to perform a moderated regression with hardware and software moderating the relationship between socio-organisational factors and successful adoption, however, the sample size is too small and based on Gpower analysis we would need 102 participants for an effect size similar to relevant literature (e.g., Santini et al., 2020; Zhao et al., 2019).

Results

Bellow (Table 11) is the descriptive results of the perceived importance of socio-organisational factors determining novel technology use split by hardware and software groups. Firstly, Levene's test was significant for the nature of clinical work, displaying homogeneity of variance. All other variables were non-significant for Levene's test. Results of the *t*-test indicated that across socio-organisational factors, there was a difference in means for communication and training. All other factors showed no difference in means and were not significant. Training had a significant difference in means with a medium to large effect size between the 30 hardware and 33 software participants. Additionally, communication had a significant difference in means between hardware and software, with a large effect size. Results Suggest that participants perceived that training and communication are more important for hardware than software when determining if healthcare professionals use novel HCT.

Table 12

T-test Analysis Results Summary of Importance Questions Split By Hardware and Software

Factors	Group	*N*	*M*	*SD*	*SE*	*t*	df	Cohen's *d*	*p*
DESOR	Software	33	2.72	0.81	.14	-.8	61	.2	.424
	Hardware	30	2.9	0.97	.18		61		
NOCW	Software	33	4.55	0.66	.12	.07	61	.05	.949
	Hardware	30	4.53	0.82	.15		61		
Culture	Software	33	4.03	0.81	.14	-.3	61	.07	.171
	Hardware	30	4.1	0.99	.18		61		
Communication	Software	33	3.85	0.8	.14	-3.2	61	.8	.002
	Hardware	30	4.47	0.73	.13		61		
Training	Software	33	4.07	0.62	.11	-2.84	61	.72	.006
	Hardware	30	4.5	0.57	.11		61		

Study 2 Discussion

This study investigated two research questions, "What are the factors important for healthcare technology adoption?" and "What is the relationship between socio-organisational factors and HCT adoption?". In this section I will discuss the findings from each analysis separately, how each of the results relate to the literature reviewed and wider research, and what conclusions might be drawn. Then I will discuss the findings across each analysis in the same way. Finally, a general discussion will follow this section to synthesise the results across both studies.

Research question 2: What are the socio-organisational factors important for HCT adoption?

To answer the first research question, simple descriptive analyses uncovered which socio-organisational factors clinicians found most important, which factors were least important, and whether clinicians varied in their answers. The results showed that patient outcomes were the most important enabler of whether clinicians used a novel piece of technology. This is unsurprising considering that is clinicians' primary role – to improve the health of their patients. This finding is supported by the literature, whereby many studies have examined how improving patient outcomes improves HCT adoption (Wald et al., 2010; Neumann et al., 2011; Eklind, 2017) and that a lack of evidence that HCT improves patient outcomes is a barrier for adoption and diffusion (Sublet et al., 2011; Hughes et al., 2014; Salzmann et al., 2017).

The two least important enablers for determining clinician technology use were being involved in the development and selection of the technology. This was surprising considering the research suggesting that being involved in the development and selection of technology was important for technology adoption, giving clinicians a sense of ownership (Paré et al., 2006; Gagné, 2000; Fuchs & Prouska, 2014). It is plausible that clinicians fail to perceive the

positive downstream effects of their involvement in technology development and selection. Their perspectives may be confined to issues with the final product, possibly overlooking opportunities for improvement through collaborative clinician input. Another explanation for this finding is that a mindset of “designing is for experts” may be prevalent among clinicians, who reside within that paradigm (Sanders & Stappers, 2008). Their profession has a great number of different specialists and experts in many areas except design. Therefore, clinicians may not feel comfortable or qualified to engage with co-designing technology.

Additionally, healthcare professionals have been found to struggle with oscillating between their expert or decision-maker roles and collaborative partnerships demanded by the co-design process (Donetto et al., 2015). Therefore, as the design process goes on, their decision-making power may decrease, and in turn, decrease their interest casting the importance of such endeavours into doubt. Furthermore, the observed outcomes may be attributed, in part, to the formulation of the survey questions. For instance, had the inquiry focused on whether clinicians in general, not necessarily the respondents themselves, were engaged in the developmental and selection processes of the technology, the responses might have exhibited a more affirmed response.

Another surprising finding is that clinicians did not find patients or whānau liking the technology to be important when considering using new technology. Research suggested that these factors, especially patients preferring the technology, were impactful on HCT adoption (De Veer et al., 2011; Mileski et al., 2017). Moreover, these items had the two highest standard deviations, suggesting that opinions varied amongst clinicians. Given the substantial importance that healthcare professionals place on patient outcomes, it stands to reason that clinicians prioritise the health outcomes derived from the technology over patients' subjective approval of the tool itself.

Research question 3: What is the relationship between perceived importance of socio-organisational factors and HCT adoption?

To answer research question three, one multiple regression with socio-organisational factors predicting clinician perspectives was performed. Additionally, one hierarchical regression looking at whether socio-organisational factors predicted successful adoption while controlling for technology characteristics and clinician perspectives was performed. The results of the multiple regression (socio-organisational factors predicting clinician perspectives) suggest that DESOR moderately predicts clinician perspectives. We composed the construct (DESOR) of items pertaining to involvement in development and selection, and perceptions of importance about whether patients and whānau like the technology. Therefore, these results highlight the importance of the role patients and whānau have in shaping clinician perspectives about novel HCT. Moreover, it suggests that being involved in the development and selection of novel HCT can have a significant impact on the anxiety clinicians may feel when grappling with new technology. Interestingly, this finding contradicts the previous finding in RQ2; that clinicians do not perceive being involved in the development nor selection of HCT to be an important determinant of use. This paradox gives credence to the argument that a "designing is for experts" mindset might exist among healthcare professionals (Sanders & Stappers, 2008; Donetto et al., 2015). On the one hand, clinicians do not think that being involved in development and selection is important for using technology, however, technology related anxiety might be a consequence of not being involved. There is no current literature that examines this tension and is a prospective avenue for future research.

The hierarchical regression outcomes suggest that all the socio-organisational factors pinpointed in Study 1 do not reliably the successful adoption of HCT. However, taken as a whole, including socio-organisational factors increased the model's predictive power. Initially, the characteristics of the technology itself only explained a moderate amount of

variance in the successful adoption of HCT, highlighting that technological attributes alone might not adequately predict adoption success. Given that ease of use is a critical component in the literature on technology acceptance and has been identified as a significant determinant of technology adoption and usage in healthcare contexts (Kijsanayotin et al., 2009; Liu et al., 2015; De Veer et al., 2015), and was the measure used to define technology characteristics in this study, one might expect these characteristics to offer higher predictive value for successful technology adoption. This expectation, combined with the noticeable impact of DESOR on the model, allows us to conclude that both technology characteristics and socio-organisational factors are crucial for the success of technology adoption. Literature supports that user acceptance is greatly influenced by perceived usefulness and ease of use (Davis, 1989). By involving healthcare professionals in the technology selection and development phase (represented by DESOR), not only can the ease of use of the technology be significantly enhanced, but it can also amplify their sense of ownership (Paré et al., 2006; Gagné, 2000; Fuchs & Prouska, 2014), likely leading to positive technology perceptions among clinicians.

Post-hoc analysis

The results of the post-hoc analysis *t*-test indicated that there were marked differences in the way clinicians thought about software versus hardware. The two stand-out factors were communication and training. Communication was operationalized with one item: *"There is effective communication about the technology roll-out."*. Understanding how it was operationalized, clinicians perceive that communication about the roll-out of technology is one of the most important enablers of technology adoption as it rivalled the NOCW. Communication of software and health information technology systems has received great attention from researchers. There are studies looking at raising software awareness (Grimson, et al., 2000; Mun et al., 2017), enhancing education for software (Wensing et al., 2019), and

as discussed in the literature review, most of the research examining technology adoption is focused on HIT. Paradoxically, these systems tend to be the medium through which new technology is communicated. Nevertheless, it seems the communication surrounding hardware is being neglected in the literature and clinical contexts as HPs find it more important for determining use. It is plausible that HIT receives more attention because it tends to affect ways of working, organisation-wide when implemented. However, these results show that for HPs to consider using a piece of technology, the need for communication about the roll-out of hardware is greater than for software.

Training was operationalized using three items; *"The training to use the technology is effective.", "There is sufficient time to learn how to use the technology."*, and *"There is sufficient time to integrate technology into work processes."*. In general, training for healthcare technology implementation is among the highest demands from physicians (Ruiz et al., 2017). However, the results provided a more nuanced view. Training received a much higher mean rating for hardware than it did for software. These differences in perceptions might be due to the inherent complexity of new hardware devices when compared with software applications. Nielsen's 10 usability heuristics is a widely popular approach to designing software and websites (Nielsen, 1994; Gonzalez-Holland, 1994). Part of this approach is understanding that when designing software, it is beneficial to avoid re-inventing the wheel. Or in other words, to stick with conventional design aspects. This creates software that feels familiar to the user, decreasing the time needed to learn how to use it (Abulfaraj & Steele, 2020). I argue that HPs do not need as much training for HIT because of this phenomenon, HPs are already familiar with how the previous system worked, and if there are new features, they have likely used software with those features before. Hardware does not necessarily have this feature. Various buttons, screens, alerts, parts, and noises may confuse HPs if they have not seen the device before. Moreover, HPs are likely aware of the serious

outcomes if an error occurs with hardware technology (Ward & Clarkson, 2004), likely increasing their proclivity and desire for training.

General Discussion

The current research demonstrates that socio-organisational factors significantly influence the success of technological innovations in healthcare organisations, clinician perspectives towards HCT, and ultimately the adoption of HCT. Throughout the research, several common threads emerged. Notably, the influence of relational dynamics on adoption outcomes is considerable. The success of HCT adoption is, to a significant extent, shaped by the nature of the relationships among individuals participating in HCT implementation. These relationships can either facilitate or hinder the adoption process depending on the quality and nature of the relationship. There is a paucity of research on this topic and deserves attention from scholars. Moreover, it has been observed that healthcare professionals universally aspire for HCT to enhance patient outcomes highlighting the critical role of positive interactions between patients and clinicians, as well as between HCT developers and clinicians. These dynamics significantly affect clinicians' perceptions of HCT and, ultimately, the success of organisational HCT adoption. We have also seen that a nuanced and tailored approach to implementing HCT may be required stemming from the differing views on training and communication depending on technology modality.

The four C's of adoption (conflict, communication, co-design, and culture)

In this section, I will discuss the findings across both studies by comparing and synthesizing the results of the present research. This section will also include practical implications of these findings where appropriate which will be followed by a section on scholarly implications.

Developers, decision-makers, and healthcare organisations need to consider the social and organisational aspects of the context in which HCT is being introduced. What we see in the results suggests that socio-organisational factors predict successful adoption of HCT over and above the technologies' characteristics. This means that when implementing a device or software, healthcare organisations need to consider conflict and relationship management, engage in effective communication, support co-design and collaborative work, and foster a culture of accountability.

Conflict

Conflict management can change potential barriers into antecedents of successful adoption. Addressing and navigating potential relationship conflicts may be difficult, however, harnessing these diverse perspectives and goals can contribute to a more comprehensive adoption process. This phenomenon holds weight due to the profound impact of fostering positive relationships between teams and individuals endeavouring to introduce technology into a particular healthcare institution. A healthcare organisation does not reside within a vacuum, it is a system, influenced by myriad individuals and groups inside and outside of the organisation often holding conflicting values, assumptions, thresholds of evidence, and aspirations (Milewa, 2006). While conflict within relationships emerged as a significant barrier in Study 1, the positive correlation between DESOR and successful adoption in Study 2 suggests that when managed well, relationships can also facilitate successful HCT adoption. This phenomenon underscores the importance of fostering positive dynamics between teams and individuals, especially in the context of introducing HCT.

Therefore, the struggle for a will to power emerges regarding HCT adoption especially considering the limited resources available to innovators and implementors. Moreover, a shift in trust from traditional hierarchical assumed trust (i.e., I trust you because you are my superior) has diminished in healthcare contexts trending toward a conditional

trust, one that is earned through honesty, reliability, competence, and shared values and agendas (Calnan & Rowe, 2008). As a result, a process of negotiation, collaboration, and partnership with stakeholders is required to improve the chances of HCT adoption success (Ven de Ven, 2005; Nielsen & Mengiste, 2014). Moreover, technology researchers and developers tend to pay less attention to social and political skills in favour of technical competence (Ven de Ven, 2005). A focus on social and political skills is an avenue of development and improvement for healthcare technology producers, diffusers, and innovators. Social skills are characterized as the capacity to discern the underlying emotions, motivations, and behaviours of individuals within one's group and effectively influence or persuade them (Ferris et al., 2001). As such, leaders, innovators, and developers should understand how clinicians may react emotionally to novel HCT, what may motivate them when presented with it, and how they may act in the face of it. To ascertain this information, open, honest, and respectful communication is key.

Communication

Engaging in effective communication is a clear cornerstone of adoption, observed across the present research. Ensuring clear, consistent, and targeted information is provided with the additional importance of customizing messages tailored to specific modalities of technology (e.g., hardware and software) emerged as a cornerstone of successful adoption.

This thread underscores the pivotal role of communication in HCT adoption. The interplay of continuous learning, transparency, and accountability, facilitated by leadership, forms the backbone of an environment where clinicians can gain insights from technological errors. Transparency, a standalone factor, and an integral part of accountability and learning culture, serves as a linchpin for effective technology implementation. However, balancing clarity and frequency in communication proves challenging amid organisational complexities.

Moreover, feedback mechanisms, attuned to clinician needs, prove ostensibly instrumental in enhancing technology uptake and mitigating communication barriers.

There are various ways through which organisations can support effective communication. Fattal and Lehoux (2008) found that in reporting healthcare technology assessments, the results of assessments should consider 'lay' organisations, groups, and individuals to help broaden the conversation surrounding assessments of novel HCT. Study 1 underscored the importance of getting information about novel technology to the right people, at the right time, through the right medium and Study 2 provided some nuance to this finding. Namely, that communication regarding hardware is more important than for software. If the logic of creating simple messages was introduced at the beginning of the implementation process, with a special focus on hardware innovations it may also help clinicians understand how a particular piece of technology works, how it helps, what it does, and what impact it may have on their roles (Belongia & Schwartz, 1998).

To help communication further, when multiple dissemination strategies are used, the likelihood of alignment between desired and actual clinician behaviour is increased (McCormack et al., 2013b). Therefore, using multiple communication channels ought to increase the chances of successful HCT adoption. However, as pointed out in the present, organisations should be cautious about imposing too much information on clinicians. There is a need to balance accurate, timely, and clear information. The findings also suggest that an opportunity to decrease information about new software and increase information about new hardware rollouts exists. Connectedly, these communication principles are aptly suited to the co-design process.

Co-design

Recognizing communication as a vital aspect of HCT adoption is insufficient on its own. Even with effective workplace communication among teams, and individuals, it becomes meaningless for the HCT adoption endeavour if not translated into a direct activity aimed at it. Co-design is an activity that should incorporate the communication strategies and principles outlined in the previous section to further enhance the likelihood of success of HCT adoption. From the results of the current research, we can see that co-design was critical to fitting the technology to the user-work environment. Although the importance ratings of involvement in HCT selection and development were low, DESOR reliably predicted technology-related anxiety and successful adoption. Therefore, co-design is critically important for the success of HCT adoption. However, the mixed findings from both studies suggest caution against assuming that all healthcare professionals equally value being part of the design process. There's a need for a more nuanced approach to involve clinicians, recognising their varied opinions and interest in adopting new healthcare technologies. Additionally, Noorbergen et al. (2021) conducted a thorough thematic analysis of mHealth co-design challenges, they found that selecting and engaging with people who understand the end-user context (e.g., first-hand experience) and the purpose of the HCT is critical for successful adoption. Noorbergen et al's. (2021) research and the findings from the present research suggest that clinicians should be incorporated within the design and implementation process as soon as possible.

However, engaging in co-design without ensuring everyone can participate may not create an equal partnership or improve health and care quality (Ni She & Harrison, 2021). This is why small or under-resourced healthcare organisations may struggle with the process or notion of co-design and possibly why we see involvement in selection and development in low repute. Engaging in co-design, which requires continuous discussions and consideration

to tackle power imbalances, becomes challenging in the absence of sufficient resources, focus on implementation, and support from senior leaders (Ni She & Harrison, 2021). Therefore, a culture of support and consideration, championed by leadership is crucial for the success of HCT adoption.

Culture

As stated in the literature review, culture can be a difficult thing to define. Yet it is one of the most important factors for an organisation's ability to innovate because it permeates the entire organisation. The culmination of overcoming conflict within a particular healthcare organisation through effective communication, applied to co-design will likely have a lasting effect on an organisation's ability to adopt HCT effectively. This thread underscores the pivotal role of culture in HCT adoption. The interplay of continuous learning, transparency, and accountability, facilitated by leadership, forms the backbone of an environment where clinicians can gain insights from technological errors. Some scholars argue that culture impacts clinician accountability (e.g., Wachter, 2012). However, I argue that there is a dynamic, a two-way street, i.e., observed accountability affects the culture and the culture affects clinician accountability. As such, the introduction of the four C's of adoption can influence the grounds of a culture of a healthcare organisation to foster more effective relationships regarding HCT implementation and adoption.

Scholarly Implications

A nuanced approach to HCT adoption is needed more broadly. In the literature review, I argued for the expansion of current frameworks that were too narrowly focused on usability aspects. The results of this thesis provide evidence of the need to broaden HCT adoption research to include socio-organisational factors. Doing so will likely beget a greater understanding of the HCT adoption context and its barriers and enablers to support effective

adoption and innovation efforts. Moreover, some of the Tech-ISM framework's (Wong et al., 2021) claims have been substantiated from the results of the present research. For example, its *socialising* aspect; the prioritisation of the co-development of technology, effective communication, and workload accommodations in the pursuit of greater adoption is given credence. Moreover, Tech-ISM's *identifying* aspect; identifying key relationships to foster greater adoption is also supported by the present research.

Limitations and Future Research Considerations

As with all research, some study limitations warrant noting. Study 1 faces four primary limitations. First, the small sample size of only eight participants limits the generalizability of the findings to the broader clinician population. This limitation is further compounded by the fact that most participants occupy leadership positions, with a few in process management roles, potentially introducing selection bias that could influence the thematic analysis. Second, while the depth of analysis provided valuable insights, its scope was restricted to these eight participants, likely missing a broader spectrum of barriers and enablers to technology adoption. Additionally, as noted in the first author's reflection on Study 1, potential subjectivity due to the author's relationships with healthcare professionals might have affected the outcomes. Despite efforts to maintain impartiality, the impact of these relationships on the findings cannot be entirely discounted. Furthermore, as health systems can vary greatly between different countries, the data from Study 1 is entirely from New Zealand potentially limiting the conclusions.

Study 2 shares several limitations with Study 1, particularly in terms of its sample size and sampling method. While the sample size was deemed sufficient for the conducted analyses, it was cuspal in terms of providing adequate statistical power. This is especially true of the *t*-test conducted which only had 63 participants. Future research should consider

increasing the sample size of these analyses to discover if the effects are repeatable. The use of snowball and convenience sampling restricts the study to individuals within a limited network, possibly introducing bias and potentially affecting the generalizability of the results. The problems with internal consistency and the decision to use single items as measures of socio-organisational factors may also fail to capture the entirety of the constructs in question (i.e., Tech characteristics, NOCW, Culture, Communication, Clinician perspectives, and Successful adoption). However, successful adoption and communication had very high face validity and the single-item methodology was practical for this research. Nevertheless, these single-item measures could affect the reliability and validity of the findings and combining single and multiple-item constructs may have complicated the data and analyses. Therefore, future research should look at performing a factor analysis on items related to the socio-organisational constructs explored in this thesis to ascertain a more comprehensive understanding of the constructs. Furthermore, as a cross-sectional study, the data only captures one-time point. Therefore, any conclusions regarding causal relationships should demand caution. Moreover, the survey methodology of self-report measures may have introduced social desirability bias. However, this is doubtful due to the survey being independent of any healthcare organisation and participants completing it at their leisure.

Future research should take these limitations into account. Researchers should aim to increase the participant count of both thematic and quantitative analyses performed in the current research. Moreover, a deeper look into the attitudinal differences between hardware and software may provide further insights into how best to approach HCT adoption. This dichotomy could provide effective moderation or mediation effects on quantitative analyses. Moreover, the construct; DESOR warrants a closer look and could be integrated into existing frameworks (e.g., UTAUT, TAM, etc.) regarding HCT adoption as it presents itself as a significant predictor.

Conclusion

The exploration of socio-organisational factors in relation to HCT adoption has uncovered the significant influence of these factors on HCT adoption. Namely, we have observed that the current frameworks for examining HCT adoption lack a focus on the social and organisational aspects of technology adoption. This thesis provides the grounds and reason for future research to explore socio-organisational factors when researching HCT adoption. Moreover, it also provides a viewpoint from which practitioners can understand how socio-organisational factors could influence technology innovation attempts and how best to mitigate the barriers to that endeavour.

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Appendix A: Ethics Amendment Approval

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN RESEARCH ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2020/47 Amendment 2

29 July 2022

Sanna Malinen
Management, Marketing and Entrepreneurship
UNIVERSITY OF CANTERBURY

Dear Sanna

Thank you for your request for an amendment to your research proposal "Balancing Job Demands and Resources for Healthcare Employees" as outlined in your email dated 21st July 2022.

I am pleased to advise that this request has been considered and approved by the Human Research Ethics Committee.

Yours sincerely

Dr Dean Sutherland
Chair, Human Research Ethics Committee

Appendix B: Study 1 Interview Information Letter

Interview information letter

Department of Management, Marketing, and Entrepreneurship

University of Canterbury Business School Email: sanna.malinen@canterbury.ac.nz; katharina.naswall@canterbury.ac.nz; jennifer.wong@canterbury.ac.nz; fleur.pawsey@canterbury.ac.nz; geoff.chase@canterbury.ac.nz

Date:

HEC Ref: 2020/47

Balancing job demands and resources for healthcare employees

Information Letter

We are organisational researchers from the University of Canterbury working on understanding the demands and resources in medical professions, particularly around technology-worker interface. We are partnering with Professor Geoff Chase from the University of Canterbury to explore the challenges and enablers for implementing new technology in healthcare workplaces.

We invite you, as a clinical director/chief or a senior clinical staff, to participate in an interview to share your experiences with introducing new medical technology at your hospital. We will be asking you questions about your specific hospital context (e.g., staffing resources) and perceptions around technology uptake (e.g., who are the key decision-makers and influencers?).

If you choose to participate, your involvement will be to take part in a 30-45 min-long interview conducted over Zoom at a time that is convenient for you. Please note that we will treat the information you provide with the strictest confidence. You will be asked if the interview's audio can be recorded so the research team can review it at a later time. You will have the opportunity to request a transcript of your interview so you can review and redact information from our analyses. If you do not want the interview to be recorded, the interviewer will take notes by hand instead.

The results of the project may be published, but presentation of the findings will include only aggregated information across job roles (i.e., overall themes that emerged from all discussions).

Your participation is voluntary and you may withdraw at any time without penalty. If you want to withdrawal during the interview, you may ask the interviewer to stop. You can provide your email to the researcher for an opportunity to review the final themes from this research.

Only the research team will have access to the recordings and data. The recordings and data will be stored on password-locked computers at the University of Canterbury.

Because of the topic of demands at work, some of the questions may concern sensitive issues, and there may be a risk of causing emotional distress. If you experience distress while participating, you should stop participating and notify one of the researchers, or contact your local community support services or your general practitioner for support.

Please indicate on the consent form if you would like to receive a summary of the results of the research project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Research Team:

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Appendix C: Study 1 Informed Consent

Interview informed consent

Department of Management, Marketing, and Entrepreneurship

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Date:

HEC Ref: 2020/47

Balancing job demands and resources for healthcare employees

Informed Consent

□ I have been given a full explanation of this project and have had the opportunity to ask questions.

□ I understand what is required of me if I agree to take part in the research.

□ I understand that participation is voluntary and I may withdraw from the study at any time without consequences. Withdrawal of participation can also include the withdrawal of any information the researcher have recorded should this remain practically achievable.

□ I understand that any information or opinions I provide will be kept confidential to the research team and that any published or reported results will not identify the participants nor specific responses.

□ I understand that all data collected for the study will be de-identified, and kept in locked and secure facilities and/or in password protected electronic form.

□ I understand that I can request a transcript of my interview for review, and can redact information from the analyses by contacting the research team.

□ I understand that I am able to receive a report on the findings of the study by providing my email address below.

□ I understand that I can contact the researcher Jake Watson (jake.watson@pg.canterbury.ac.nz), Dr. Sanna Malinen (sanna.malinen@canterbury.ac.nz), Dr. Katharina Näswall (katharina.naswall@canterbury.ac.nz), Dr. Jennifer Wong (jennifer.wong@canterbury.ac.nz), Dr. Fleur Pawsey (fleur.pawsey@canterbury.ac.nz), or Dr. Geoff Chase (geoff.chase@canterbury.ac.nz).

If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee once the human ethics approval is completed (human-ethics@canterbury.ac.nz)

□ I agree for this interview's audio to be recorded.

□ By signing below, I agree to participate in this research project.

Name: Signed:

Date:

Email address:

(optional; for receiving a report of findings and/or reviewing the final themes. Please underline which you prefer)

Appendix D: Study 1 Interview Structure

Project Overview and Informed Consent

- Introduction to the project, its objectives, and the importance of participant consent.
- Ask the participant for permission to record the interview.
- Walk through the process for collecting signed informed consent or recording verbal consent.

Part 1: Hospital Context, Staffing, and Resourcing

- Can you describe your role, tenure, and any managerial responsibilities at the hospital?
- What is the nurse-to-bed ratio in your hospital?
- Could you provide an overview of the population and area served by the hospital, including beds per population and typical occupancy rates?
- How would you describe the demographics of the area the hospital services?
- Is your hospital considered tertiary or county level, and what are the general attitudes toward public health and the status of doctors in your region, including any political or financial pressures?

Part 2: Technology Uptake Barriers and Enablers

- Can you reflect on a time when new technology was introduced in your workplace?
- What was the nature of the technology?
- How was the technology introduced to the workplace?
- What were the initial reactions to the technology?
- Can you discuss any barriers and enablers to technology uptake, both system and person related?

- What has been the impact of the new technology on professional practice and decision-making?

Part 3: Organisational Practices and Culture Around Innovation

- Can you explore general barriers and enablers to technology adoption in your organization, including decision-making processes for new technology introduction?
- Who are typically involved in the decision-making for new technology, and what are the key steps and duration for implementation?
- How would you describe your team's structure, culture, and attitude towards innovation and risk associated with technology developments?
- Can you discuss the level of openness, learning culture, psychological safety, and confidence in handling new technology within your team?
- What does successful technology uptake look and feel like in your organization?

Conclusion

- Expression of gratitude for the participant's time.
- Inquiry if they know anyone interested in being interviewed and request to pass on the advert blurb and contact information.

Appendix E: Study 2 Information Letter and Consent

Kia ora,

We are a group of organisational and engineering researchers from the University of Canterbury, Christchurch (NZ), exploring healthcare personnel's attitudes toward medical technology adoption, used for clinical diagnosis, monitoring, and treatment. We aim to understand some of the challenges that come with introducing new medical technology in healthcare.

We would like to invite healthcare leadership and staff to take part in a survey, taking ~5 mins to complete. Your participation is voluntary and you may withdraw at any time without penalty. You can withdraw simply by closing your browser.

The survey is completely anonymous and your responses cannot be linked back to you. The results of the project may be published, but presentation of the findings will include only aggregated information. The data will be stored on password-protected computers at the University of Canterbury, and only the research team will have access to the data.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee (REF 2020/47), and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Thank you very much for your contribution.

If you agree to participate, please click the arrow below to start the survey. By clicking this, you acknowledge that you have read the above information and consent to taking part in the survey.

Please feel free to contact any member for the research team for more information.

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Appendix F: Study 2 Survey Poster

Appendix G: Study 2 Survey Materials

Importance Questions

Preface	Item
Please rate how important these factors are in determining whether or not you use new medical technology:	1. The technology meets my user needs. 2. The technology makes my job easier. 3. The technology improves my patients' outcomes. 4. The technology is easy to use. 5. I was involved in the development of the technology. 6. The training to use the technology is effective. 7. There is sufficient time to learn how to use the technology. 8. There is effective communication about the technology roll-out. 9. My supervisors consistently support the use of the technology. 10. My patients like the technology. 11. The technology is cost-effective. 12. The technology is physically accessible in the workplace. 13. My patients' whānau like the technology. 14. The technology provides valuable patient data. 15. My team preferred I use the technology rather than the old system/equipment. 16. There is sufficient time to integrate technology into work processes. 17. I was involved in the selection of the technology. 18. There is enough availability of the technology for all users.

Workplace Environment Items

Thinking of your current work team in general (refer to the one team that you mostly interact with):	1. We are united in trying to reach our goals for performance. 2. We all take responsibility for any poor performance. 3. I can bring up concerns with my team.
Thinking about your manager/director in general (refers to the leader you mostly interact with), how often do they:	4. Explain rules and expectations to my work group. 5. Lead by example. 6. Show openness to new ideas. 7. Notice when I put effort into my work.
Thinking of your current organisation in general:	8. My organisation is orientated towards investing in innovations. 9. My organisation has been successful in implementing new technologies.
No preface	10. There are tasks associated with new technologies that I could not do well. 11. I feel I can handle the new technologies with ease. 12. I feel anxious when I work with new technologies.

Demographic Questions

What is your age in years?
What is your gender
- Female
- Male
- Another gender
- Prefer not to say

What is your current job title?
How long have you worked in your current role?
How long have you worked in healthcare?
What particular piece of technology were you thinking of when completing these ratings?