

Exploring stroke survivors' experiences and perspectives of mHealth applications to inform guidelines for good UX design

Soheila Mohammadyari

A thesis submitted to

Auckland University of Technology

in fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD)

2022

Design and Creative Technologies Faculty

School of Engineering, Computer, and Mathematical Sciences

Dedication

This is my honour to dedicate this thesis to my beloved mother; Mrs. Tahereh Samefouroghi, who was my utmost supporter who nonetheless passed away last year. This was my impetus to explore stroke and to find a way to support stroke survivors in managing well with their conditions, improving health outcomes, and better quality of life to empower them to live with dignity.

Soheila Mohammadyari

Attestation of authorship

“I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements) nor material which, to a substantial extent, has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.”

Soheila Mohammadyari

2022

Acknowledgements

“What you seek, is seeking you”.

Rumi

To me, this quote is imbued with a sense of trust and belief that the things I am seeking are meant for me and in time will find their way to me. Thus, a key part of living by the principle is trusting the process, which, in this generation of instant gratification, is no easy achievement.

I write this thesis in remembrance of my mother who passed away when I was writing it up. I would lovingly like to thank mum for always being there for me. Mum: Even after you are gone, I feel your presence. You always supported me no matter what. You sacrificed your life for your children. I went through this journey for you, you always wanted me to follow my dreams. My dreams were to make you happy and proud of me.

I would like to acknowledge and thank individuals who have supported me along the way of this journey. I would like to give my sincere thanks to all. I would firstly like to express my heartfelt thanks to my supervisory team, without whom I would not have had the confidence to complete this study; *Dr. Robert Wellington*: for all of the time and patience he devoted to supporting and encouraging me to think critically. His support was endless, and also for enlightening me during the entire process of my PhD. His faith in me has been tremendous. Thank you for guidance and supporting me at my critical times and for empowering me to realise my potential. *Professor Nicola Kayes*: for her guidance, patience and constructive comments throughout my PhD journey were invaluable. She is an outstanding supervisor, always offering a flawless combination of academic freedom and direction. Her passion to learn, research and service is admirable. I was influenced and inspired by her personality; she has a BIG HEART. To me, YOU both are role models, when I do supervise PhD students in the future, I would like to be like YOU. Each of you taught me how to achieve academic performance to the best but in different ways. You taught me more than I ever imagined learning about being academic.

I would like to acknowledge and express my heartfelt thanks to individuals who generously devoted their time to taking part in this inquiry to support my research; health care professionals, app designers, and especially stroke survivors who enthusiastically wanted to make a big difference. I express my sincere thanks to all who have contributed their invaluable perspectives and experiences, which resulted in the development of the proposed guidelines in this inquiry. If anybody was ever under the illusion that survivors of stroke are not active contributors in their social lives, they need to meet you guys. I honestly did not expect to have stroke survivors actively take part due to their health issues, but you did. That was my honour to carry out this research with your contributions.

This inquiry could not have been accomplished without the huge support from Stroke Foundation NZ and TalkLink Trust in the recruitment of potential participants. I would like to thank Lorna Crawford from Stroke Foundation NZ and Ann Smaill - CEO of TalkLink Trust for helping me to recruit passionate participants. I also would like to sincerely thank all stroke survivors for their help in the recruitment process and for introducing other potential survivors to contribute to this study.

I would like to especially thank my mum's health care professional team and I also would like to thank the staff who worked in the ward where mum was admitted, for their support and help in this research.

I am grateful to my sister and brother for their endless support. I know how challenging the journey has been for you after mum's stroke, especially during that first very tough year and I continue to be awed by your resilience. You are my rocks, I am so proud of the thoughtful, caring person that you are. I am so grateful to have you in my life.

I am grateful to have my friends and my colleagues throughout this process who have continuously encouraged me when I was uncertain about what to do and generously supported me during difficult times I have been through. I am privileged to have you as my friends and colleagues.

Special thanks go to Barry Dowdeswell who generously proofread my work. His support was endless. he always tried to motivate me during this journey. I cannot thank him enough. I am very lucky to have him as my friend and colleague.

I would like to thank individuals from my personal and professional network who kindly assisted me to find potential participants. Special thanks to the IT department and staff who are working at the University of Auckland and AUT, in particular the altLAB centre, for their assistance and the summer research scholarship I was awarded.

Last but not least, my PhD journey was funded by MedTech CoRE. This funding has contributed meaningfully to my growth and development as a health-related technology researcher and educator. Without this support, this inquiry could not have been completed. And for this support, I am very grateful.

Table of contents

Dedication	i
Attestation of authorship	ii
Acknowledgements	iii
Table of contents	vi
List of figures	xv
List of tables	xvii
List of abbreviations	xviii
Abstract	xix
Chapter 1: Introduction	1
1.1 The inquiry in context	1
1.2 Positioning the researcher as an insider	5
1.3 How the inquiry was situated	7
1.4 Terminology	8
1.5 Research questions and aims.....	9
1.6 Inquiry approach and cycles	9
1.7 Structure of this PhD inquiry.....	11
Chapter 2: Literature Review	15
2.1 Overview of this chapter	15
2.2 The epidemiology of stroke and its burden	16
2.2.1 Overview and aims of recovery in stroke	18
2.3 Self-management	20
2.3.1 Self-management definitions.....	21
2.3.2 An outline of the implementation of self-management.....	23
2.3.3 Significance of self-management to survivors.....	24
2.4 Mobile health (mHealth) technology as an opportunity	26
2.4.1 mHealth technologies for stroke self-management	28

2.4.2	Potential for mHealth applications considering user experience (UX) in the context of human-computer interaction (HCI)	32
2.4.3	Factors that are associated with UX of mHealth applications.....	34
2.4.3.1	The design of mHealth applications.....	35
2.4.3.2	Post-stroke complications that affect usage	39
2.4.3.3	mHealth applications acceptance	41
2.4.3.4	Social support.....	42
2.4.4	The primary aim of this PhD work	43
2.5	Conclusion	45
Chapter 3:	Philosophical Stances and Methodology	47
3.1	Introduction	47
3.2	Epistemological foundations for this PhD inquiry.....	49
3.3	The theoretical stances that underpin this inquiry.....	52
3.4	Methodological considerations of this inquiry	55
3.5	Introduction to action research – the origins	57
3.6	Action research model adopted in this inquiry.....	61
3.7	Different forms of action research used in this inquiry	63
3.7.1	Critical action research (CAR).....	64
3.7.2	Practical action research (PAR)	66
3.7.3	Insider action research (IAR).....	68
3.8	Characteristics of practical knowing in the context of quality and rigour.....	69
3.8.1	Everyday concerns	70
3.8.2	Socially derived knowledge.....	72
3.8.3	Unique situation awareness	73
3.8.4	Ethically driven knowledge	74
3.9	Summary	76
Chapter 4:	Cycles and Methods	77
4.1	Introduction	77
4.2	Pre-step phase: Context and purpose of this doctoral work.....	78

4.3	Cycle one: Initial consultations: Exploring the perspective of participants on the acceptance and use of mHealth applications.....	81
4.3.1	Phase one – Constructing and planning actions.....	81
4.3.2	Phase two – Taking actions.....	81
4.3.2.1	Sampling.....	82
4.3.2.2	Recruitment processes.....	83
4.3.2.2.1	Survivors and HCPs.....	83
4.3.2.2.2	App designers.....	85
4.3.2.3	Sample size.....	86
4.3.2.4	Data collection.....	88
4.3.2.4.1	Focus group interviews with app designers and HCPs.....	89
4.3.2.4.2	Follow up individual interviews with app designers and HCPs.....	96
4.3.2.4.3	Individual interviews with survivors.....	98
4.3.3	Phase three – Evaluating actions.....	102
4.4	Cycle two: Enrichment and further development of cycle 1 themes: Exploring the perspective of participants towards the usefulness of the draft guidelines.....	102
4.4.1	Phase one – Constructing and planning actions.....	102
4.4.2	Phase two – Taking actions.....	103
4.4.2.1	Sample size and participants.....	103
4.4.2.2	Data collection.....	103
4.4.2.2.1	Individual interviews.....	103
4.4.3	Phase three – Evaluating actions.....	105
4.5	Cycle three: Refinement of the proposed guidelines: Evaluation of the proposed guidelines using ACCESS.....	105
4.5.1	Phase one – Constructing and planning actions.....	105
4.5.2	Phase two – Taking actions.....	106
4.5.2.1	Development of software-based prototype.....	106
4.5.2.2	Sample size and participants.....	107
4.5.2.3	Data collection.....	108
4.5.2.3.1	Individual interviews.....	108

4.5.3	Phase three – Evaluating actions	109
4.6	An action inquiry is valued and ethical	109
4.6.1	Ethical action inquiry in context	110
4.7	Trustworthiness of this PhD work.....	112
4.8	Summary	114
Chapter 5:	Data Analysis.....	115
5.1	Introduction	115
5.2	Pre-step phase: Context and purpose	115
5.3	Cycle one: Phase three – evaluating actions.....	115
5.3.1	Data familiarisation	117
5.3.2	Initial code generation	119
5.3.3	Initial themes proposition – categories	125
5.3.4	Theme review and refinement	127
5.3.5	Theme definition – key themes	129
5.3.6	Report production.....	130
5.4	Cycle two: Phase three – Evaluating actions	130
5.4.1	Data familiarisation	131
5.4.2	Initial code generation	132
5.4.3	Initial themes proposition – categories	134
5.4.4	Theme review and refinement	134
5.4.5	Theme definition – key themes	135
5.4.6	Report production.....	136
5.5	Cycle three: Phase three – Evaluating actions.....	136
5.5.1	Data familiarisation	136
5.5.2	Initial code generation	136
5.5.3	Initial themes proposition – categories	136
5.5.4	Theme review and refinement	137
5.5.5	Theme definition – key themes	137
5.5.6	Report production.....	138
Chapter 6:	Findings.....	139

6.1	Introduction	139
6.2	Cycle one – Initial consultations: Exploring the perspective of participants on the use of mHealth applications by survivors.....	141
6.2.1	Participant characteristics.....	141
6.2.2	Findings from stroke survivors.....	143
6.2.2.1	Theme 1: Qualities promoting acceptance of mHealth - desired applications	145
6.2.2.1.1	Connecting – An application that facilitates socialising and provides an opportunity to connect to other survivors	145
6.2.2.1.2	Reminding – An application that assists survivors with remembering daily life activities.....	147
6.2.2.1.3	Monitoring – An application that monitors survivors’ progress.....	148
6.2.2.1.4	Being informed – An application that facilitates access to stroke-related information	149
6.2.2.2	Theme 2: Post-stroke capability of survivors.....	150
6.2.2.2.1	Physical	150
6.2.2.2.2	Emotional	151
6.2.2.2.3	Psychological	152
6.2.2.2.4	Medical	153
6.2.2.3	Theme 3: Qualities influencing survivors' possibilities for access to mHealth applications	154
6.2.2.3.1	Digital literacy.....	154
6.2.2.3.2	Social support.....	155
6.2.2.3.3	Technological support.....	156
6.2.2.3.4	Language barriers.....	157
6.2.2.3.5	Affordability.....	157
6.2.3	Findings from app designers	158
6.2.3.1	Finding 1 – Post-stroke capability of survivors	158
6.2.3.2	Finding 2 – Design of interface.....	159
6.2.3.3	Finding 3 – Affordability	163
6.2.4	Findings from HCPs	164

6.2.4.1	Finding 1 – Post-stroke capability of survivors	164
6.2.4.2	Finding 2 – Engagement.....	165
6.2.4.3	Finding 3 – Motivation	166
6.3	Cycle two – Enrichment and further development of cycle 1 themes: Exploring the perspective of participants towards the usefulness of the draft guidelines	167
6.3.1	Participant characteristics.....	167
6.3.2	Findings from stroke survivors.....	168
6.3.3	Findings from app designer.....	168
6.3.3.1	Eye-tracking.....	169
6.3.3.2	Gamification	169
6.3.4	Findings from HCP	170
6.4	Cycle three – Refinement of proposed guidelines: Evaluation of proposed guidelines using ACCESS.....	170
6.4.1	Participant characteristics.....	171
6.4.2	Findings from stroke survivors.....	172
6.4.2.1	Font size	172
6.4.2.2	Colour	172
6.4.2.3	Customisation	173
6.4.2.4	Simplicity	173
6.4.2.5	Notifications	173
6.4.2.6	Eye-tracking feature.....	173
6.4.2.7	Reminder feature	174
6.4.3	Findings from app designer.....	174
6.4.3.1	Further findings.....	174
6.5	Summary	174
Chapter 7:	Practical Knowing and the Proposed Guidelines.....	176
7.1	Introduction	176
7.2	The process of guidelines development	176
7.3	Cycle one - Practical knowing and associated guidelines	180

7.3.1	Qualities promoting acceptance of mHealth - desired applications	181
7.3.1.1	Guideline #1: Social connection should be integrated into the design	181
7.3.2	Post-stroke capability of survivors.....	184
7.3.2.1	Guideline #2: Thumb zone	184
7.3.2.2	Guideline #3: Integrate a voice user interface into the design	185
7.3.3	Qualities influencing survivors' possibilities for access to mHealth applications	188
7.3.3.1	Guideline #4: The level of survivors' digital literacy needs to be assessed	188
7.3.3.2	Guideline #5: Ensure social support is available.....	193
7.3.3.3	Guideline #6: Ensure accessibility to network or internet connectivity is not an issue and applications are responsiveness.....	194
7.3.3.4	Guideline #7: Ensure that relevant mHealth applications have a multi-language feature	195
7.3.4	Design of interface	197
7.3.4.1	Guideline #8: Make use of appropriate font size and accent colours with respect to frequency and proximity.....	198
7.3.4.2	Guideline #9: Relevant mHealth applications should be customised for survivors	200
7.3.4.3	Guideline #10: Ensure simplicity is applied in the design.....	203
7.4	Cycle two - Practical knowing and associated guidelines	209
7.4.1	Guideline #11: Eye-tracking feature should be integrated into the design	209
7.4.2	Guideline #12: Game-based applications should be considered in the design	211
7.5	Cycle three - Practical knowing and associated guidelines	214
7.5.1	Guideline #13: Secure users' confidentiality and privacy.....	214
7.6	Extra consideration	216
7.6.1	Guideline #14: Ensure financial assessment.....	216
7.7	Summary	217

Chapter 8: Discussion and Conclusion	219
8.1 Introduction	219
8.2 Key findings of this doctoral work.....	219
8.3 Discussion of key contributions of this doctoral work.....	223
8.3.1 mHealth technology acceptance	223
8.3.1.1 The role of virtual connectivity in mHealth acceptance	226
8.3.1.2 Post-stroke capability of survivors in the context of mHealth acceptance	
228	
8.3.1.3 The role of culturally based design in mHealth acceptance	231
8.4 The contribution in context	235
8.5 Latest developments – future work.....	237
8.6 Strengths and limitations of this doctoral work	242
8.7 Personal reflections.....	245
8.8 A message from the Author	247
8.9 Closing statements.....	249
References	252
Appendices.....	296
Appendix A: Flyer designed to invite individuals to take part in this inquiry	297
Appendix B: Information sheet designed for stroke survivors	298
Appendix C: Information sheet designed for app designers and HCPs	304
Appendix D: Consent form designed for focus group interviews.....	306
Appendix E: Consent form designed for individual interviews.....	307
Appendix F: The focus group protocol.....	308
Appendix G: Demographic form designed for app designers and HCPs.....	312
Appendix H: Confidentiality Agreement Form.....	313
Appendix I: The individual interviews protocol	314
Appendix J: Demographic form designed for stroke survivors.....	317
Appendix K: Some screenshots of the paper-based prototype.....	318
Appendix L: Development of the prototype	320
Appendix M: Approval letter for ethics application	340

Appendix N: Final AUTEK approval letter	342
Appendix O: Safety protocol designed for the researcher's safety	343
Appendix P: Definitions of four core post-stroke complications.....	344

List of figures

Figure 1.1: PhD inquiry structure	12
Figure 3.1: Four elements of this thesis, adapted from Crotty's (1998).....	49
Figure 3.2: The action research cycle model adopted from Coghlan and Brannick (2014, p. 9).....	62
Figure 3.3: Action research cycles used in this inquiry	63
Figure 4.1: Three cycles and associated planning actions are undertaken in this inquiry	78
Figure 4.2: Three dimensions of interpersonal relations adapted from Schutz (1958) .	92
Figure 5.1: An excerpt from my reflexive notes	119
Figure 5.2: An excerpt of the coding framework in NVivo.....	121
Figure 5.3: An excerpt of defining themes.....	128
Figure 5.4: An excerpt of my journal.....	131
Figure 6.1: Thematic map	140
Figure 6.2: Key themes and associated categories proposed in cycle one.....	144
Figure 8.1: Overview of the cycles and associated activities.....	221
Figure 8.2: Three main aspects of applications design	225
Figure 8.3: The login page of StrokeLink.....	240
Figure 8.4: Screenshot of face recognition login in StrokeLink	242
Figure 0.1: Screenshots of the sign-in and sign-up pages.....	322
Figure 0.2: Screenshots of the main pages	323
Figure 0.3: A screenshot of the Med reminder page.....	324
Figure 0.4: A screenshot of the Med info page.....	325
Figure 0.5: Screenshots of pages that users go through to book an appointment with their HCPs.....	326
Figure 0.6: A screenshot of the Online consulting page	327
Figure 0.7: Screenshots of the Chat room pages.....	328
Figure 0.8: Screenshots of the Group chat page.....	330

Figure 0.9: We designed this way to increase accessibility and address guideline #2 .	331
Figure 0.10: A screenshot of the eye-tracking setting page	332
Figure 0.11: A screenshot of the setting voice page.....	333
Figure 0.12: A screenshot of the Home page	334
Figure 0.13: Screenshots of the Event pages	335
Figure 0.14: Screenshots of the my story's pages.....	336
Figure 0.15: A screenshot of the main icons.....	336
Figure 0.16: Screenshots of the eye-tracking setting pages	337
Figure 0.17: Screenshots of both keyboards	338

List of tables

Table 2.1: Summary of the stroke epidemiological data relevant to the 1990-2016 studies (Feigin et al., 2017; Feigin et al., 2015; Johnson et al., 2019)	17
Table 3.1: Aspects of CAR adopted in this study	65
Table 3.2: Aspects of PAR adopted in this study	67
Table 3.3: Aspects of IAR adopted in this study.....	68
Table 3.4: Summary of the adopted concepts.....	69
Table 4.1: Inclusion criteria for each participant group.....	82
Table 4.2: Trustworthiness criteria, adapted from Ballinger (2004)	113
Table 5.1: Total amount of minutes, words, and pages of transcriptions – cycle one.	118
Table 5.2: An example of my interpretation process – cycle one	123
Table 5.3: An excerpt from the codes list and their associated descriptions.....	125
Table 5.4: An example of my interpretation process – cycle two	133
Table 6.1: Participant characteristics – survivors	141
Table 6.2: Participant characteristics – app designers.....	142
Table 6.3: Participant characteristics – HCPs.....	143
Table 6.4: Participant characteristics – cycle two.....	167
Table 6.5: Participant characteristics – cycle three	172
Table 7.1: Examples of the key topics associated with three aspects.....	178

List of abbreviations

Abbreviated Form	Full Name
ACCESS	A Comfortable Communication Environment for Stroke Survivors
App Designers	Mobile Application Designers
AUT	Auckland University of Technology
AUTEC	Auckland University of Technology Ethics Committee
CAR	Critical Action Research
CEO	Chief Executive Officer
CoRe	Community Rehabilitation
DALY	Disability-Adjusted Life Years
GBD	Global Burden of Diseases
HCI	Human-Computer Interaction
HCPs	Health Care Professionals
HIPC	Health Information Privacy Code
HPCA	Health Practitioners Competence Assurance Act 2003
IAR	Insider Action Research
MedTech CoRE	MedTech Centre of Research Excellence
mHealth	Mobile Health
OT	Occupational Therapist
PAR	Practical Action Research
PDA's	Personal Digital Assistants
PHI	Personal Health Information
QALY	Quality-Adjusted Life Years
R&D	Research and Development
SMS	Short Message Service
Survivors	Stroke Survivors
TIA	Transient Ischemic Attack
UX	User Experience
WHO	World Health Organization

This inquiry looked at the use of mobile health (mHealth) applications among stroke survivors (survivors). Literature shows that mHealth applications have the potential to support self-management following stroke. Despite this, the acceptability rate by survivors is currently deemed low. This inquiry sought to understand why this is so to inform a set of actionable guidelines to support the design and development of mHealth applications for survivors.

Social constructionism guided this inquiry, revealing the views and perceptions of participants in their unique situations. Along with this, an interpretivist approach underpinned the decision to use action research to collaboratively undertake this doctoral work. Data was collected by examining current literature and conducting interviews with survivors, application (app) designers, and health care professionals (HCPs). The interviews, undertaken in three cycles, were aligned with Coghlan and Brannick's (2014) action research cycle model including phases of constructing and planning action, taking action, and evaluating action.

The outcome of cycles one and two were applied in the creation of a proposed prototype called '*A Comfortable Communication Environment for Stroke Survivors*' (ACCESS) to test the user experience (UX) of a proposed user interface to provide insights into the usefulness of the proposed guidelines in practice.

Findings indicated that three main themes with 17 supporting categories were of value to the stroke community. Themes included: 1) *qualities promoting acceptance of mHealth* - desired applications, which included four categories: connecting, reminding, monitoring, and being informed; 2) *post-stroke capability of survivors*, which is related to the capability of stroke survivors with regard to the use of mHealth applications, and produced four categories: physical, emotional, psychological and medical complications; and 3) *qualities influencing survivors' possibilities for access to mHealth applications*, which are supported by nine categories: digital literacy, social

support, technological support, language barriers, affordability, design of interface, engagement, motivation, and security.

The process of undertaking this inquiry led to actionable knowledge – guidelines that contribute to the human-computer interface field and demonstrate the value of finding solutions through action research. The guidelines that were created and evaluated are now available for app designers to use.

This doctoral work contributes to mHealth technology acceptance literature by: 1) examining the factors that affect mHealth application acceptance; and 2) exploring participants' insights into mHealth services from different perspectives to identify the key factors relevant to human decision-making in the context of mHealth applications and survivors. To the best of the writer's knowledge, this inquiry is among the first to explore survivors' experiences of the acceptance of mHealth applications, and certainly the first to propose guidelines for developing stroke-related mHealth applications with good UX.

Chapter 1: Introduction

1.1 The inquiry in context

The primary aim of this doctoral work was to develop a set of guidelines to help mobile application (app) designers to design intuitive user experience (UX) mobile health (mHealth) applications to increase their acceptance rate among stroke survivors (survivors). With this aim in mind, I examined and explored the perspectives of survivors, app designers and health care professionals (HCPs) on survivors' acceptance of mHealth applications. My particular interest was in identifying and investigating the factors influencing the acceptance of mHealth applications for self-management among people who have experienced a stroke, to inform the development of guidelines for app designers.

mHealth applications are health-related applications that use mobile technology to provide health care services including the support that patients such as survivors may need (Piran et al., 2019). There has been a recent growth in mobile application development for health care, including applications focused on supporting people to manage their own health. mHealth applications with effective usage show promise to enhance *access* to health care services, *deliver* information and *engage* survivors more actively in managing the ongoing consequences of their condition (Singer & Levine, 2016). As such, the acceptance of mHealth applications is critical to access, delivery and engagement outcomes.

The acceptance can be successful by way of the design of an mHealth application that effectively involves UX, which is known as *User Experience* in design circles, in its process. UX design is a process of designing and developing mHealth applications that offer meaningful and pertinent experiences to their users. In the context of the present inquiry, promoting a good UX is essential to the acceptance and adoption of mHealth applications. UX is regarded as dynamic because of the internal emotional states of survivors, which can be changed by a different context of use through and following

interactions with an application (Vermeeren et al., 2010) for managing post-stroke complications.

A stroke is a serious and common neurological event that can result in significant psychosocial and physical impacts (Katan & Luft, 2018; Skogestad, Kirkevold, Indredavik, Gay, & Lerdal, 2019). The World Health Organization (WHO) and associated researchers Aho et al. (1980) defined a stroke as: “the rapid development of clinical signs and symptoms of a focal (or global) neurological disturbance lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin” (p. 114). Generally, a stroke is a sudden interruption in the blood supply of the brain, a form of cerebrovascular disease. This is the result of abrupt obstruction of the arteries within the brain. As a result, there are two main forms of stroke: 1) *ischaemic stroke*, which people can appear to have fully recovered from; and 2) *haemorrhagic stroke*, which causes people to end up with permanent damage (Bamford, Sandercock, Dennis, Warlow, & Burn, 1991; Sacco et al., 2013).

Common sequelae of stroke include: cognitive impairment (Jokinen et al., 2015); upper-extremity motor deficit (Woytowicz et al., 2017); speech impairment (Yourganov, Fridriksson, Rorden, Gleichgerrcht, & Bonilha, 2016); neurological deterioration (Lattanzi, Cagnetti, Provinciali, & Silvestrini, 2017); apraxia (the inability to accomplish specific purposive actions) (Kleineberg, Richter, Becker, Weiss, & Fink, 2020); post-stroke depression (Winstein et al., 2016); post-stroke fatigue (Skogestad et al., 2019); and physical impairments (Hirakawa et al., 2018). A stroke is regarded as a long-term chronic condition with a high risk of disability and mortality (World Health Organization, 2018b). Stroke is often linked to an older population. In Auckland, New Zealand, 86% of ischaemic stroke cases are reported in people aged ≥ 55 years (Barber et al., 2016). Overall, a stroke has wide-ranging psychosocial, cognitive and physical impacts which contribute to difficulties in performing day-to-day activities independently and in reintegrating into society (Walsh, Galvin, Loughnane, Macey, & Horgan, 2015). Post-stroke rehabilitation is required to reduce the impact of the sequelae of a stroke to improve quality of life.

Despite the need for post-stroke rehabilitation, only one in five survivors discharged from hospital who require rehabilitation receive the service for more than three months (Ranta, 2018). This is despite the impact of stroke lasting for several years. Currently, New Zealand is not coping with the number of people requiring this care (Feigin & Vos, 2019; Ranta et al., 2019). Survivors have reported unmet health-related requirements after being discharged from rehabilitation services (Hotter et al., 2018; McKevitt et al., 2011; Olaiya et al., 2017; Walsh et al., 2015). Ranta (2018) reported that the global burden of disease (GBD) estimates that the number of individuals living with post-stroke effects will be increased by 40% by 2028. Recovery after stroke already costs New Zealand billions of dollars (Feigin & Vos, 2019), and this implies a need for an assessment of how the global burden will be addressed in 10-20 years when the stroke numbers within the population have increased.

As continuous support is mostly unavailable, survivors now need and expect to be more involved and active in managing their own condition and health to optimise their long-term outcomes (F. Jones, Riazi, & Norris, 2013). mHealth applications provide novel ways to promote self-management and have the potential to support survivors to self-manage (Singer & Levine, 2016). Stroke-related mHealth applications can help to reduce the burden on health care caused by the increasing prevalence of stroke by addressing the long-term sequelae of stroke and thus empowering survivors in managing their health.

A systematic review indicates that mHealth applications have the potential to improve adherence to chronic disease management (Hamine, Gerth-Guyette, Faulx, Green, & Ginsburg, 2015). Notably, only a limited number of studies reported on the usability, feasibility, or acceptability of mHealth applications (Hamine et al., 2015). Another review aimed to provide an overview of commercially available mHealth applications in stroke rehabilitation, emphasising their potential as a cost-effective strategy to support the rehabilitation of survivors in their daily lives (Ortega-Martín, Lucena-Antón, Luque-Moreno, Heredia-Rizo, & Moral-Munoz, 2020).

As of 2016, among 30,132 mHealth applications, 843 of them were stroke-related applications. Out of 843, 74 applications were specifically designed for survivors focusing on different aspects of stroke and 769 applications were designed for other purposes but could potentially be used by survivors for self-management purposes (Piran et al., 2019). mHealth applications are considered to be economical and convenient for self-management among survivors, with acceptable reliability (Chang et al., 2018). However, studies have found there are factors that hinder survivors' acceptance of stroke-related mHealth applications.

It has been found that inadequate functions may negatively affect survivors' acceptance (H. Zhang, Liang, & Wang, 2018). Another study identified that lack of accountability in the information provided by most applications, poor functionality of applications, and lack of HCP engagement in the development of applications would hinder survivors' acceptance of stroke-related applications (H. Zhang et al., 2020). H. Zhang et al. (2020) also found that the majority of applications did not provide a platform to facilitate online interactions with HCPs, which can contribute to low acceptance. They also reported that users were unwilling to engage in physical activities via stroke-related applications. Brandenburg, Worrall, Copland, and Rodriguez (2017) identified the design of stroke-related applications such as font size and post-stroke sequelae as influential factors that have negative effects on application adoption.

Consequently, it is important for app designers to further define the factors that lead to a low acceptance of stroke-related applications. An investigation of survivors' needs is important because it not only enables app designers to create comprehensive applications to support self-management for survivors but also improves survivors' acceptance. As such, this PhD inquiry aimed to develop guidelines for app designers to support this process. To achieve this, the inquiry explored participants' perceptions regarding stroke-related mHealth applications to gain insights into survivors' expectations of these applications to make sense of how app designers can be guided to design intuitive UX to increase the acceptance rate.

Before discussing how this inquiry was situated, I first provide some details about how I became involved in this inquiry followed by terminology, research questions, cycles that were undertaken, and the structure of this doctoral work at the end of this chapter.

1.2 Positioning the researcher as an insider

I became involved in this inquiry as the daughter of a survivor. I was shocked and distressed when the neurologist told me that my mum had experienced a ministroke called Transient Ischemic Attack (TIA). However, the effects were severe and, given there had been such a huge effect, I was surprised when I was told mum would not be considered for rehabilitation after she was discharged from hospital. I had presumed that an individual with a stroke would use and receive post-stroke rehabilitation. My choice was to take mum home following discharge from inpatient stroke rehabilitation.

I shared my concerns with my mum's health care team and requested that they consider mum for home-based rehabilitation. One of the physiotherapists contacted me and shared that mum's condition had been reassessed but that the review had shown no progress and that no further rehabilitation would be provided through the public service. However, she stated that private HCPs who provide health care services in the community are available, and she suggested it would be better to go with this option rather than look for a suitable nursing home for mum. She personally believed that mum was able to make a considerable recovery. Therefore, I decided to take mum home, although we were not financially in a situation to take on a private HCP.

Public providers were contacted several times to discuss mum's condition, how her health was improving, and what rehabilitation services may foster her recovery. There were several discussions and communications. Finally, based on the recommendations of an occupational therapist (OT), a physiotherapist and speech-language therapist were assigned to provide rehabilitation services at home. After two months of home-based rehabilitation and therapist support, it was recommended that mum be readmitted to inpatient stroke rehabilitation for five months. However, taking

mum to the rehabilitation centre was another challenge for us, so they reviewed the case and extended the home-based rehabilitation for a further five months. Though mum struggled with hemiparesis¹ (weak motor control, left side weakness); mild hemianopsia² (a problem in vision); dysphagia³ (difficulty in swallowing); fatigue⁴ (tiredness and lack of energy), and mild cognitive syndrome, she enjoyed life and being there for me.

Literature supports my experience that once a survivor is discharged from hospital, they will be left to cope with diverse sequelae such as physical, communicative, and cognitive impairments with little professional support (Dworzynski, Ritchie, & Playford, 2015; Teasell, Fernandez, McIntyre, & Mehta, 2014). Survivors and their families face new and unexpected responsibilities, such as adjusting their lives to their new situation as a result of a stroke (De Wit et al., 2017; Haley, Roth, Hovater, & Clay, 2015; McKeivitt et al., 2011; Schulz, Tompkins, & Rau, 1988). In spite of the extensive scholarly work available on stroke caregiving and the impacts of stroke, few researchers have investigated how survivors can manage their conditions and cope with challenging situation (F. Jones et al., 2013).

Studies have reported that delivering stroke-related self-management interventions using digital technology devices is associated with great improvement in outcomes, including health behaviour change (Grau-Pellicer, Lalanza, Jovell-Fernández, & Capdevila, 2020). However, there are few studies reporting on the improvement of survivors' acceptance of stroke-related applications for self-management (Aljaroodi, Adam, Chiong, Cornforth, & Minichiello, 2017; Ferreira, Guimaraes, Santos, & Sousa, 2014; Ohno et al., 2017). In the next section, I make sense of how my personal experiences contributed to situating this inquiry.

¹ https://www.heart.org/-/media/stroke-files/stroke-resource-center/recovery/patient-focused/lta-complications-after-stroke-ucm_474388.pdf?la=en&hash=8CB1D9888C9AA004C64942F294CBE077FD1DDB7D

² <https://www.rnib.org.uk/eye-health/eye-conditions/stroke-related-eye-conditions>

³ <https://www.stroke.org/we-can-help/survivors/stroke-recovery/post-stroke-conditions/physical/dysphagia/>

⁴ <https://www.saebo.com/tired-after-a-stroke-understanding-post-stroke-fatigue/>

1.3 How the inquiry was situated

The focus of this PhD inquiry was influenced by my personal situation and experiences which made me decide to incorporate my research skills into a project which may find a way to support survivors following discharge from hospital. I was inspired by survivors' stories while in the hospital with my mum, observing how they were struggling to self-manage and appreciating the role of technologies in better outcomes in rehabilitation. The original PhD research proposal, therefore, was developed during this period. I would like to particularly acknowledge the role of two survivors in the hospital who persuaded me to undertake this PhD. They inspired me in many ways, particularly in sharing the importance of help with reintegrating into society. I was also guided by mum's health care team, and with the help of my supervisory team, the final draft of the proposal was completed.

As a carer, I was engaged in the process of mum's rehabilitation, which led me to create a connection with the rehabilitation centre to better understand the rehabilitation process. Being involved in the process meant that I had roles that overlapped with my inquiry. The role I had as a carer in helping mum in rehabilitation and in supporting her to manage the ongoing consequences of stroke contributed to the role I had as a researcher. This role duality reflected my positioning as an insider researcher, a member of a community that researches the community. This is discussed in more detail in section 3.7.3. The truth is that I sought to do this PhD to help survivors like mum to have a life with the dignity they deserve.

How I situated this inquiry methodologically was influenced by my previous research experiences. I was familiar with qualitative approaches. Acknowledging that this is an umbrella term describing a variety of methodologies, I sought to employ an appropriate methodology to allow me to work collaboratively with participants to achieve the aim of this inquiry. I was introduced to action research by my primary supervisor. My knowledge of this method was very limited. Therefore, I spent the first few months of my PhD reading to make a sense of this methodology and its relevance

in the context of this inquiry. Following this, action research (described in detail in Chapter 3) was adopted.

My starting point for this PhD was recognising that the adoption and use of mHealth applications may provide alternative opportunities to intervene after a stroke. As such, I set out to explore participants' views regarding stroke-related mHealth applications and the factors influencing survivors' acceptance of such applications. Choosing the social constructionist view to underpin this inquiry was influenced by my social interactions and experiences in the hospital. Being in the hospital for six months (on and off) and interacting with survivors and HCPs helped me see that social interactions have great significance in the construction of meaning. I interacted with many survivors and HCPs during my stay and listening to their unique stories provided me with belief and confidence that each story has its own meaning and, while there may be some patterns, each story is unique. This is consistent with a social constructionist perspective which argues that multiple realities exist. The original context and the purpose of this inquiry were constructed by my early social interactions. I consider this period as 'pre-step' phase in which my understanding of the context was established.

1.4 Terminology

For clarity, in this inquiry, three groups took part in the study. The first group were *older adult stroke survivors* who were individuals aged 55 and over who had a stroke (see section 4.3.2.1). The term '*survivors*' is used to describe this demographic. The second group were *mobile application designers* involved in the design of health-related applications to promote self-management. The term '*app designers*' is used to describe this demographic. The third group of participants were *health care professionals*. These are individuals who are registered under the Health Practitioners Competence Assurance Act 2003 (HPCA) and provide health care services to survivors such as occupational therapy, physiotherapy, and speech-language therapy. The term '*HCPs*' is used to describe them.

1.5 Research questions and aims

This inquiry aimed to develop guidelines to assist app designers in designing stroke-related mHealth applications to increase their acceptance by survivors for self-management purposes. To achieve the aim, I sought to explore the views of individuals who are involved in the use and development of mHealth applications to synthesise their perceptions of how such applications can be designed to meet survivors' needs and expectations. Two research questions were generated to address this aim. The research questions are:

1. What are the factors that affect the acceptance of mHealth applications by survivors?
2. How can app designers be guided to develop intuitive UX stroke-related applications to meet survivors' needs and expectations?

The following objectives were pursued to address these two research questions:

- to explore the views of survivors, app designers and HCPs to provide insight into factors influencing the acceptance of stroke-related applications to support self-management by survivors;
- to interact with survivors to understand their needs and expectations;
- to engage in a design process with app designers; and
- to identify and appraise HCPs' perceptions and experiences regarding survivors' use of stroke-related mHealth applications.

1.6 Inquiry approach and cycles

This inquiry was undertaken in three cycles which are further described in Chapter 4. Each of these cycles was aligned with the action research cycle model of Coghlan and Brannick (2014) included phases of constructing, planning, taking, and evaluating action. The constructing and planning action phases were combined in each

cycle to better fit the context of each cycle. Coghlan and Brannick's action research cycle model also comprises a pre-step phase, context and purpose, that was taken before initiating this inquiry. The pre-step phase and three cycles are briefly explained below.

Pre-step phase: This phase involved seeking an insight into the context of the inquiry. To understand the context of this inquiry, I used my collaborative relationship with my mum's HCPs to create social interactions with HCPs and stroke patients (who were admitted to the hospital where my mum was admitted) who have the knowledge of post-stroke needs to understand why this inquiry is desirable. These social interactions helped me to establish the purpose of this inquiry. This phase also informed the initial steps I took to approach potential participants with whom I worked in this inquiry. In this phase, an initial examination of the literature was also undertaken. This phase is further explained in Chapter 4.

Cycle 1: The first cycle involved constructing, planning, taking actions, and reflecting on findings at the end to achieve the aim of this inquiry. To begin this process, further examination of the literature was undertaken to investigate factors that affect the utilisation of mHealth applications by survivors. The aim of doing this examination was to investigate the topic in depth to acquire a broad understanding to inform the further development of this inquiry. In addition, this inquiry was intended to extend beyond the literature findings and seek to engage with lived experiences to provide new insights that would emerge as practical knowing to contribute to current knowledge. As such, in cycle one, I interviewed participants to identify factors perceived to affect the acceptance of stroke-related mHealth applications. The findings were fed into the development of a draft set of guidelines. The draft guidelines were the result of this cycle.

Cycle 2: The second cycle involved testing the usefulness of the draft guidelines. To do this, participants from cycle one were invited to share their perspectives on the draft guidelines. Interviews were undertaken and participants' views on the usefulness of the draft guidelines were explored. This process led to the refinement of the guidelines. However, a valuable proposition was made by some participants.

Participants proposed that drawing on the guidelines in application design would be a more effective way to provide insights into the usefulness of the draft guidelines. The refined guidelines were the result of this cycle.

Cycle 3: To address the proposition made by participants, a working prototype called '*A Comfortable Communication Environment for Stroke Survivors*' (ACCESS) was developed by drawing on the guidelines to test the utility of the guidelines. Therefore, the third cycle involved the work of developing ACCESS and evaluating the functionality of the guidelines in practice using ACCESS. Participants were invited for a third and final time to explore their views on the revised guidelines. Cycle three involved interacting with participants to provide more insights that emerged as practical knowing. This practical knowing contributed to the development of the proposed guidelines.

1.7 Structure of this PhD inquiry

Figure 1.1 shows the structure of this PhD inquiry. This introductory chapter has provided the background context to this inquiry and its association with the aim of this inquiry, the development of guidelines for app designers. I have also provided a broad outline of the pre-step phase and three cycles undertaken to conduct this inquiry. In the following, I provide an outline of the remaining PhD inquiry structure.

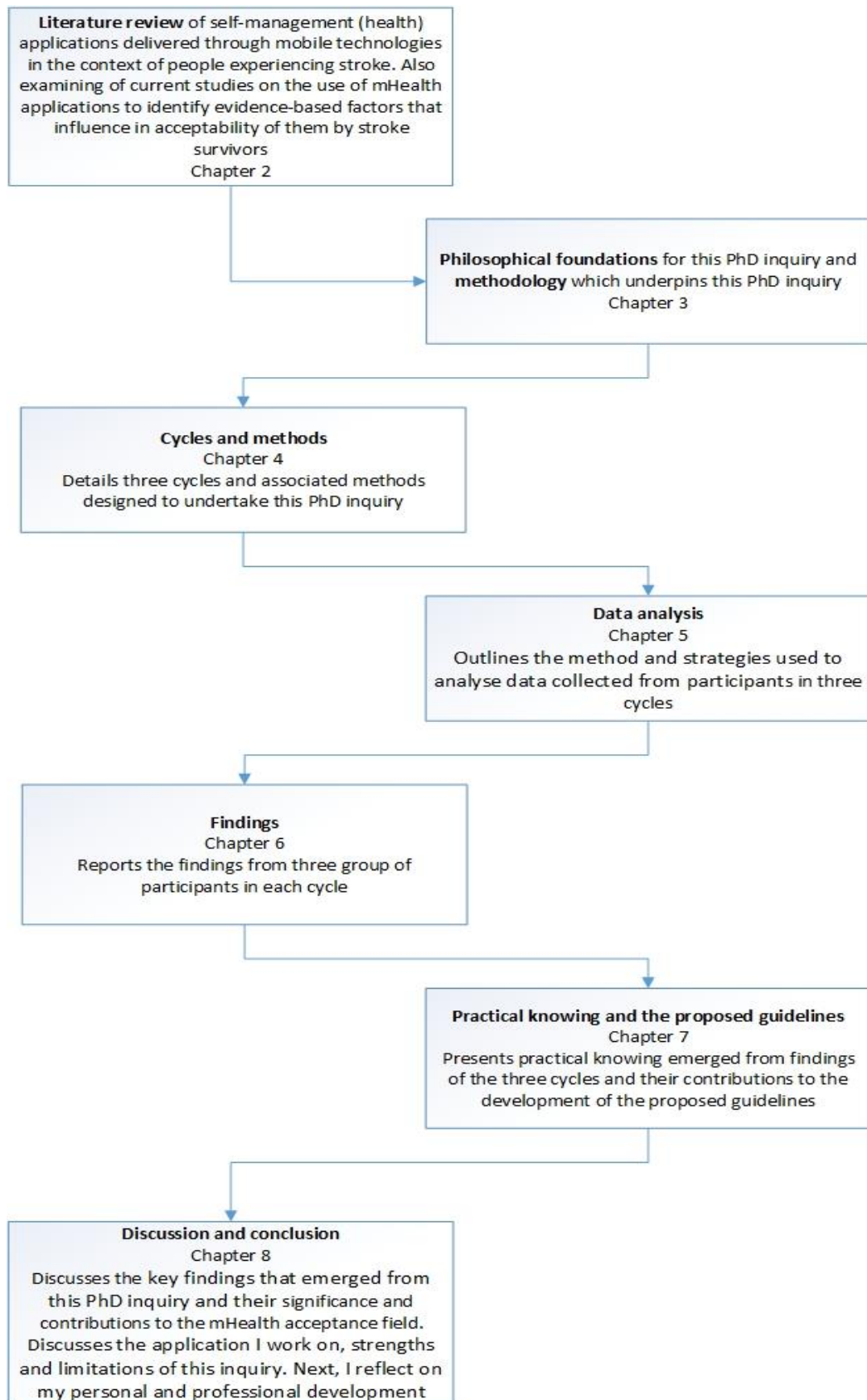


Figure 1.1: PhD inquiry structure

Chapter 2 presents an overview of the epidemiology of stroke and its burden globally and in New Zealand. An overview of self-management concepts and self-management interventions in mHealth technologies, and emerging mobile technologies in health services and stroke, is also presented. Finally, this chapter also provides findings of current studies on mHealth applications and factors influencing the UX and use of mHealth applications. This was undertaken early in this PhD inquiry to better understand the low acceptability of these technologies and to inform the further development of this inquiry.

Chapter 3 situates my methodological approach within the action research context. It describes how action research is consistent with the aims of this inquiry by making transformative changes through the concurrent processes of taking actions and carrying out research that contributes to socially constructed actionable guidelines. This chapter also presents an overview of and justifies the epistemological and theoretical perspectives underpinning this inquiry and the methodology employed.

Chapter 4 details the three cycles and associated methods used to undertake this doctoral work. This chapter concludes with a discussion on the criteria applied to ensure the trustworthiness of the inquiry.

Chapter 5 outlines the method used in analysing data as well as explaining the thinking behind the method of data analysis. Strategies used to provide insight into how the data was analysed also are described and justified over three cycles.

Chapter 6 reports the findings of this doctoral work which led to the development of the guidelines. Findings are presented as key themes pertinent to the first research question and the key themes and associated categories are used to structure this chapter. Findings from each group of participants who took part in each cycle are presented separately.

Chapter 7 presents and discusses practical knowing that emerged from the findings of three cycles and how they informed guidelines development - the proposed guidelines that were produced through this doctoral work. It is suggested that these

guidelines should be considered by app designers in the design of intuitive UX stroke-related mHealth applications to meet survivors' needs and expectations to increase the acceptability rate of applications. However, I also consider the outcomes of this doctoral work as the first cut of ongoing refinement of guidelines. That is, there might be a need for further refinement in the future, as T.S. Eliot (1888-1965) expressed "we must not cease from exploration and the end of all our exploring will be to arrive where we began and to know the place for the first time" (Eliot, 1942, p. 27).

Chapter 8 discusses the key findings, drawing together the findings from three cycles with a consideration of the objectives of this inquiry. I endeavour to provide an insight into survivors' experiences of the use of mHealth applications. The focus is on how the current findings contribute to existing knowledge of acceptability of these technologies. This chapter also incorporates a discussion of the strengths and limitations of the inquiry and introduces the application that is planned to be undertaken in the future. In addition, I will reflect on how undertaking this doctoral work contributed to my personal and professional developments and share lessons for app designers.

Chapter 2: Literature Review

2.1 Overview of this chapter

This chapter provides an overview of the role and significance of mobile-based applications in supporting survivors with their self-management. The chapter is structured into three main sections. In the first section, an overview of contemporary knowledge and perspectives on the epidemiology of stroke in New Zealand and worldwide is provided. Statistical information on stroke incidence is presented to draw a clear picture of the stroke burden and the significance of supporting post-stroke challenges to reduce the negative impacts of the stroke burden on societies.

In the second section, the literature regarding self-management, associated concepts, and the significance of self-managing interventions for survivors is reviewed. This section presents a definition of self-management in an overview of three aspects of self-management involving medical, emotional and role management aspects. These three aspects of self-management are discussed to illustrate a point: that survivors are affected by stroke in different ways, and therefore their needs and expectations are diverse. As such, a range of self-management techniques tailored to accommodate various outcomes of post-stroke effects is needed to accommodate survivors' individual needs and expectations. This section also highlights the important role of self-management in post-stroke complications and its significance to survivors' quality of life.

The third section presents an overview of emerging health-sector specific smart technologies that offer support to chronically ill individuals, such as survivors, with self-management through mHealth technologies. This section provides an overview of mHealth applications usage in managing chronic diseases followed by an outline of the significance of how such technologies may provide post-stroke support to survivors through self-management. An examination of current studies is also provided which focuses on underlying reasons for the use of mHealth applications to construct a broad understanding of their acceptability.

2.2 The epidemiology of stroke and its burden

Stroke has reached the status of a global epidemic with one in every five people incurring a stroke in their lifetime (Johnson et al., 2019). Stroke is the third most prominent reason for mortality in New Zealand (Hogan & Siddharth, 2018), and is the second most prominent reason for mortality and one of the leading reasons for disability worldwide (Katan & Luft, 2018). Approximately 9,000 people in New Zealand experience a stroke each year (Ranta, 2018) with approximately 15 million people experiencing stroke worldwide each year (World Stroke Organization, 2019). The number of survivors is increasing in New Zealand and worldwide (Hogan & Siddharth, 2018; Johnson et al., 2019) with post-stroke sequelae involving both physical and psychological complications that mean survivors require assistance to perform day-to-day activities (Katan & Luft, 2018). A rise in the number of survivors living with the ongoing consequences of stroke indicates that the requirement for support will continue to rise, driving calls for an improvement in the resources for survivors to reduce the burden of the consequences of stroke.

Further to this, stroke disproportionately affects people aged ≥ 55 years in New Zealand (Barber et al., 2016) with the same age range affected worldwide (Mozaffarian et al., 2016; Thrift et al., 2017). Therefore, stroke incidence is also increasing as the population of the world ages. Ageing is considered one of the key factors contributing to stroke incidence. One major consequence of stroke in old aged survivors is high dependency on others for daily activities, often leading to poorer quality of life (Hogan & Siddharth, 2018). This suggests that alternative ways empower survivors through self-management after stroke become imperative for their independence and improved quality of life.

Stroke is considered the second most common reason for global DALYs⁵ (116.4 million) (Johnson et al., 2019). Table 2.1 presents the epidemiological data associated with stroke over time. As of 2016, a reduction in the prevalence of stroke by 8.1% since 1990 was indicated as there was a significant decline in mortality caused by stroke by 36.2%. However, there was an increase in stroke incidence rates by 1.3% which contribute to its burden worldwide. Even with a significant decrease in age-standardised stroke rates by 34.2%, the population has continued to rise. Quantified by age-standardisation, the overall DALY rate declined. Yet, there has been an absolute rise in the DALYs as the incidence of stroke has risen with time (Johnson et al., 2019), leading to a prediction of an increase of 40% by 2028 in New Zealand (Ranta, 2018). This increase is chiefly a result of population growth and a larger ageing population contributing to the increased occurrence of stroke incidences. These statistics indicate a critical need for improvement in post-stroke care, global awareness of self-management, identification of risk factors, identification of prevention strategies and the provision of ongoing support to survivors.

Table 2.1: Summary of the stroke epidemiological data relevant to the 1990-2016 studies (Feigin et al., 2017; Feigin et al., 2015; Johnson et al., 2019)

The global age-standardised	1990-2013	1990-2015	1990-2016
DALYs	-25.7%	-32.3%	-34.2%
Mortality	-22.2%	-30.0%	-36.2%
Prevalence	4.54%	-9.8%	-8.1%
New incidence	10.3 m	-	13.7m
Note: m=million			

⁵ The burden of stroke is estimated through the Disability-Adjusted Life Years (DALY) and the Quality-Adjusted Life Years (QALY) metric designed by the WHO to measure the worldwide burden of disease. DALY is a time-based mechanism to calculate the health status that integrates both the mortality as well as the disability. Estimating the overall time lost as a universal and common measurement unit facilitates a comparison of the relative burden of health conditions while offering guidance to the planning of the health system (Hong, 2011). For the DALY statistic lost for every individual survivor, it is important to measure the life expectancy of every survivor.

The approximate annual cost associated with stroke for New Zealand is \$700 million and this is expected to increase over the coming years as the number of survivors is increasing (Hogan & Siddharth, 2018). Factors contributing to increased cost include hospitalisation, residential care, medication, lost income, community services, loss of quality of life and premature death costs (Hogan & Siddharth, 2018). This trend indicates an increase in the stroke burden in New Zealand which calls for greater attention on how to empower survivors to be more involved in managing and contributing to their own health outcomes.

Given these circumstances, survivors generally impose a vast burden on well-being and social care thus stroke contributes to lowering the socio-economic status of society in general (Xiao, Gao, & Zhang, 2019). As survivors are often unable to go back to work, reduced economic status is therefore included in the social outcomes associated with the stroke burden (Feigin et al., 2010; Sheridan et al., 2011). Major socio-economic consequences include lost productivity, and a decrease in household income and spending (McAllister, Derrett, Audas, Herbison, & Paul, 2013). Therefore, stroke leads to a number of socio-economic challenges where increases in long-term health care costs affect society and can flow on to the productivity of associated family and support persons.

The high degree of complications demands ongoing treatment, rehabilitation approaches and the availability of support services. These demands place some of the burdens of increasing stroke incidence in areas of economic concern (Mukundan & Seidenwurm, 2018). This scenario highlights how providing post-stroke support to improve survivors' quality of life would positively impact the socio-economic status of our society.

2.2.1 Overview and aims of recovery in stroke

The duration and extent of post-stroke recovery vary dramatically from survivor to survivor depending on a number of factors, including stroke severity, type and related complications (Lipson et al., 2005). Recovery is generally categorised into two types:

neurological and functional. While neurological recovery is the recovery of neurological impairments (an intrinsic process), functional recovery signifies the regaining of independence in daily activities, which can be affected by extrinsic factors (Lee et al., 2015).

Teasell, Foley, Hussein, and Speechley (2007) found peak neurological recoveries occur within the first three months after the stroke hits and continue at a slower pace for another three months. In these six months, up to 70% of survivors' greatest potential improvement occurs (Prabhakaran et al., 2008; Teasell et al., 2007). This time frame is known as the "critical window for recovery" (Ballester et al., 2019). Specific percentages of recovery within this period contain many variations. Teasell et al. (2007) stated that for ischemic stroke patients, 95% reach maximal neurological recovery within six weeks. For survivors with more severe strokes, 95% reached their maximal recovery within 10 to 15 weeks, depending on stroke severity. Lee et al. (2015) revealed that in the first three months after the occurrence of stroke, survivors recovered from its effects; however, recovery variables indicate progress of between 48% and 91% of the highest score achieved. Significantly, only 5% of survivors continue their neurological recovery after a year (Teasell et al., 2007).

Ballester et al. (2019) maintained that the 'window' is poorly defined, and the extent of a patient's chronicity can remain unclear. Ballester et al. suggested that the window may extend beyond one-year post-stroke. Functional recovery, on the other hand, can continue for months after the critical window, although improvement does tend to be most rapid in the first few months. This is shown in a study conducted in Benin which indicated a mean score of 67% for functional recovery within the first six months (Kossi, Batcho, Adoukonou, & Thonnard, 2016), although the recovery process differs from survivor to survivor and varies according to the survivor's age.

For some survivors, recovery is quick, while for most others the need for rehabilitation and support for major impairments can last months, if not years (Jorgensen, Nakayama, Raaschou, & Olsen, 1999). What is consistent; however, is that the post-stroke physiological changes and effects span the cognitive, behavioural and

emotional domains (Kneebone & Lincoln, 2012). Some of the effects of these changes can be present years after a stroke (Bernhardt et al., 2017). Post-stroke depression and post-stroke fatigue can last a lifetime. Since stroke is followed by psychological complications, including depression and reduced self-regulatory capacity, these complications impact engagement in rehabilitation or further impact the probability of early recovery (Skogestad et al., 2019). Thus, health care services, therapy and rehabilitation needs to vary as much as the illness itself. It follows, then, that it is important for survivors to equip themselves with relevant knowledge, tools and skills so as to be engaged at the forefront of addressing their continuing post-stroke needs and lifestyle changes.

Increasing the independence of survivors by contributing to their quality of care would develop a direct implication for the cost of health care services (Wray, Clarke, & Forster, 2018). As the number of survivors increases, self-management interventions can play a life-changing role in improving the quality of life (Demain et al., 2013). Therefore, post-stroke recovery can be facilitated where it is possible to promote self-management strategies. When considering the differentiation of the recovery process from survivor to survivor, and with findings consistently showing that recovery time varies as a process that unfolds over many years, survivors require ongoing care (Lainay et al., 2015). Thus, health care needs rehabilitation frameworks that can vary as much as the condition itself. However, what can be consistent is the importance of post-stroke self-management, especially when professional therapies and ongoing support are not always available.

2.3 Self-management

The concept of self-management for chronic illnesses first emerged in the 1960s (Lorig & Holman, 2003). Generally, self-management refers to the tasks that a chronically ill individual engages in to promote and improve their health. This includes self-managing and monitoring disease symptoms, managing the impact of the disease on functioning, evaluating and responding to emotional well-being, maintaining social

relationships and following treatment schedules (J. Richardson et al., 2014). S. J. Taylor et al. (2014) recognised the innovative and developing arena of self-management. Self-management shifts the primary focus and responsibility of the care of chronic illnesses away from HCPs and facilities, to be shared with the patients themselves, shifting from solely medical management to considering behavioural management (D. Taylor & Bury, 2007).

Self-management is suggested here as a technique to actively involve patients in their own care and empower them to make decisions regarding their care to manage well with their conditions as H. Morgan et al. (2017) stated. In self-management, it is critical for patients to adopt new skills and perspectives for living with a chronic illness (J. Richardson et al., 2014). Self-management interventions are recommended for patients with chronic diseases as an integral factor of care for improved health outcomes and the effective utilisation of health care services (Boger, Demain, & Latter, 2013). The following sections provide an in-depth understanding of the significance of this concept in health care services.

2.3.1 Self-management definitions

Defining self-management assists in the clarification of the rationale behind the intention of this inquiry. However, there is no widely accepted definition of self-management, as different scholars have different perspectives on chronically ill individuals. N. M. Clark et al. (1991) outlined self-management as a set of activities undertaken to reduce or manage the influence of a disease. Based on their findings, self-management is viewed as attaining sufficient information to effectively manage and monitor disease symptoms through performing different yet specific activities. Barlow, Wright, Sheasby, Turner, and Hainsworth (2002) discussed self-management as the capability of individuals to effectively manage disease symptoms through bringing about a radical change in the social and psychosocial standard of living. Thus, this second definition can be effective as self-management has the potential to augment the ability of patients to live with chronic illness. Through assisting them to be proactive in maintaining a balanced lifestyle within their abilities, it tasks them with having

responsibility for their emotional, behavioural and cognitive responses. Self-management processes that additionally provide survivors with adequate knowledge for managing symptoms of the disease may also help with acceptance of their condition. Another perspective, provided by Newman, Steed, and Mulligan (2004), described self-management as the ability and capacity of individuals to handle treatment and symptoms, along with psychological and physical consequences. This encourages participation in all aspects of their recovery. Rather than being the object of treatment by others, they are empowered as part of their treatment.

Some researchers have recently aimed to explore survivors' definitions of self-management. They reported a new way of defining this concept. Survivors defined self-management as "doing things for yourself" and "looking after yourself" (Sadler, Wolfe, Jones, & McKeivitt, 2017, p. 4). Through this research, it has been asserted that the majority of survivors were unaware of the concept of self-management while relying on others for undertaking basic day-to-day activities. However, through adequate knowledge and support, survivors may be offered the potential to take part in managing their health and recovery by learning specific technical skills to assist with functional tasks like walking and exercising regimes. In this way, self-management is linked to managing a balanced and healthy lifestyle, including timely medication management, monitoring of symptoms, psychological functioning, problem-solving, health-related decisions, using resources linked to HCPs, being open to goal setting, and planning actions, as outlined in the study by Jonkman et al. (2016).

All perspectives and definitions provided by different scholars above contribute to the notion that self-management concept has developed over time (H. Morgan et al., 2017). The idea of support for self-management focused on helping individuals with long-term conditions to manage daily activities as they go; they are part of treatment; working with them to empower them; or offering them control over their lives. H. Morgan et al. stated that ideas focused on supporting individuals working with long-term conditions could be seen as needing individuals to *manage their conditions*, whereas the authors proposed a new view of support focused on enabling individuals to

manage well with their conditions. This suggests that individuals with long-term conditions can learn how to cope better with their current conditions, with supporters affording some responsibility to the survivors.

Given these perspectives, the components of self-management education programmes for health and welfare mostly focus on medical management and therapeutic processes, whereas a self-management programme can emphasise people's behaviour, attitudes, and consequent beliefs as well (Kinney & Kahana, 1989). Hence, the self-management concept in chronic diseases is not just about the delivery of information but is composed of tactics and strategies that are helpful in changing and transforming the behaviour, attitude, and belief of a survivor. If survivors can achieve a considerable amount that positively improves outcomes, it can also address their beliefs and attitudes to assist them in their roles of better managing this chronic illness (Bratzke et al., 2015).

2.3.2 An outline of the implementation of self-management

The term *self-management* is widely used in encouraging healthy behaviours and education. Lorig and Holman (2003) clearly explained the aspects of self-management in their study titled "Self-Management Education". The authors explained that when an individual engages in a health-related activity such as jogging or is potentially suffering from a disease like asthma, that person must actively manage it. In the context of this inquiry, the focus is put on how people with chronic diseases, such as stroke, engage in their everyday care over the duration of their disease. The article by Lorig and Holman (2003) described this self-management as a lifetime task.

Interventions for self-management should support aims to increase the skills and confidence of a patient so that they are comfortable managing their chronic illness, able to assess their progress and any problems that arise, set goals, and problem-solve. As such, self-management involves three aspects of management: 'medical', 'emotional', and 'role' (Lorig et al., 2012). According to Lorig et al. (2006), medical management refers to managing activities that are significant for the improved health outcomes of

patients with chronic disease. Emotional management deals with the emotional repercussions of living with chronic diseases, such as depression, anger and fear. Role management refers to the adoption of new life roles that adapt to the constraints of living with chronic conditions while aiming towards reintegrating back into the community (Kneebone & Lincoln, 2012; Lorig et al., 2012; Lorig et al., 2001; Parke et al., 2015). As focus varies, for those who have been through a severe stroke, it is role management that poses the greatest long-term challenge. After an acute stroke, 50% of survivors suffer from post-stroke fatigue, so emotional management may initially form the primary focus followed by physical and social needs (Skogestad et al., 2019).

The long-term care of survivors makes self-management concepts more important than ever before with consideration of two management aspects – role management and emotional management (Hwang, Park, & Chang, 2021). The inclusion of these two aspects has led to the wave of a growing provision of effective self-management programmes and interventions to assist patients and families. The health service repertoire could also improve if more effective self-management programmes are developed related to chronic illnesses (Hwang et al., 2021). As chronic illnesses and their severity differ from one patient to another, self-management interventions are accordingly professionally designed along with the variations required and can be delivered in a group or on an individual basis (Coster & Norman, 2009).

2.3.3 Significance of self-management to survivors

The WHO (2018b) stated that only 10% of survivors recover almost completely from their stroke while 40% of survivors live with moderate to severe post-stroke impairments, and approximately 10% are dependent on institutionalised long-term or lifetime care. These statistics indicate that most survivors encounter various long-lasting physical, psychological, and social challenges, indicating there are advantages for them to participate in their own long-term care. Accordingly, self-management techniques are significant since they assist survivors with creating new daily routines after going through a period of complicated health issues and emotional as well as neurological disturbance. Without HCPs' assistance, this change can be challenging; consequently,

HCPs are in a position to integrate self-management concepts into health services to promote self-aid with post-stroke complications and social aspects.

Self-management terminology is widely used in reference to post-stroke support, concerning its techniques increasing the quality of life of survivors (Boger et al., 2013; Parke et al., 2015). The ideas underpinning self-management not being new in emphasising a transition from institutionalised care and control to survivors' control. Fryer, Luker, McDonnell, and Hillier (2016) have described this transition as confidence and self-efficacy of survivors to confront and resolve a problem and create their own action plan that could assist tackle post-stroke challenges survivors experienced. In this regard, many strategies such as workbooks, quizzes or videos are applied in self-management interventions to facilitate self-efficacy and problem-solving (Fryer et al., 2016; F. Jones & Riazi, 2011; S. C. Jones et al., 2006).

The bridges self-management programme, which is a programme that can be tailored to survivors' individual needs, is widely integrated into the process of rehabilitation. This programme is informed by self-efficacy and social cognition theory, which are recognised as foundations for the triumph of various self-management interventions. Evidence-based studies reported the association of self-efficacy with post-stroke functional capability, depression, and quality of life (Wray et al., 2018). While self-efficacy is involved in survivors' emotional and psychological states, a self-management intervention that focuses on improving survivors' self-efficacy could contribute to positive psychological and physical outcomes. The literature further reported the acceptance and benefits of stroke-related self-management interventions and their impact on self-efficacy (F. Jones & Riazi, 2011; McKenna, Jones, Glenfield, & Lennon, 2015; Woodman, Riazi, Pereira, & Jones, 2014).

Literature indicates that self-management interventions such as the 'bridges programme' are supported by growing evidence base and survivors who had been supported by such interventions perceived a greater sense of control and responsibility (Kulnik, Poestges, Brimicombe, Hammond, & Jones, 2017). The bridges programme has been contextualised in different settings such as New Zealand and the results showed

that the intervention pointed out the significance of confidence in survivors' own skills and how to support their own post-stroke challenges (Hale et al., 2014). The study of Hale et al. highlights that implementation of interventions like the bridges programme in a different context can be challenging and survivors' cultural values and needs should be considered to ensure that interventions are in line with certain cultural values and needs. In areas or countries where delivering health care services is limited, such interventions could be investigated as strategies to support more social participations and greater community reintegrations. In these circumstances, mobile technologies have the potential to deliver additional channels for survivors to enhance self-management practices, even if the help of HCPs is sometimes unavailable as is the case, for example, in rural areas.

2.4 Mobile health (mHealth) technology as an opportunity

The opportunity to develop mHealth dedicated to supporting survivors may have enormous potential as an important part of long-term recovery. The WHO has defined mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" (World Health Organization, 2018a, p. 6). The WHO recognised different kinds of mHealth technologies, for example, short message service (SMS) as a widely used technology, as well as mobile computing, mobile telecare/telemedicine devices, smartphones, MP3 players, personal digital assistants (PDAs), and monitoring devices (Abaza & Marschollek, 2017). mHealth technology is, therefore, an application emerging from mobile communication and network technology, and is considered a potentially beneficial tool for the delivery of health care services (Chib, van Velthoven, & Car, 2015).

Mobile devices, due to their accessibility, network connectivity and portability can be carried easily and used anytime and anywhere (Nam et al., 2012). As of January 2019, the New Zealand population was 4.77 million and mobile subscriptions were at 6.35 million, that is, the average number of subscriptions for each person is 1.33,

indicating that some individuals have more than one mobile device and suggesting the prospect of widespread use of mHealth technology (Kemp, 2019). The use of smartphones to deliver health applications is perceived as a significant opportunity within the field of post-stroke support (Brandenburg et al., 2017). Hence, the integration of mobile technologies into health care has the potential to not only expand the productivity and efficiency of health care services but can also assist in minimising the reliance on hospitals, enhancing ongoing out-patient health care access, and reducing the costs of health care services. As a result, mHealth applications offer a cost-effective and relatively accessible approach to providing behaviour change interventions. This, together with inexpensive devices, is altering how health care services are provided and accessed.

In addition, the utilisation of mobile applications has emerged as a promising approach to disseminating health information to patients, thereby offering an additional avenue for patients to access health education. This novel method enables patients to enhance their knowledge and understanding of healthcare through the utilisation of both conventional educational materials and app-based resources, thereby catering to their individual preferences and empowering them in the process (Y.-N. Kang et al., 2019). Studies have attempted to develop interventions aiming at providing post-stroke education to survivors and their caregivers as they transitioned back into the community. The studies have expressed that the lack of adequately trained personnel within the healthcare system could be addressed by implementing a comprehensive training approach (Kamal et al., 2020; Langan et al., 2020; Requena et al., 2019). Kamal et al. (2020) developed an intervention consisting of 5-minute educational movies presented in sequential order of relevance. Using such an approach utilising high-quality audiovisual aids would serve as a checklist, facilitating the acquisition of necessary competencies and survival skills by survivors and their caregivers, thereby enhancing their preparedness for the challenges encountered in their poststroke journey.

The findings of Kamal et al.'s (2020) study have unveiled prospects for the integration of tracking strategies into rehabilitation systems, thereby facilitating data-

driven practices for both patients and healthcare providers. The incorporation of telerehabilitation data offers physical and occupational therapists the ability to comprehensively assess and closely monitor patients, enabling informed treatment decisions. Simultaneously, patients themselves stand to benefit from such data, as it fosters an understanding of their progress and achievements, provides motivation, and offers insights into future expectations.

mHealth advancements can also be linked to higher patient autonomy and self-management (Brew-Sam & Chib, 2020), which offer the health care system better prospects for managing post-stroke care, preventing reoccurrence, and minimising post-stroke complications. Considering the aforementioned factors, it becomes evident that mHealth technologies hold promise as a viable and efficacious method for addressing the crucial aspect of self-management.

2.4.1 mHealth technologies for stroke self-management

Existing mHealth applications are already available which are designed to support survivors to manage the ongoing effects of stroke. These include for example: 1) Dexteria, which provides interactive exercises and games that target various motor and cognitive skills (Short et al., 2017). The application tracks progress over time and provides personalised feedback; 2) Jintronix, which combines virtual reality (VR) technology with motion-capture sensors to deliver personalised stroke rehabilitation exercises. The application offers a range of therapeutic activities and games that target specific areas of improvement (Yeng, Han, How, & Yin, 2022). It tracks users' movements, measures progress, and provides real-time feedback; and 3) RecoverNow, which offers assistance to survivors in their recovery process with respect to physical injury or undergoing medical treatment. This application enables survivors to track their recovery progress over time (Mallet et al., 2019).

The extensive use of mHealth technologies has enabled chronically ill patients such as survivors to easily access a range of information for making better decisions regarding their health care (DeBronkart & Sands, 2013; Mesko, 2013, 2014). Given the

increasing occurrence of chronic illness along with the rising mobile technologies acceptance, the use of mHealth technologies for self-management is promising (Hamine et al., 2015). mHealth technologies enhance the tracking and monitoring of health behaviours, communication among HCPs and patients, the following of treatment schedules, and the collection of health information (Simpson et al., 2020; Steinhubl, Muse, & Topol, 2013). For instance, a study conducted by Simpson et al. (2020) has shown that the utilisation of an app and sensor-based system for the prescription and monitoring of exercises demonstrated feasibility and safety in the context of stroke rehabilitation. The authors expressed, to ascertain the potential of this technology in facilitating increased exercise participation among stroke survivors, a definitive trial is warranted. The outcomes of such a trial will provide conclusive evidence regarding the efficacy and effectiveness of this technological approach in promoting exercise engagement following stroke.

The findings of another study conducted by Caldeira et al. have unveiled prospects for the integration of tracking strategies into rehabilitation systems, thereby facilitating data-driven practices for both survivors and HCPs. The incorporation of telerehabilitation data offers physical and occupational therapists the ability to comprehensively assess and closely monitor survivors, enabling informed treatment decisions. Simultaneously, survivors themselves stand to benefit from such data, as it fosters an understanding of their progress and achievements, provides motivation, and offers insights into future expectations (Caldeira et al., 2021). Therefore, dedicated mHealth technologies can potentially empower survivors with regard to self-care and enhance the convenience and personalisation of their care where they are assisted by HCPs.

The use of mHealth technologies to promote well-being has grown over the last decade (Garcia, 2019; Hughes et al., 2019; Kringle, Setiawan, Golias, Parmanto, & Skidmore, 2020; Stoyanov et al., 2015), with the global use of mobile devices reaching 5.1 billion phone users in 2019 (two-thirds of the global population). In 2016, the number of health-related applications available totalled 30,132 worldwide (Piran et al.,

2019). While most available health-related applications are wide-ranging wellness applications, the number of applications associated with patients' care and health condition management continues to increase and now represents 40% of all health-related applications (Research 2 Guidance, 2017).

In a study with elderly people, Changizi and Kaveh (2017) undertook to examine the effectiveness of mHealth in improving health behaviours. It was found that mHealth utilisation provided self-management, care, medication adherence, and behaviour promotion (diet, quality of sleep, mental health and physical activity). mHealth technology is useful in the management of disease, as shown by the preventative management of diabetes and cardiovascular disease through lifestyle changes for elderly people. Free et al. (2013) and Bhattacharjya et al. (2019) directed studies of mHealth technology used to advance the process of health care delivery. They found that mHealth technologies positively impacted the provision processes of health care, especially, for example, in rural areas. In addition, a study conducted by Ramesh et al. (2020) aimed to investigate the impact of technology specifically designed for stroke symptom identification on the diagnostic decision-making processes of clinicians. By analysing changes made by clinicians in their video-based stroke diagnoses when provided with data visualisations and predictions generated by a machine learning tool, notable insights were gained regarding the influence of computational aids on clinicians' decision-making. The findings indicated that these aids had an effect on clinicians' decisions, particularly when they aligned with or contradicted the clinicians' existing beliefs. Consequently, it is recommended that future computational aids for stroke diagnosis prioritise supporting clinicians in reinforcing their decisions rather than solely providing them with an overwhelming amount of quantitative information that may hinder or confuse their judgment.

As a result, self-management and mobile-based interventions are planned to engage survivors in accessing the support they need. People who have high chances of a stroke are in low-income and middle-income countries (Chimatiro & Rhoda, 2019; Yan et al., 2016), though the rate is currently increasing in high-income nations too. Statistics

have also revealed that people who have financial stress or financial instability have high chances of stroke occurrence. Survivors belonging to low socio-economic groups are also, at times, unable to afford the resources required to manage post-stroke complications (Sureshkumar, Murthy, Kinra, Goenka, & Kuper, 2015). Hence, in order to make health care services financially accessible to low-income and middle-income survivors, and to encourage them to participate in health care practices for better health outcomes, mHealth applications are seen as a potentially effective innovation. However, the digital divide – the inequality of access to mHealth technologies due to socio-economic factors – is the greatest barrier to overcome, highlighting a need for affordable and accessible mHealth. App designers, therefore, have sought to design stroke-related mHealth applications to support this demographic with the self-management of post-stroke complications at low cost.

As has been discussed in section 1.1, stroke leaves survivors with different post-stroke complications such as physical and/or psychological complications, varying survivors' needs. App designers have the ability to design applications accordingly to provide exercise activities, which support survivors' physical complications and promote self-management, such as the STARFISH application (L. Paul et al., 2018). The applications contain built-in software to measure the physical activities of a survivor. The attitude and acceptance of primary caregivers and survivors towards mobile-based exercise programmes were examined by Mahmood et al. (2019). The authors found that 90% of survivors and 92% of carers showed readiness to accept and use mHealth applications. Mahmood et al. concluded that carers and survivors greeted the idea of mobile-based exercise programmes positively in low-resource environments. Also, Lynch et al. (2018) found that mHealth applications for enhancing the levels of physical activities in survivors are effective. The promotion of exercise or physical activity is therefore a positive health intervention for survivors.

Despite the advantages, mHealth applications provide; Krohn and Metcalf (2012) noted a high prevalence of obstacles to the implementation of mHealth applications which need to be overcome. These included lack of infrastructure, cost of ownership,

difficulty in technology acquisition, and resistance to innovation. Bajwa (2014) explained that security related to health information accessed through phones is a problem in regard to the use of mHealth applications. Remote connectivity and data transfer as provided by mHealth applications bring stringent security considerations as compared to traditional applications. Further, different policy determinations associated with mHealth include security issues and liability risk management can lead to costly implementation. Additional limitations include regulatory compliance, business risk modelling, standards for mHealth, and the unavailability of internet facilities (Pankomera & van Greunen, 2018), and these problems challenge the sustainability and scalability of mHealth initiatives.

Further to the challenges of sustainability and scalability, stroke-related mHealth applications were found to be poorly accepted by survivors for different reasons, such as survivors' unwillingness to engage with such applications (Brandenburg et al., 2017), due to post-stroke complications (Rinne et al., 2016), the lack of accountability in the information provided by most applications, the poor functionality of applications, or lack of online interactions with HCPs (H. Zhang et al., 2020), all of which led to poor UX. Potential advantages including portability and access highlight the importance of studying the factors that have influential roles in developing good UX for mHealth applications and that can lead to the acceptance of mHealth applications by the chronically ill. For these reasons, it remains important to explore survivors' UX in their interactions with mHealth applications.

2.4.2 Potential for mHealth applications considering user experience (UX) in the context of human-computer interaction (HCI)

Designing interactive interfaces, systems and services has been a concern since the birth of personal computers in the 1970s. Several methods were developed to tackle this concern. User-centred design emerged out of human-computer interaction (HCI) research as a method to improve interactive software systems (Norman & Draper, 1986), and deal with the demands for improved UX (Benyon, 2019). The term UX was coined by Norman and Draper (1986) in regard to usability testing. UX has emerged

during the internet era to highlight the engagement of the whole interactive experience. The user-centred method allows designers to develop the design according to users' needs, expectations, capabilities and experiences. User-centred design involves a user as an active participant and co-designer in the design process (Sanders & Stappers, 2008).

UX involves the users' perceptions and thoughts (Norman & Nielsen, 2019). Further expectations, moods, and needs can also be associated with the features of a service or product, the context of usage and the period in which interactions occur (Biduski, Bellei, Rodriguez, Zaina, & De Marchi, 2020). Dedicated UX is concerned with the design of systems, websites, and applications to support cooperation between individuals and with the development of novel applications. HCI's concerns are about how to design such experiences in a user-centred way that considers users' preferences and abilities to make sure that services or products are acceptable and usable. Therefore, good UX aspects need to be tested or applied in designing stroke-related mHealth applications to assess and increase their acceptance.

There are a number of dedicated mHealth applications for stroke already available on the market given the potential they have to offer for better quality of life and disease management. However, the challenge is to engage survivors on a long-term and ongoing regular basis in their use of applications (Cechetti et al., 2019), despite the lack of insight into how HCPs, patients and app developers perceive mHealth applications (Lewis, 2013). Developing effective mHealth applications through appropriate evaluation is still needed to gain insights into experiences involving these applications (Nelson, Mulvaney, Johnson, & Osborn, 2017). Moreover, the design of applications that effectively include the UX in the process can further address the deficiency in establishing long-term usage.

Effective usage of mHealth applications could contribute to increasing access to health care services providing information and support in treatment. Moreover, such tools could enable interactions between HCPs and patients by involving patients more actively in maintaining their health care (Qudah & Luetsch, 2019). App designers will be

required to consider a number of categories, namely the maintenance of personal health archives, training, interaction, and monitoring of information (Mosa, Yoo, & Sheets, 2012). Although mHealth applications might target diverse pathologies, they are all capable of supporting and improving patients' quality of life (Abaza & Marschollek, 2017).

Given these capabilities of mHealth applications, current UX features can act as enablers to prompt feelings about systems, services or products. Zarour and Alharbi (2017) identified three core elements of UX, namely users, products and the context of usage. These three elements contribute relationally to the creation and improvement of the interaction between users and products. These may take into account UX responses to potential privacy issues, context, functionality, service reaction time and infrastructure. Reflecting on long-term UX, it is necessary to understand that a system can evolve and, yet, that a user who uses it will do likewise in finding out how to interact and engage with the system. To further understand this aspect, identifying what factors affect this interaction and engagement is the purpose of the next section in providing insights into how good UX can be addressed.

2.4.3 Factors that are associated with UX of mHealth applications

Mobile devices are effective and flexible tools for providing health-improving applications to improve cognitive function of stroke-affected survivors. mHealth applications are effective in assisting physical activities and healthy behavioural changes, enabling individualised content, providing real-time feedback and facilitating social assistance, as demonstrated by L. Paul et al. (2018). Further, some applications can record health values like body temperature (Naik & Sudarshan, 2019). mHealth applications, therefore, not only offer comparatively inexpensive and entertaining ways of encouraging and improving the cognitive and physical activities of survivors but also have the capability for health monitoring of survivors (Sarfo et al., 2019). Despite the potential that mHealth applications offer, the literature shows that there are additional factors to consider associated with the UX of mHealth applications that affect the use. Factors have been classified into four main categories: 1) the design of mHealth

applications; 2) post-stroke complications that affect usage; 3) mHealth applications acceptance and 4) social support. These four categories are discussed below.

2.4.3.1 The design of mHealth applications

Technology design is a key factor affecting the UX and use of mHealth applications, including, for example, size of the font, keyboard, text and button; difficulties with using touch phones; difficulty in locating buttons or in navigation; complexity of applications; lack of real-time communication; complexity in exchanging information; customisation; and game-based design (Aljaroodi et al., 2017; Brandenburg et al., 2017; Fletcher & Jensen, 2015; Mallet et al., 2016; Micallef, Baillie, & Uzor, 2016; Moron, Yanez, Cascado, Suarez-Mejias, & Sevillano, 2014; Wong, Wang, Stolwyk, & Ponsford, 2017). Considering such factors in design would contribute to the development of good UX, therefore, further exploration of survivors' expectations in this context is beneficial. However, as I remarked earlier in Chapter 1, UX is also associated with the internal states of users, the design of mHealth applications could, as such, further benefit from exploring, through a mental model that survivors may have, how something should work in alignment with survivors' experiences in real life. Older survivors are likely to count on their 'rule of thumb' strategy to make decision(s) and to perform actions for obtaining and incorporating up-to-date information to construct knowledge (Price, Crumley-Branyon, Leidheiser, & Pak, 2016). Their strategy may apply to known functions of mobile devices or applications. Yet, when the functionality of mobile applications is integrated with unfamiliar application functions, survivors may struggle in their utilisation. Complexities, customisation, and game-based design aspects are considered further, as they are identified as the main features of design for increasing acceptability rate by Aljaroodi et al. (2017), Allen, McGrenere, and Purves (2008), Fletcher and Jensen (2015), Hamm, Money, and Atwal (2017), and Micallef et al. (2016).

Considering mHealth applications, due to cognitive limitations, survivors may constantly experience complexities in deciding how to navigate through application functions (Paez & Del Río, 2019), since navigation relies on recalling a series of actions.

This aspect highlights that integrating survivors' perspectives into the design process is significant in providing app designers with opportunities to explore the barriers hindering survivors' acceptance of mHealth applications. Such factors validate the association between physical impairment and cognitive skills impacted as a result of stroke, and usability problems occurring as a result of the complexities in the functionality and design of mHealth applications (Wildenbos, Jaspers, Schijven, & Dusseljee-Peute, 2019). Therefore, the effective design of mHealth applications that deliver functionality aligned with the survivors' needs is as important as the innovation itself.

Customisability was found to be a driver that facilitated people with aphasia to use mHealth applications (Allen et al., 2008). Studies have used different kinds of mHealth interventions to assist survivors in post-stroke rehabilitation (Aljaroodi et al., 2017; Allen et al., 2008; Ballard, Etter, Shen, Monroe, & Tien Tan, 2019; Mallet et al., 2016); nevertheless, all studies commonly identified that to enhance the adoption of mHealth applications, app designers should integrate customisation features within the design. Customisation makes it easy to tailor the application to suit the needs and preferences of an individual survivor. It is, as such, an evolutionary feature that is designed to give everyone using the mHealth applications what they need. Instead of the application being static, customisation makes it dynamic such that it bends to the needs and desires of the end-user. Further, customisation may provide a feeling of individuality to survivors, a feeling that the controls are still in the hands of the user to meet their needs. In Aljaroodi et al.'s (2017) study, customisation which was performed through avatars, animations and other screen or caption features communicated a feeling of empathy towards survivors, thereby keeping them utilising the application (Cho et al., 2017). Customisation can help to trigger the sentiment of communicating importance to an individual. For this reason, survivors will feel more cared for and that they have more interaction with mHealth technologies, leading to greater adoption of these applications in the longer run.

The integration of gamification to keep survivors interested and engaged with the application act as a driver for the adoption of mHealth applications. Gamification refers to the employment of digital games in non-game environments (Deterding, Dixon, Khaled, & Nacke, 2011). As such, apart from entertaining users, its goal is to help motivate and inspire users towards achieving their own objectives. As a strategy, if done right, it can help in increasing the learning rate of survivors, and the overall motivation for engagement with the product (Aljaroodi et al., 2017; Ferreira et al., 2014; Moron et al., 2014; Rinne et al., 2016; Tang et al., 2016). Therefore, game-based mHealth applications provide the potential to overcome learning challenges to achieve a goal.

Studies of the integration of games into applications emphasised that games can work as physiotherapy activities for survivors (Rinne et al., 2016). Consequently, the assessment showed that physiotherapy game-based applications helped survivors to increase the time spent self-training by a continuous movement of hands. The games can be integrated to improve different sensory functions such as handgrip control and finger-swipe control. Game-based applications are also being driven by novelty in helping to fight memory problems (Charlier, Ott, Remmele, & Whitton, 2012), which are commonly experienced by most survivors. Further, Moron et al. (2014) explained that gamification works as an interactive medium having positive effects on cognitive functions of survivors, such as enhancing memory and improving the span of attention. Thus, video games integrated within the application can help survivors in memory training which will increase their motivation to increase their use of these applications.

Accordingly, the use of game-based mHealth applications could assist survivors in significantly improving their physical and psychological capabilities. They create the prospect of facilitating recovery in a home-based environment, consequently making continual involvement more likely (Aljaroodi et al., 2017). Thus, fun activities and gamification elements were found to be influential in keeping survivors interested and motivated. These elements added value to the services survivors were getting through the application. In spite of this, the adoption of game-based applications for older adult survivors can be challenging because older adults are not the most avid consumers of

the gaming industry. As such, the integration of games to suit this elderly profile is important to enhance their adoption of mHealth applications (Ferreira et al., 2014).

One study has identified eight principles as essential components in the design of games which include that games should: 1) necessitate focused attention from survivors, enabling them to engage deeply with the game; 2) present an appropriate level of difficulty, aligning with the survivors' skill level to stimulate a sense of challenge and accomplishment; 3) facilitate the development and mastery of survivors' skills, offering opportunities for skill progression and improvement; 4) offer survivors a sense of agency and control over their actions within the game, allowing them to shape the outcome through their decisions and interactions; 5) provide survivors with explicit and well-defined objectives, ensuring clarity and direction in their gameplay experiences; 6) give timely and relevant feedback, enabling survivors to assess their performance, make adjustments, and learn from their actions within the game; 7) engender a state of deep engagement and immersion, captivating survivors and fostering a sense of effortless involvement in the game world; and 8) facilitate social interaction among survivors, creating opportunities for collaboration, competition, and social engagement within the game environment (Magnusson, Rasmus-Gröhn, Rydeman, & Caltenco, 2018). These principles, when adhered to in game design, contribute to enhancing the overall gaming experience and supporting meaningful survivors' engagement.

However, a concern highlighted in the literature is that continuous usage of such game-based technologies may contribute to an over-dependence on these technologies, which in turn may lead to lack of interest in confronting new health-related challenges and over-dependence on external motivation. This requires app designers of game-based applications for health to incorporate surprise features and new challenges to assist in overcoming or mitigating the tedium associated with regular challenges within applications. Design strategies for game-based applications must encourage self-regulation and self-empowerment, challenge survivors' abilities, and provide ongoing support for survivors with diverse impairments through the customisation of game-based mobile applications (Kytö, Maye, & McGookin, 2019).

The literature showed that integrating a good interface into the design can contribute to overcoming design-related barriers (Aljaroodi et al., 2017; Ferreira et al., 2014; Hamm et al., 2017; Mallet et al., 2016; McMahon, Vankipuram, Hekler, & Fleury, 2014; Moron et al., 2014). App designers, as such, are expected, while applying identified features, to apply the concept of simplicity to the design to improve UX and survivors' acceptance of such applications (X. Wang, Du, Zhu, Xu, & Zhang, 2021).

2.4.3.2 Post-stroke complications that affect usage

Post-stroke complications are presented in the literature as significant, and they may limit the use of mHealth applications, leading to poor UX. For example, in the context of physical barriers, the functionality and skills of survivors are restricted because of the physical and cognitive consequences of stroke (Brandenburg et al., 2017; Fletcher & Jensen, 2015; Tang et al., 2016; Winberg et al., 2017). Wong et al. (2017) also included the following factors that minimise survivors' engagement: reduced memory recognition; loss of ability to speak and communicate; inability to use mobile applications; loss in process and memory capacity; and barriers associated with age and decline in spatial activity.

As such, the effective usage of mHealth applications by survivors is complex and related to their physical ability, cognitive skills, and perception. The physical complications that survivors experience make it difficult to use mHealth applications and need to be considered. For instance, it could be problematic to click on a small button on mobile interfaces and weakness with one arm can make holding mobile devices in one hand uncomfortable.

Cognition barriers are associated with reduced capacity for work, attention, and perspective, which can also negatively influence mHealth application use. The impact of this barrier is that survivors can process fewer distinct information pieces in a given time, and the ability to remember also declines more quickly (Farage, Miller, Ajayi, & Hutchins, 2012). For example, recall of a task such as taking pills becomes an issue. Moreover, survivors with cognition issues need more time to learn how to use mobile applications

as difficulties in mentally transforming spatial information can influence mobile task performance negatively (Paez & Del Río, 2019). Furthermore, a deterioration in representational fluency and numeracy can hinder survivors from understanding content specific to mHealth applications (Wildenbos, Peute, & Jaspers, 2018).

The studies of Allen et al. (2008), Brandenburg et al. (2017), and Brandenburg, Worrall, Rodriguez, and Copland (2013) have pointed out 'Aphasia' as another post-stroke impairment that acts as a barrier in accessing information and using mHealth applications. Aphasia is a communication impairment that prevents survivors from understanding and communicating with others and hence this impairment stops survivors from interacting with other people or technology. Aphasia affects approximately a third of survivors (Van Oers et al., 2018); as a result, even fluent aphasia, where survivors have flowing speech with normal grammatical structure but lacking in actual content, has an effect on survivors' quality of life, including an ability to participate fully in everyday activities and maintain social participation.

The age factor was presented as significant in the literature and includes the limitations on older patients' abilities reducing their use of technology (Marcheschi, Von Koch, Pessah-Rasmussen, & Elf, 2018). Due to the age factor, physical and cognitive degradation can make it difficult for survivors to use mHealth applications or understand their usage. Paez and Del Río (2019) stated that older mobile devices users, even after a year of experience, still had misapprehensions of simple functions and operations and, as such, still faced complex issues with respect to understanding how mobile technologies are structured. Older survivors might find it challenging, for example, to use small-sized screens that contribute to usability issues. Therefore, considering ageing characteristics and stroke complexities to assess the usability problems of mHealth applications for survivors would be useful, since they would provide insights into the inherent causes and impact of the usability issues survivors face. In addition, having specific user interface designs for survivors is important in reaching the goal of older survivors' independence. As such, it could be argued that the elements of user interface design should be adjusted to the older survivors' population needs. It is important to

point out that current knowledge of usability-driven concepts regarding older survivors' utilisation of mHealth applications has not yet been applied to these technologies.

Usage obstructions also point to the evidence that survivors need assistance with how to use aspects of the technology so that they can use mHealth applications. Marcheschi et al. (2018) found that the effect of physical environment (interior or architecture design features) differs according to the type of post-stroke complication. Thus, considering stroke-related factors, app designers are encouraged to collaboratively design easy-to-use and customisable interfaces with rich content to motivate survivors to use these applications (Cornet et al., 2020; Trombetta et al., 2017). As such, it could be argued that emphasising user interface design and aligning and dedicating its elements to survivors' needs, becomes significant.

2.4.3.3 mHealth applications acceptance

The literature showed that the acceptance of mHealth applications can be affected by many factors, including users' attitudes towards and thoughts about using mHealth applications, and lack of knowledge and experience of the benefits that these technological innovations can provide (McMahon et al., 2014; Wallace, Graham, & Saraceno, 2013). Training to increase the knowledge of survivors can be a solution (Barnard, Bradley, Hodgson, & Lloyd, 2013). However, a point of interest is that technology always brings change which may meet resistance prior to its adoption (Ngafeeson, 2015; Siegel, Acharya, & Sivo, 2017). This could lead to the lack of acceptance by survivors of the use of applications for their self-management. The lack of acceptance is also associated with the fear that the technology is too difficult for them to use (Khasawneh, 2018).

Fear has a significant role in regard to survivors regaining confidence (Horne, Lincoln, Preston, & Logan, 2014). The fear of using technology, commonly known as technophobia, is very common and may significantly impact the adoption of technology (Khasawneh, 2018). Such a fear might prevent survivors from using technological devices for monitoring physical or cognitive activities. Older adults, in particular,

commonly resist any new technology or technological device or application (Nimrod, 2018). Nimrod stated that many older adults consider they lack skills to use or learn new technology and they find the learning process challenging. Similarly, Cooray, Matusevicius, Wahlgren, and Ahmed (2015) illustrated how patients or older people with moderately severe stroke find it problematic to use phones, either due to their unfamiliarity with the technological device or due to cognitive impairments. In addressing the lack of confidence users may have, training may help them to regain confidence and find the learning process less challenging or even an accomplishment. Lack of training, therefore, may form a barrier for survivors, as pointed out in the study by Mallet et al. (2016).

2.4.3.4 Social support

Accessible resources, supportive social environment and mastery of the caregiving role were found to be facilitative factors (Kamwesiga, Tham, & Guidetti, 2017). Family members who acted as carers considered such drivers, along with technology-based assistance, to be positive in encouraging survivors to perform rehabilitation including the use of applications (Y. Kim et al., 2019). Carers can suffer from challenges, such as isolation, as most of the time, they are with survivors and cannot find enough time to mingle with other people (Greenwood, Mackenzie, Cloud, & Wilson, 2009). Lastly, there is the issue of financial burden, which cannot be overlooked (Bhattacharjee, Vairale, Gawali, & Dalal, 2012). Often, family as carers have to forego their usual commitments to take care of survivors (Greenwood et al., 2009). All these issues point to the circumstance that carers have to maintain professionalism at times to ensure that they are available for immeasurable amounts of rapport and affinity with survivors (Greenwood et al., 2009).

Sureshkumar et al. (2016) asserted that mobile-based stroke-related applications help family members and carers to understand the significance of stroke rehabilitation and assist survivors in their use of mHealth applications in daily life. In this case, mHealth applications can act as a motivator for the carers. Furthermore, a recent study found that 92% of carers are ready to embrace mobile-based technology for post-

stroke rehabilitation purposes (Mahmood et al., 2019). As such, while family members and carers are considered to be key factors in the rehabilitation process (Kurniawati, Rihi, & Wahyuni, 2020), they are likely able to encourage and support survivors in using mHealth applications for managing post-stroke complications, which may contribute to survivors' acceptance of such applications. Further, Xie and Kalun Or (2020) stated that HCPs have a major role in promoting mHealth among survivors. These suggest that mHealth applications have the potential to transfer the burden from HCPs to carers if survivors need support to engage with mHealth applications.

Assistance from family members, HCPs and carers could play a crucial role in driving and motivating survivors to use mHealth applications. As family members play a fundamental role in the life of the survivor, they could positively influence the survivor towards mHealth application use. The survivors' families were recognised as a support avenue for enabling survivors to use smartphones (Brandenburg et al., 2013; Ferreira et al., 2014; Fletcher & Jensen, 2015; Mallet et al., 2016; Moron et al., 2014). This suggests that support from HCPs, family and carers may decrease the despondency that develops due to the isolation after stroke and increase the feeling of confidence in the rehabilitation process for getting better. As such, survivors may feel confident in using mHealth applications for rehabilitation purposes, which supports the measures taken to reduce the factors acting as barriers.

2.4.4 The primary aim of this PhD work

Three existing mHealth applications including Dexteria, Jintronix, and RecoverNow are discussed above. These applications may lack meaningful engagement from survivors. Users' involvement, especially in the form of user-centered design methodologies such as usability testing, is important to gain insight into survivors' preferences, and the challenges they may face. Without extensive user involvement, there is a risk that the applications may not fully address the specific needs and concerns of this population. Moreover, these applications may lack features that motivate sustained involvement/engagement, such as gamification elements or regular updates to keep the content updated and engaging. These applications may lack sufficient

flexibility with respect to adapting exercises or tailoring the content to accommodate survivors' differences. There is also a possibility that these applications may firstly focus on a specific aspect of recovery such as motor function while neglecting other important aspects such as psychological supports. Therefore, while these applications may offer valuable support for survivors, their development processes could get benefit from considerations of survivors' needs and preferences. Focusing on user involvement, customisation, survivor-centred design, considering rehabilitation approaches and long-term involvement strategies could enhance the UX of these applications.

Notwithstanding the significant advantages offered by mHealth applications, it is important to acknowledge that they can potentially pose risks to a patient's life and well-being if they fail to operate as intended (Cook, Ellis, & Hildebrand, 2016). It appears that the majority of mHealth applications are being developed without adhering to established standard and specialised mHealth guidelines, not undergoing rigorous scientific evaluation or having evidence to support their claims of usability, functionality, and behavioural aspects. (Larson, 2018). Guidelines encompass a collection of criteria used to evaluate the safety, efficiency, and usability of mHealth applications' interfaces across diverse user populations (Andrade, Nascimento, Wood, & Calil, 2015). Consequently, it becomes imperative to regulate mHealth applications by incorporating relevant guidelines to assess their effectiveness, acceptability and safety for patients.

A range of existing guidelines such as Nielsen's principles (Aldekhyyel, Almulhem, & Binkheder, 2021; Nielsen, 1995), Xcertia (Xcertia mHealth App Guidelines, 2019), HE4EH (Khowaja & Al-Thani, 2020), and UGmHA (Nasr, Alsaggaf, & Sinnari, 2023) have been drawn on to design mHealth applications. Some of the guidelines such as Xcertia and HE4EH cover specific features such as privacy, consistency, and interactivity; while others such as Nielsen's principles are more general. Some do not consider accessibility features for people experiencing disability or older adults. Despite survivors having unique and specific access needs, there are no guidelines which explicitly attend to their needs as a specific user group. As such, the aim of this study is the development of a bespoke set of guidelines tailored to stroke survivors to provide recommendations and

standards for the development, implementation, and evaluation of mHealth applications in stroke rehabilitation. Guidelines should typically cover various aspects, including user interface design, functionality, usability, data privacy and security, clinical integration, and evidence-based practice. The guidelines should serve as valuable resources for app developers, health care providers, and researchers to ensure the quality, effectiveness, and safety of mHealth applications for survivors. It is important to note that the guidelines should continuously be evolving as new evidence and technologies emerge. Therefore, the primary goal of this PhD work was to develop a set of guidelines to ensure that app designers will be able to critically evaluate the evidence base behind their applications to ensure they align with established standards and guidelines and accordingly contribute to the mHealth technology research and practice.

2.5 Conclusion

Stroke is the second most prominent reason for mortality worldwide, the third most prominent in New Zealand, and it is one of the leading reasons for disability worldwide. The number of stroke cases and survivors living with ongoing post-stroke consequences is increasing due to the growth in population and the ageing of the population worldwide. This increase in the number of survivors lessens our ability to meet survivors' needs. Through technology and new approaches to care, survivors now have the possibility of actively engaging in managing their own conditions in terms of medical, emotional and role management.

mHealth applications are becoming effective ways of delivering health services to support survivors to manage their conditions and improve their health outcomes (Mallet et al., 2019). mHealth technologies have been used in applications involving heart attack and diabetes for collecting, analysing, reporting and using data in real-time. The successful interactive features of other applications demonstrate some overlaps that could be tailored to survivors. In this context, limited research is reported on the use of mHealth applications by survivors. Further to this, evidence-based studies

reported poor acceptance of mHealth applications by survivors, despite the potential they offer.

Together, these factors call for further investigation exploring digital interventions delivered via mobile devices aimed at survivors, along with an exploration of survivors' perspectives to identify their expectations and the factors that affect their acceptance of mHealth applications. The literature identified key factors that assisted in broadening the development of the doctoral work reported in this thesis. Accordingly, this doctoral work attempted to find out what contributes to low acceptance rates, given that so little was known about the contributing factors, an area of concern in the literature. With this idea in mind, in this PhD inquiry, I explored potential participants' views, in particular survivors, with a social constructionist view (discussed in the next chapter) to identify factors that may influence survivors' decisions around accepting mHealth applications to contribute further knowledge. As a result, a set of guidelines - the aim of this PhD inquiry - were constructed to assist app designers to develop mHealth applications with good UX to support survivors as well as to increase acceptability of such applications. From this point, this thesis aims to report what has been done to achieve the aim of this doctoral work.

Chapter 3: Philosophical Stances and Methodology

3.1 Introduction

In this chapter, I situate myself theoretically and provide an overview of my selected methodology. The methodological origins of this inquiry, the terminology used, and how my knowledge and perception of these have developed during this project are discussed. I draw on Crotty's (1998) framework as a structure for this chapter (Figure 3.1, below). Therefore, first, I provide an overview of social constructionism and the associated epistemological assumptions that shape this inquiry. Four core epistemological assumptions of social constructionism are: research requires engagement with the social world; the world is culturally and historically contingent; multiple realities co-exist; and social knowledge is a construction. These assumptions are discussed in section 3.2 below to highlight their significance in creating actionable outcomes to achieve the aim of this PhD inquiry.

Second, I introduce interpretivism and, more specifically, symbolic interactionism and hermeneutics as the theoretical stances that underpin this inquiry. I employed symbolic interactionism to view survivors' perceptions of and expectations from mHealth applications as composed of symbols that participants use to establish meanings, develop views about the survivors' world, and communicate with one another. I sought to be a thinking being who acts according to how I interpret the situation. I also employed hermeneutics to engage with data that was collected from participants to present an interpretation that emerged from the interaction. These two theoretical stances are further discussed in section 3.3 below.

Third, I situate this inquiry methodologically to provide insight into the applied methodology. I sought to employ a methodology that allowed me to work collaboratively with participants to produce practical knowledge and I found action research methodology was an appropriate fit. Action research is a collaborative study

process that balances problems-solving action with research; it is put into operation in an interactive setting with data-driven collaborative inquiry to identify underlying causes to provide practical solutions that make change happen (Reason & Bradbury, 2008). Lewin (1946) stated that action research is a process in which knowledge acquisition occurs through action and for action (Adelman, 1993). Section 3.5 discusses the origins of action research. Sections 3.6 and 3.7 introduce the action research model adopted in this study and three types of associated approaches that underpin this inquiry.

Lastly, I discuss how the rigour and quality of this inquiry are achieved. From my research experience, I was aware that to maintain rigour and quality, the research must involve knowledge that assists in describing practical reality and is methodical and applicable in reality. I found that the ‘practical knowing’ concepts proposed by Coghlan (2016) form an appropriate framework to provide the rigour and quality of the outcomes. Coghlan stated that four elements – namely, focusing on common concerns, socially driven knowledge, acknowledging the uniqueness of each situation, and applying ethical dimensions – characterise a quality inquiry. As such, these elements are employed in this inquiry. These four characteristics are further discussed in section 3.8, below.

The chosen epistemology, theoretical stance, and methodology guided me in choosing methods and helped shape the use of these methods. Attending the doctoral training programme was also helpful in refining the use of the methods. This programme comprised six modules over six weeks and was organised by MedTech CoRE⁶ for first-year PhD students to complete. Chapter 4 will introduce and discuss the methods and techniques that were used to socially construct knowledge, along with the rationale for my choices.

⁶ MedTech Centre of Research Excellence (MedTech CoRE). MedTech CoRE is a research platform undertaking basic research into health applications.

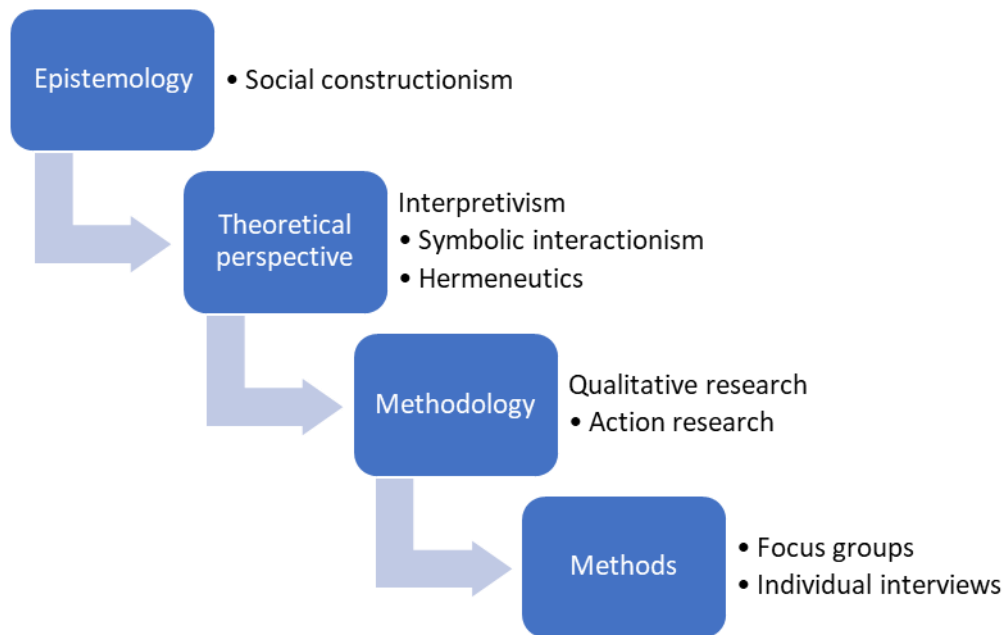


Figure 3.1: Four elements of this thesis, adapted from Crotty's (1998)

3.2 Epistemological foundations for this PhD inquiry

Epistemology is the study of the nature of knowledge and how knowledge is acquired or constructed in a given situation (Crotty, 1998). Maynard (1994) described epistemology as “concerned with providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate” (p. 10). Ontology, in turn, is the study of the nature of realities and the existence of realities in the world (Ormston, Spencer, Barnard, & Snape, 2014). Blaikie (1993) described ontology as ‘study of being’ and took it to mean “the assumptions that a particular approach to social enquiry makes about the nature of social realities” (p. 6). In the section below, I focus primarily on epistemology and I address ontological issues as they emerge, when I need to discuss 'being', for example, in sections 3.3, 3.7.2, 3.8 and 3.8.3.

This inquiry adopts social constructionism as the epistemological foundation; it is based on the belief that truths or meanings come into existence through individuals' engagement with the realities in the real world. Meanings are, therefore, not discovered but constructed. In this perception of knowledge, individuals may construct meanings in diverse ways with regard to the same phenomenon (Crotty, 1998). Consistent with Crotty's (1998) view, Hjelm (2014) regarded social constructionism as one of the key epistemological orientations in the social sciences, one that offers diverse frameworks for understanding the human world and emphasises the social, historical, and cultural forces that shape the human world. Berger and Luckmann (1966) viewed social constructionism similarly, as a way in which realities in the world are communicated through interaction between individuals who are, in turn, shaped by the social and cultural world they live in.

The views of Crotty (1998), Hjelm (2014) and Berger and Luckmann (1966) highlight four main aspects of social constructionism, all of which specifically relate to my approach in this inquiry. First, from a social constructionist viewpoint, researchers are engaged with the world and with objects in the world. The world and objects in the world may be meaningless in themselves but both associate in the creation of meanings and, as such, they need to be explored; knowledge about the world comes from this engagement and interaction among individuals in the world. In this sense, I, as a researcher, approached my participants in spirit of openness to their potential for making meaning and constructing knowledge about what survivors need from mHealth applications.

Second, the centre of the constructionist stance is "the collective generation and transmission of meanings" (Crotty, 1998, p. 58). Knowledge of realities, as such, is constructed by engaging with the social world. Constructionism taken in this sense draws attention to the hold culture has on society, as it affects the way in which people perceive their world (Hjelm, 2014). Society is composed of individuals and each individual may have a unique perception or experience. Each person's way of perceiving and making sense of their world may be different but is as acceptable, and as worthy of

respect, as any other (Crotty, 1998), and therefore should be voiced. Given the uniqueness of each experience, 'the way things are' is about the sense individuals make of those things. The ways in which people see things are culturally and historically shaped. As such, individuals may sense and interpret the same phenomena differently at divergent times and in divergent places.

Third, social constructionism is relativist (Crotty, 1998), meaning that it is based on the belief that reality exists in relation to the social world and that knowledge produced by relativist interactions provides solutions to problems (Creswell, 1998). Following the precepts of relativism, I hold the notion that different participants may live in quite divergent worlds and their divergent worlds constitute for them different ways of knowing, different sets of meanings, and multiple realities. For that reason, in this thesis, I do not mirror what realities exist. Instead, I report how realities are perceived and reacted to, and thus meaningfully constructed within the community. As such, each participant's world, situation, or experience is a unique world, situation or experience that may generate exclusive meanings that are different from one another. Knowledge then emerges from the interpretation of these exclusive meanings.

Lastly, social constructionism assumes that '*something*' is socially constructed. This '*something*' is knowledge, one of the aspects of social constructionism. In this PhD inquiry, I refer to the 'guidelines' as a social construct. From a sociological viewpoint, the social construction of knowledge comes from individuals' experiences and implies the epistemological assumptions of diverse individuals and the knowledge-construction practice through which those epistemologies are enacted (Riley, 1996). In this inquiry, I am interested in knowledge-construction practice to the extent that the knowledge helps to design good UX mHealth applications considering their current low level of acceptance. Therefore, I intended to explore the experiences of participants who are considered collaborators in the knowledge-construction process.

The epistemological stance of this inquiry is thus the perspective that knowledge, and thus meaningful realities, in essence, are contingent upon participants' experiences, and each participant's experience is as valuable as any other and should be voiced. In

this sense, knowledge is constructed through my interactions with my participants, and communicated and shared in a social context. Given that, there was a need for a theoretical lens to look through the participants' experiences to make sense of the realities that exist in their world. I found the interpretivist view consistent with social constructionism as their assumptions overlapped. The next section explores further the theoretical foundations for this doctoral work.

3.3 The theoretical stances that underpin this inquiry

There are distinctively different theoretical perspectives, which impact how a particular methodology and method works within research. These theoretical perspectives, broadly framed, include positivism, interpretivism, and pragmatism. Interpretivism is the theoretical perspective adopted in the inquiry reported in this thesis; it serves to frame research questions, the design and undertaking of the inquiry, and the analysis of the outcomes. Interpretivism involves understanding and explaining human and social realities. Schwandt (1998) described it as being "conceived in reaction to the effort to develop a natural science of the social. Its foil was largely logical empiricist methodology and the bid to apply that framework to human inquiry" (p. 125). This inquiry holds to that notion and seeks culturally and historically derived interpretations of social realities that contribute to knowledge construction.

The interpretivist paradigm posits that an interpretivist rejects the belief that one fact, truth, or reality occurs. An interpretivist believes it is conceivable that there are multiple facts, truths or realities that can be incompatible, but all believed and considered to be facts simultaneously. For instance, different participants in this inquiry may understand and interpret the acceptance of mHealth applications by survivors in diverse ways, which may be completely opposed to each other, but the survivors' experiences of and perspectives on the acceptance of mHealth applications remain real. The central objective of this inquiry is to produce knowledge through interacting with participants and this objective was central in informing the selection of methods to underpin this inquiry.

An interpretivist researcher posits that truth is contextual and active. In turn, I believe that truth is an occurrence in which there is reality and a real situation. The truth also must derive from a reliable source. An interpretivist researcher does not seek an absolute single truth or attempt to 'find' or quantify knowledge. Rather, an interpretivist approach explores the construction of knowledge through interactions within the social world. Therefore, researchers and their participants are considered to co-produce data, as the data itself is collected and produced by these relativist interactions. This influences the methodology employed, which is defined as a qualitative, explorative, or interpretative approach and endeavours to incorporate a recognition of the context in which outcomes are produced (Ormston et al., 2014). It is thus common for research with an interpretivist focus to adopt a qualitative methodology.

The discussion to this point corresponds to the idea that an interpretivist approach is a good fit for this inquiry. However, the view of interpretivism is not clear to the point of being unambiguous when researchers frame their position within research against a process of establishing a paradigm and its consequent influence on methodology and methods (Crotty, 1998). A paradigm is described as a philosophical perspective in which an inquiry is influenced by the set of beliefs and knowledge that researchers use to support how they structure their research question(s), methodology, and methods (Chinn & Jacobs, 1987). Therefore, the interpretive paradigm is not a straightforward concept or perception but comprises three core philosophical views, symbolic interactionism, hermeneutics, and phenomenology, each of which has been widely used as the basis of interpretive study methodology, each with distinctive characteristics that maintain theoretical clarity (Crotty, 1998). Symbolic interactionism and hermeneutics were selected as theoretical foundations for this inquiry.

Symbolic interactionism enunciates three core principles: 1) that individuals act in accordance with the meanings they generate from their world; 2) that the meanings are derived from social construction; and 3) that the meanings are revised and interpreted by individuals when they interact with their world (Blumer, 1986). Symbolic interactionism involves individuals to "take the role of others" (Crotty, 1998, p. 74). The

role-taking in symbolic interactionism is an interaction, which is achievable because of the 'symbols' that are the language and other tools people use to share and communicate. Through dialogue, an individual can become aware of other individuals' perceptions, experiences and feelings and can interpret emerged meanings (Crotty, 1998). Therefore, symbolic interactionism demands a level of engagement to perceive an individual as a social object and thus to see others within the same context. In this respect, symbolic interactionism looks to draw researchers, in the context of the inquiry, into the researched. The interaction is reached once researchers and participants achieve common understanding through language and shared experiences.

This inquiry took symbolic interactionism as a theoretical foundation as it is a perspective that expects involvement in the participants' experiences. With this approach, this inquiry could gather the meanings that participants attached to their experiences and these meanings could be comprehended by orientating me to the perspectives of participants through the usage of symbols. With this orientation, there was engagement and, by experiencing the symbolic perspective, I could understand how participants were able to attach the meanings that arose from language and other social constructs.

Hermeneutics is described as the principles and methods of interpretation used to understand meanings within or emerging from a text. As such, hermeneutics is a notion that language is the expression of social realities and, thus, the way realities are comprehended can be accessed through study of the texts and the sharing of meanings between communities (R. Palmer, 1969). The notion of the sharing of meanings situates hermeneutics in the view that interpretation is the understanding that we can communicate only as culturally and historically located humans in relation to social realities (Crotty, 1998).

In this inquiry, I took a hermeneutic stance as it allowed me to examine and interpret texts. The tenets of hermeneutics facilitated the interpretations to become apparent from texts on an assumption that texts are intended to commune meanings and those interpretations inform meanings. I also considered the hermeneutic approach

to be a relational approach involving both the text and reader of the text. In this sense, there was a relation between the transcriptions and me as the reader of the transcriptions making sense of participants' experiences when I analysed data. I refer to the process as '*hermeneutic reading*', which involves reiterated engagement with transcriptions; and '*hermeneutic meanings*', which are meanings that the reader interprets the intention of the message through engagement. Hermeneutic reading goes beyond what is expressed and, in this study, allowed me to create new understandings or meanings. In this sense, meanings emerged from participants' experiences to create new insights, with my intention being to communicate new meanings through engagement with the readers of this thesis.

The interpretive research paradigm, thus, has specific philosophical assumptions and specific schools of thought that inform the methodology. An appropriate methodology is then needed to align with the epistemological and theoretical perspectives of this inquiry to address issues that exist in the situation. A qualitative research approach employing an action research methodology was deemed appropriate as action research is an interactive research process that allowed me to work with participants in a collaborative manner to understand the situation and the social realities contributing to knowledge construction. The adopted methodology is discussed further below.

3.4 Methodological considerations of this inquiry

The research questions stated in section 1.5 required an appropriate methodology to satisfactorily respond to them. According to Silverman, the methodology employed should not be considered right or wrong, but rather it should be judged according to the extent to which it is suitably applied to respond to the research question(s) (Silverman, 2013). The most challenging phase of this inquiry was choosing the appropriate methodology to undertake this inquiry to respond to research questions.

There have been various perspectives that argue quantitative and qualitative methodologies are distinctive in their methodological and philosophical assumptions. However, using a mix of these two methodologies is widely supported to explore a phenomenon (Hesse-Biber, 2015). My experiences prior to instigating this inquiry were predominantly in utilising a mix of quantitative and qualitative methods. I believe that combining these two methodologies ensures rigour is maintained in research and quality research outcomes are produced. The justification for using mixed methods was studied and a common argument is that “the combination of both approaches can offset the weakness of either approach used by itself” (Creswell & Clark, 2007, p. 9).

Initially, my understanding of qualitative research and relevant philosophical assumptions was limited. I originally perceived the role of qualitative methodologies to be predominantly a way of describing, supporting, or validating quantitative findings. Throughout this inquiry, my perception of the diverse research paradigms that researchers use has been expanded as I explored the strengths, weaknesses, and potential applications that each methodology can have. A quantitative methodology is involved in calculating/computing and producing numerical data while a qualitative methodology produces textual data through interaction between researchers and the researched. In other words, qualitative methodologies explore a specific phenomenon through varied approaches to constructing knowledge, while quantitative methodologies use statistical analyses and numerical values to provide solid conclusions to answerable questions (Bryman, 2015). As a result, there can be no engagement between researchers and participants realities which does not lead to collaborative outcomes. While the epistemological foundation of this inquiry required socially construction of knowledge, quantitative approach was not deemed to be appropriate for this PhD inquiry.

The epistemological and theoretical stances which underpinned this inquiry drove the choice of appropriate methodology. The intention of this inquiry was to construct knowledge by exploring participants’ views on how survivors take up the acceptance of mHealth applications. Given that, I needed an appropriate methodology

that was congruent with the philosophical foundations of this inquiry to allow me to interact with participants and explore their views as well as collaboratively work with them to construct knowledge. Qualitative research, thus, underpinned this inquiry due to: 1) its interactive nature, which allowed me to engage with my inquiry since, as Bryman (2015, p. 8) explained, it is “the way in which people being studied understand and interpret their social reality is one of the central motifs of qualitative research”; and 2) its social nature, which allowed me to co-construct knowledge since, as argued, the social nature of qualitative research refers to how both the researcher and the study participants can affect the outcomes that develop out of the research. Qualitative research is an umbrella term used to describe a diversity of methodologies and therefore since my intention was to reach an agreement with the people involved on what action to take (Coleman, 2015), the action research methodology was appropriate for promoting collaboration with participants and enabling common issues of practice to be addressed by way of reflection and action, so that a contribution is made to practical knowledge construction.

Before I introduce the adapted action research approach that I used, I present an introduction to action research to provide a rationale for this methodological choice.

3.5 Introduction to action research – the origins

One contentious aspect of action research is identifying its origins. Kurt Lewin (1946) is the first person who formalised action research as a methodology (Marrow, 1977). Lewin (1946), a practical theorist, was well known as a social psychologist who, with the term ‘topological psychology’, originated the concept of field theory which explores the interaction between individuals and the environment and situation as a total field. Exploring and understanding can only begin with the situation represented as a whole; therefore, in order to make change happen, the entire situation must be considered (Burnes & Cooke, 2013). The action research methodology driven by Lewin is derived from Peirce’s work. Peirce (1905) stated that exploring the situation should

relate to that which affects individuals' behaviours and understanding occurs through this exploration.

The basic notion of action research is that knowledge is created by the group (individuals who are involved in the inquiry such as researchers and participants) in a collaborative context. Hence, it has become very important that, under action research, there must be relational understanding within the group while undertaking a study and exploring issues (J. S. Clark, Porath, Thiele, & Jobe, 2020), as consistent epistemologically. This, therefore, describes the action component of action research. The group is also accountable for the decision about a suitable time frame to develop and implement the action or plan that will result in new knowledge construction (Adelman, 1993).

Scholars have provided different perspectives on action research which derived from the original definition of action research by Lewin (1946) as "A comparative research on the conditions and effects of various forms of social action and research leading to social action" (p. 38) that utilises "a spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action" (p. 35).

Lewin categorised his work further into four foundational action research methods (Marrow, 1977).

1. **Diagnostic Action Research** is designed to generate a required plan of action. In this action, researchers observe and explore an existing problem situation, diagnose the problem and provide recommendations (Cohen & Alroi, 1981). Although this type of action research is not commonly used nowadays, its relevant principles mean it is considered the simplest type of action research. No statistical knowledge is required, and recommendations are made based on past experience and present diagnosis. Therefore, this method could fit in this present inquiry as knowledge construction would be based on the analysis of the group's experiences. However, this PhD inquiry intended to construct knowledge that comes from relativist interactions with participants and to explore their

lived experiences to provide solutions to problems. Diagnostic action research is not epistemologically consistent with this intention.

2. **Participatory Action Research** claims that the members of society who are affected should be incorporated into the development of the study (Baum, MacDougall, & Smith, 2006). The notion of this type of action research could fit in this inquiry since my participants and I would be involved in working together in the study in the collaborative context that leads to actions for change. Given that, participants and I would have relational understandings of the situation which would lead to valid knowledge construction as consistent epistemologically. Participatory action research is collective and self-reflective research in which actions are achieved through a reflective cycle process. With this in mind, while I theoretically place confidence in the authentic accounts of participants' experiences, I sought to see the cultural and historical forces that shape these accounts. I also intended to reflect critically on these accounts as social realities to take actions for changes by radically calling into question the acceptance of mHealth applications by the survivors that this inquiry studies. Therefore, participatory action research does not seem a suitable fit for this inquiry.
3. **Empirical Action Research** is linked to record-keeping and amassing experiences in daily work. This type of action research is based on practical experiences without reference to scientific principles. It is also based on observation and experiment without reference to theory (Kaiser & Bostrom, 1982). The notion of this methodology could fit this inquiry using empirical evidence, namely, participants' experiences, to investigate their situation to identify problems and provide solutions. However, empirical evidence as knowledge is produced by the direct and neutral observations of realities and can be justified by demonstrating its correspondence to realities. Therefore, no interactions occur, and knowledge is not socially constructed. Empirical action research, as such, is not consistent with the epistemological and theoretical position of this study, and, thus, is not a suitable fit for this inquiry.

4. **Experimental Action Research** is research that involves manipulating one environmental variable to determine if a change in that variable causes a change in another environmental variable. Experimental action research relies on controlled methods and the manipulation of variables to test hypotheses (Styhre & Sundgren, 2005). The notion of experimental action research is that the experiment serves as the basis for further experimentation if the experiment is inconclusive. Therefore, the notion of this methodology could fit this inquiry, as my participants and I would be looking at providing actionable knowledge that would serve as a basis for continuous developments in organisational practice. However, the main concept of experimental action research is that change is created on basis of scientifically based insights; as such, the knowledge used for change is not interactively and socially constructed. Thus, experimental action research does not feel consistent theoretically and epistemologically with this inquiry.

Action research contains two compelling outcomes, to involve and to improve. The focus of practical improvement is based on three key factors: improvement in everyday practice, improvement in the condition of practice, and improvement of understanding by experts who are actively engaged in everyday practice (Carr & Kemmis, 1983). The foundational principle of Lewin's view is that he saw participants as clients (Argyris, 1993). The involvement of researchers, therefore, is to help clients and if the help is effective enough, it will improve practice and the condition of practice. The improvement produces valuable actionable knowledge (Argyris, 1993).

Lewin's work showed that each inquiry begins by identifying a problem and postulating a solution relating to the identified problem, so as to make a change (Argyris, 1993). A relational understanding of the situation by researchers and the wider community is needed in order to make a change (M. S. Richardson, 2004). Knowledge construction occurs through trying to implement change. Lewin stated that change at individual and group levels is important and learning at an individual level can be

generalised to a group level and vice versa. Lewin saw learning at one stage as a building block for the foundation of the next stage and saw that understanding is achieved when a phenomenon is systematically changed (Argyris, 1993). This increases the validity of the group's knowledge and, therefore, its ability to decide what effective action needs to take place in a concrete situation. The outcomes of group knowledge construction in this inquiry are presented in Chapters 6 and 7.

The aspects of action research presented in this section form the basis of a view that is congruent with the epistemological and theoretical foundations for this inquiry. However, the specific action research model that was adopted in the current inquiry is introduced in the next section.

3.6 Action research model adopted in this inquiry

The action research cycle model proposed by Coghlan and Brannick (2014) was adopted in this PhD inquiry to produce new practical knowledge and achieve the aim of the study. The four phases included in the cycle are constructing, planning, taking, and evaluating action, as shown in Figure 3.2. Coghlan and Brannick's model has a pre-step, 'context and purpose' phase, which encourages researchers to assess the situation before starting their research. In this phase, I began by seeking to understand the context of this inquiry by asking: Why is this inquiry needed? What social, community and personal impacts are driving improvements or change? I endeavoured to make sense of the inquiry and the rationale for carrying out the inquiry. I started to consider the establishment of a collaborative process before I even started this inquiry. I used my collaborative relationships with those who were involved in mum's situation to give a sense of purpose to this inquiry. These collaborative relationships also helped me in the further development of this inquiry. This phase is further described in section 4.2 in the context of this doctoral work.

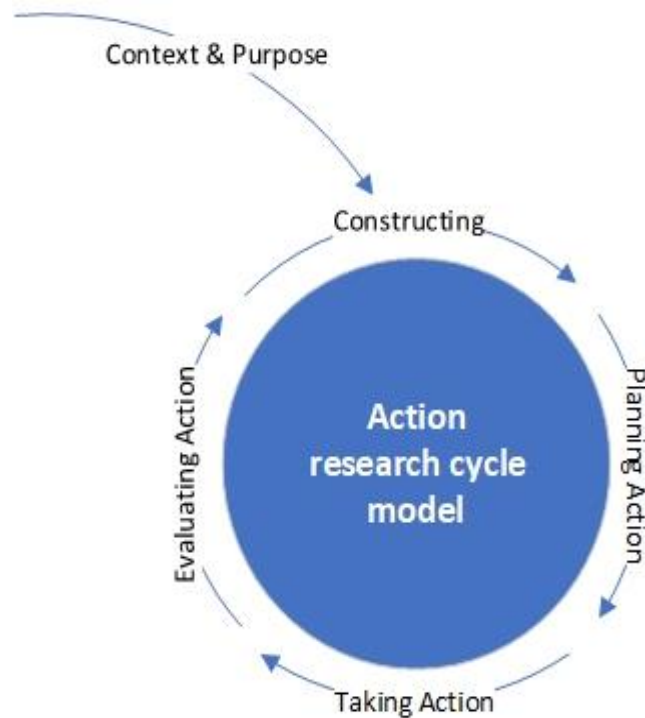


Figure 3.2: The action research cycle model adopted from Coghlan and Brannick (2014, p. 9)

Coghlan and Brannick (2014) recommended that the model be a guide rather than an absolute recipe, and the application should be responsive to the issues of the group. As shown in Figure 3.2, the constructing and planning action phases of Coghlan and Brannick’s cycle model are defined as different phases. Though, in this inquiry, these phases were combined as their intentions overlapped. Therefore, the model was modified to fit into three phases in each cycle in this inquiry. Figure 3.3 illustrates three different, but related cycles used in this inquiry. Figure 3.3 also shows that the outcomes of each cycle inform the next cycle, together contributing to the development of guidelines through to the end. These three cycles along with the context and purpose phase will be further discussed in Chapter 4.

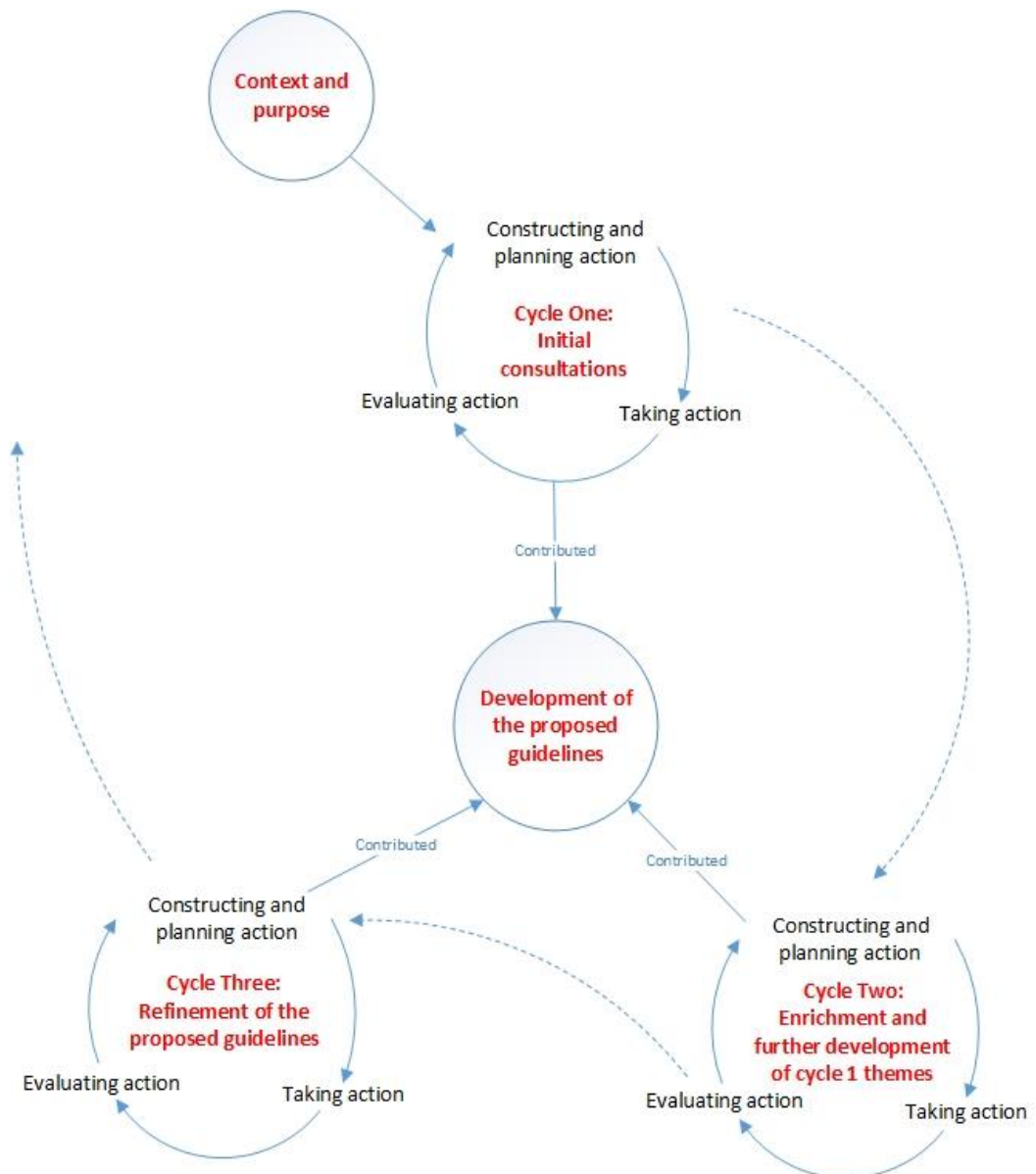


Figure 3.3: Action research cycles used in this inquiry

3.7 Different forms of action research used in this inquiry

Three key activities – cyclic, reflective, and participatory – are inherent in action research methodology with respect to improvement (Coghlan & Brannick, 2014). These activities help action researchers to gain insights into the world of practice or the environment we live in. The study of Coghlan and Brannick characterised action research in three ways:

1. “Research in action rather than research about action,
2. a collaborative democratic partnership, and
3. a sequence of events and an approach to problem-solving” (p. 6).

Coghlan and Brannick (2014) identified the descriptive characteristics of an action research approach as a methodology that is collaboratively undertaken in an environmental democracy as a problem-solving approach in which research is undertaken to identify the action required. Given that, it is impossible to know how the inquiry will be developed in the first stage. People involved in action research as co-workers in a collaborative context are developing a relational understanding of the problem(s) and plans for action(s). As such, at the outset of this research, I did not know how this inquiry would develop.

Many scholarly studies were read on action research to establish an effective approach. I reached the view that the level to which the above three characteristics of action research are achieved is related to three key principles. These key principles are: a critical perspective, for example, critical action research (CAR) (Kemmis, McTaggart, & Nixon, 2015); the underpinning paradigm, for example, practical action research (PAR) (Schmuck, 2006); and the researcher position, for example, insider action research (IAR) (Coghlan, 2007a; Coghlan & Brannick, 2014). These three types of action research were adopted to establish an effective approach to undertaking this inquiry and they are further discussed below to provide a rationale for choosing certain aspects of each type of action research.

3.7.1 Critical action research (CAR)

Critical action research (CAR) was selected because it is an approach in which all individuals involved collaborate as *co-participants* in a process of understanding a certain situation in a *critical context* that informs actions for social change (Kemmis et al., 2015).

CAR creates a space where the conversations are being undertaken without direction, and there is an attempt among participants to articulate *voluntary opinion* and appreciate the difference of each participant’s input. Liberty is promoted within the *communicative space* where participants create a cohesive sense of shared decision making (C. Davis, 2008). Kemmis, McTaggart, and Nixon (2013) stated that *communicative action*, where participants in a communicative space have the *freedom to decide* what is understandable to them and speak out on what their needs are and what they believe is real, contributes to valid action for change. The development of communicative spaces that would support everyone’s ideas would enhance the chances of each voice being heard and each voice being honoured. Aspects of CAR relevant to this inquiry are presented in Table 3.1.

Table 3.1: Aspects of CAR adopted in this study

Adopted aspects of CAR	
1.	Co-participants
2.	Critical context
3.	Voluntary opinion
4.	Communicative space
5.	Communicative action
6.	Freedom to decide

Certain aspects of the CAR approach (Table 3.1) were selected because, first, I intended to provide a transformative process in a communicative space in which participants have the freedom to explore other ways of viewing the environment, situation or world and relate differently to one another and the environment, situation or world compared to the ways that others might relate.

Second, the collaborative nature of CAR aligns with the participatory nature that is inherent in the action research methodology which enables me to collaboratively work with participants to understand the situation and identify problems and their underlying

issues. I believe that individuals who live in a situation must be the ones who explore the situation and identify possibilities for action and change. This collaboration occurs through engagement with participants who contribute to the best possible actionable knowledge, which is congruent with the epistemological foundations of this inquiry. In addition, CAR assumes that social realities are historically located by individuals in a given situation (Kemmis et al., 2015), and making sense of multiple existing realities is also congruent with the epistemology that underpins this inquiry. CAR examines the social, historical, and cultural processes of everyday life to construct knowledge (Carr & Kemmis, 1983).

Third, I aimed to help participants in developing a self-critical understanding of the situation by incorporating a set of social values, such as democracy (to encourage participants), equitability (to acknowledge my participants' value), liberation (to free participants from the directives of tradition or coercion), and improvement (to encourage participants to voluntarily share their opinion and understanding). Therefore, the orientation of this research was toward freedom, and it was directed by a critical interest in liberating participants. This created reflective knowledge.

3.7.2 Practical action research (PAR)

PAR epistemologically assumes that knowledge is an act of *interpretation* that is affected by *interactions* within social environments (Herr & Anderson, 2015). The epistemological stance of this inquiry was directed towards knowledge construction through interpretations. The interaction with participants allowed me to value my position as a *facilitator*, becoming a member of the group and, as such, adding my experiences to the contribution of new knowledge (Herr & Anderson, 2015). As a facilitator, I worked with my participants and directed the process of research towards joint purposes and provided possible solutions to contribute to practical knowledge.

PAR ontologically assumes that social realities are products of the process by which participants agree on the meaning of the situation and that multiple realities can exist (Masters, 1995). The ontological view of this inquiry was also that *multiple realities*

exist and are constructed in society. This interpretative understanding aims at gaining knowledge to inform practical judgment and practitioners' choice of action (Herr & Anderson, 2015).

Researchers using PAR are collectors and interpreters of data and their research involves making a change with people directly involved in the change process. Table 3.2 shows the aspects of PAR relevant to this study.

Table 3.2: Aspects of PAR adopted in this study

Adopted aspects of PAR	
1.	Interpretation
2.	Interactions
3.	Facilitator
4.	Multiple realities

Certain aspects of the PAR approach (Table 3.2) were selected because, first, in remaining congruent with the theoretical perspective that underpins this inquiry, I intended to interact with participants to identify multiple realities, problems, and the underlying causes of those problems.

Second, this inquiry was intended to provide a process for developing practical solutions to improve the given situation. PAR allowed me to establish a practical inquiry that relied on the pragmatic approach that looks for common sense supported by understanding and knowledge to enhance practice (Pernecky, 2016). According to McNiff (2017), action research is described as the practical form of inquiry that allows an individual in any profession to assess their work. On that basis, the work is analysed to see whether anything needs to be improved and, if yes, then the researcher asks: How can it be improved and why should it be improved? Therefore, the orientation of this study was toward collective communication and was directed by practical interests in understanding participants' views and the situation. This produced a situational, interpretive, and practical knowledge.

3.7.3 Insider action research (IAR)

Insider action research (IAR) was selected because it is a form of research conducted by a *member of a community* with other members of that community, with the goal of identifying issues and creating change (Coghlan, 2007a). My position as a carer of a survivor and my understanding of the survivors' community guided me to incorporate IAR in this inquiry. IAR is recognised as commonly being used by researchers when their research is combined with their day-to-day work or activities (Coghlan, 2007a).

IAR involves individuals who are affected by the issue being studied. It is considered an effective way to deal with an issue through *collaboration* with others to understand issues and their causes (Coghlan, 2007a). Working collaboratively on issues of social concern provides opportunities for both learning and effective action. IAR is a form of study where the people involved in the research evaluate learning opportunities in a collaborative setting. Participants and researchers learn from the experiences, working together to understand the issue and evaluate their effectiveness in addressing the issue and in improving relationships. The researcher is engaged in society and has developed knowledge of society from being a member. This knowledge is derived from the member engaging in the *learning* cycle of experiencing and reflecting on an everyday situation (Coghlan, 2007b). Table 3.3 illustrates the aspects of IAR relevant to this inquiry. I also created Table 3.4 to illustrate the aspects of CAR, PAR, and IAR in one table allowing readers to quickly view all adopted aspects.

Table 3.3: Aspects of IAR adopted in this study

Adopted aspects of IAR	
1.	Member of a community
2.	Engagement
3.	Collaboration
4.	Learning

Certain aspects of the IAR approach (Table 3.3) were selected because, first, I believed that being an insider and member of the community provided direct experience of the issue at hand and so it was a privileged position from which to both understand the situation and to create change.

Second, IAR promoted collaboration between me as an insider researcher and my participants to enable a common concern about the situation to be identified through actions and reflections; therefore, the contribution to practical knowledge occurred.

Third, I believed that my engagement as an insider in this inquiry and collaborative activities with others in the community led to learning and the contribution of actionable knowledge to the community. Therefore, the orientation of the study was toward collaboration, and in my understanding of the community, the research was directed by insider interests. This produced direct experiences, learning and practical knowledge.

Table 3.4: Summary of the adopted concepts

	CAR	PAR	IAR
1.	Co-participants	Interpretation	Member of a community
2.	Critical context	Interactions	Engagement
3.	Voluntary opinion	Facilitator	Collaboration
4.	Communicative space	Multiple realities	Learning
5.	Communicative action	-	-
6.	Freedom to decide	-	-

3.8 Characteristics of practical knowing in the context of quality and rigour

The establishment of a process that ensures the quality of the outcomes is crucial in an inquiry. Rigour must also be evident to ensure the quality of the outcomes. The

intended outcome of this inquiry was “generating robust actionable knowledge” (Coghlan & Shani, 2014, p. 525). Coghlan (2016) proposed a philosophy of ‘practical knowing’ to provide quality knowledge construction through action research. Coghlan (2016) characterised practical knowing as:

1. Everyday concerns
2. Socially derived knowledge
3. Unique situation awareness
4. Ethically driven knowledge

These four characteristics are based on Dewey’s (1910, 1922) work. His viewpoint was that knowledge is obtained through investigating issues in the environment in ways that involve identification and evaluation, an approach that has a resemblance to action research. The substance of how we know what we know was the focus of Dewey’s (1922) work. Dewey stated that knowing is inherently related to experiences. Dewey emphasised that gaining knowledge in the real world provides an opportunity for researchers to discover how things occur, which makes how they happen conceivable, and researchers can select and examine the situations and processes to provide possible solutions. Knowledge generated through action research is practical knowing. The four practical knowing characteristics are used to ensure quality in the outcomes of this inquiry and are discussed below in relation to this inquiry to make sense of how they are, epistemologically and ontologically, closely congruent with the philosophic stances of this inquiry.

3.8.1 Everyday concerns

What we get exposed to in the realm of day-to-day activities, and how we are exposed to it, provides practical knowledge. Coghlan (2016) argued that aspects of obtaining practical knowledge are human experience of regular activities and finding solutions that will work. To comprehend the problem contexts, prior research into

people's experience, the significance that they have gained from it, their stake in the world and their activities, also offer researchers an opportunity to address concerns within the group. The influence of the group's obligations and conventions, along with their values and standards, generates appropriate practical knowledge (Coghlan & Brannick, 2014). Stroke is a common concern for survivors, their families, and the community. It is essential to clearly describe how participants and I agreed that the improvement of the quality of survivors' life is a common concern to be addressed. It is also essential to address the reality that post-stroke support has an imperative role in the improvement of quality of life. Therefore, participants and I were the co-producers of the data that assisted in providing practical knowledge to address these concerns.

To gain practical knowledge, I do not need to obtain granular scientific information but to focus upon more general and valuable outputs derived from the practical experiences of my participants. Outputs that are tangible in nature provide the main benefit of an effective application of action research (Coghlan, 2016). While constructing practical knowledge in action research, members of a large group acquire their own interpretations, based upon their understandings, which drive their actions. Such interpretations are likely to generate practical insights in the group. Practical knowledge is not completely relevant unless the requirements for specific situations are identified. Therefore, identifying why changes are desired for each situation is needed in order to produce practical knowledge (Coghlan, 2016). The absence of ongoing post-stroke support has been identified as a reason why changes are needed for survivors. Ongoing support is an issue at personal and wider community levels. My personal experiences of providing support, being a carer, and seeking help grounded this concern as valid.

Researchers or facilitators assist by addressing and involving themselves in the everyday concerns of the group, to the eventual benefit of the group and an enhanced practical knowledge output. In the context of this inquiry, concerns were identified and expanded upon. Personal experiences, empirical evidence, and interactive communications with survivors and HCPs in the hospital, before initiating the inquiry,

verified that the problem extended to our society. An agreement was achieved on the need for ongoing post-stroke support to improve the quality of survivors' lives. Experiencing a stroke is an everyday concern at individual and societal levels; thus, I am interested in engaging with participants to construct socially derived knowledge to address the concerns identified.

3.8.2 Socially derived knowledge

Coghlan and Brannick (2014) emphasised that aspects of practical knowing are derived from various social phenomena. Kivunja and Kuyini (2017) stated that practical knowledge is derived and constructed from the social perception of individuals. As the social dimensions of an environment are embedded in the perceptual viewpoints of human experience, this develops social practical knowledge while undertaking action research. Significance is placed upon individuals in a society and their understanding of the objects and situations that are occurring in their surroundings (Kivunja & Kuyini, 2017). The underlying notion, which inspired me to undertake this inquiry, is that survivors should be supported after stroke. What is regarded as supportive is socially derived by the people who are involved in this inquiry.

Action research is a method that produces practical knowledge derived from social context, as it combines wider techniques in specific ways to develop an emerging comprehension. This is similar to Dewey's (1922) view on the social aspects of seeing a child learn how to walk. The child observes and intently experiments and is curious, watching every incident. The child is aware of all social input which is invariably positive and encouraging. Each fall is the basis of trying the next step and a fall is not seen as a limitation. Participants and I interacted with each other and with society to create socially derived knowing. In this sense, I was aware of the relation between our activities and the knowledge which we collaboratively created. Supportive behaviours when a thing goes wrong are likened to the child's fall. Each time the child falls is the basis of another try. I, as the facilitator of this inquiry, was aware of my position in directing the group when something went wrong. This was not a limitation for the group but part of

the learning process. Learning is created that can be seen as a building block at one stage or the foundation of the next stage and is socially derived knowledge.

The procedure of action research is enhanced through processes of social development. Action research intends to provide solutions to the social issues which are present, and these solutions are supplied by gathering knowledge from society (Coghlan, 2016). My participants and I worked in a social context to focus on real problems to gain solutions to social issues. As a member of the stroke community and a facilitator of this inquiry, I was aware of the essence and manifestation of social norms and could provide insights into how these standards and values vary from time to time. I aimed to develop an environment in which the group could discover a broad range of perceptions, which would output practical knowledge with social impact.

3.8.3 Unique situation awareness

What is implemented in one situation might not be appropriate in a different context. Therefore, the third characteristic of practical knowing is the essence of awareness of the differences in every situation and the differences of one situation from another in action research. Producing quality practical knowledge involves paying attention to the uniqueness of each situation, as there is little possibility that two situations are identical (Coghlan, 2016). I entered into this inquiry with an ontological view that there are multiple realities in our society. My ontological view was shaped while I was in the hospital and has expanded further since I started this PhD inquiry. Listening to survivors' and HCPs' stories and observing their situations contributed to the development of my belief that each participant's experience is a unique reality, and I needed to make each participant's reality visible in the output of this inquiry.

Paying attention to the uniqueness of a situation provided me with the opportunity to further my own personal development as a researcher as well as developing my role as the group facilitator. I was aware of my closeness to the problem and the way in which I could frame the issue to the group. This helped me to assess the distinctiveness of the situation. I was interested to explore other situations outside of

my own experiences. Doing so consisted of the ability to capture the experiences of others, comprehend them, and understand participants' practical knowledge while interpreting each situation distinctively.

In action research, the experiences of the group should be explored to recognise the exceptionality of the situation as a whole and to generate new knowledge on how to solve issues in the new setting. To develop new knowledge, I was aware that I had to avoid a habitual response to a situation, as custom and routine brought on by past habits are detrimental to thoughtful reasonability (Dewey, 1910). Coghlan (2016) stated that the group, therefore, needs to explore the current situation and then confront what action is to be taken before moving through the action cycle and reflection. For this process, participants and I engaged in interactive communications in which I came to an understanding that each participant's situation was unique, and action was needed to improve the situation as a whole.

3.8.4 Ethically driven knowledge

Coghlan (2016) emphasised that practical knowing and action are directed by the ethics and moral values of individuals who are engaging with the inquiry. The individuals involved in the inquiry as participants might find themselves confronting ethical dilemmas in different ways. In this situation, it is important for researchers, as group facilitators, to keep the aims of the inquiry in mind. The facilitator of action research aims to improve the relationships among group participants by illustrating how each participant's ethical values are respected to gather positive emotional responses from the group. For practical improvement, facilitating the process of self-reflection is needed. As such, the function of the researcher is to provide reflection to the group in situations of disturbance, doubt or confusion, to transform the group's direction to one of clear, coherent harmony and to lead to the resolution of conflict (Dewey, 1922). As the facilitator of the group, I intended to ensure that the privacy of participants was protected and that they were aware of the nature and aim of the inquiry. I made it clear that participants, especially survivors' safety, was my priority in this inquiry. I assured

participants that their details would remain confidential to create a trustworthy atmosphere where they could share their experiences.

When faced with frequent decisions, issues, and alternatives, which were not always self-evident as a result of the evolving nature of the action research procedure, ethical considerations were constantly reviewed. The requirement for collective discussions about these situations with the group, and enhancing local exposure to existing realities, are all aspects of establishing the ethics of this action inquiry, as explained by Coghlan (2016).

Working collaboratively with participants, yet also being the facilitator of a group having the aim of choosing the best action to take to improve the situation, created ongoing tension. As I am a carer of a survivor and undertook a scholarly review, I had in-depth understanding of the situation and scholars' standpoints. I needed to come up with a possible solution and present it to the participants. Transparency is important. I needed to make the choices transparent to the intended target audience of this inquiry. Coghlan (2016) stated that practical knowing involves the foundation that creates ethical knowledge. The concept of ethical knowledge suggests that, to create productive outcomes, I needed to look not only at describing, defining, and understanding realities but at understanding the underlying causes. In the context of practical knowing, I was acting in concrete situations and ethics were the focus. Coghlan (2016) stated that researchers who are confronted with real problems actively find out what possible course of action there might be to solve the problems, and then decide to implement the action. Therefore, considering the collaborative nature of action research, as a researcher I was aware that I was ethically responsible for sharing my reflections on the possibilities for and decisions about the best choice. As I decided what was to be the best option, therefore, I was responsible for consistency between my knowing and my actions. As Coghlan (2016) stated, when researchers evaluate and reflect on realities, they should act ethically. Practical knowing emphasises that researchers should know how to act in a unique situation to produce ethically driven knowledge. During the production of the result, my intention was to transparently present the outcomes.

3.9 Summary

The purpose of this chapter was to examine the philosophical and methodological foundations for this PhD inquiry. The chapter began with a discussion of social constructionism and associated epistemological assumptions followed by a discussion of interpretivism (symbolic interactionism, hermeneutics) as the theoretical stance that underpins this inquiry.

Action research as the methodology that underpins this inquiry was discussed. An action research methodology was undertaken to study participants' views in a collaborative context. The action research cycle model introduced by Coghlan and Brannick (2014) was introduced as the process applied in the context of this inquiry including phases of constructing, planning, taking action, and evaluation. Aspects from three types of action research were introduced and their alignment with the aims, epistemological and theoretical foundations of this inquiry discussed. These aspects enabled me, as an insider of the survivors' society, to create communicative space in a collaborative context to be able to interact and work with participants to identify the problem(s) and the underlying issues in their social environment. This was achieved by incorporating social values such as democracy, equitability, liberation, and improvement. The aim was to provide actionable solutions to identified issues.

Practical knowing and its four characteristics, proposed by Coghlan (2016), were introduced to make sense of how these characteristics are relevant to this inquiry and ensure the quality of the outcomes.

Chapter 4: Cycles and Methods

4.1 Introduction

This chapter introduces and discusses the cycles and integration of the methods implemented in each cycle. As noted in Chapter 3, this inquiry was undertaken in three cycles, in line with the action research cycle model proposed by Coghlan and Brannick (2014) (see Figure 3.2). Consistent with Coghlan and Brannick's model, the first two phases, constructing and planning action(s), were combined in each cycle. The model also has a pre-step phase (see section 3.6). Accordingly, this chapter is organised as follows.

First, this chapter discusses the pre-step phase that was undertaken while I was in the hospital supporting my mum. Second, cycle one and associated methods include ongoing literature review; capturing lived experiences and perspectives on what affected survivors' decisions to accept mHealth applications; and constructing a sample size and methods sufficient to collect data to feed into the development of the first draft of guidelines, are described.

Third, this chapter discusses strategies and methods used in cycle two, which involved exploring participants' views on the draft guidelines that fed into the refinement of the guidelines.

Fourth, this chapter discusses strategies and methods used in cycle three, which involved developing a prototype namely ACCESS and using the prototype to test and evaluate the refined guidelines. The cycles, and actions undertaken in those cycles, are illustrated in Figure 4.1, below.

Lastly, this chapter discusses the ethical values that underpinned this inquiry. This chapter also describes the criteria applied to maintain trustworthiness to assure readers that the outcomes are credible.

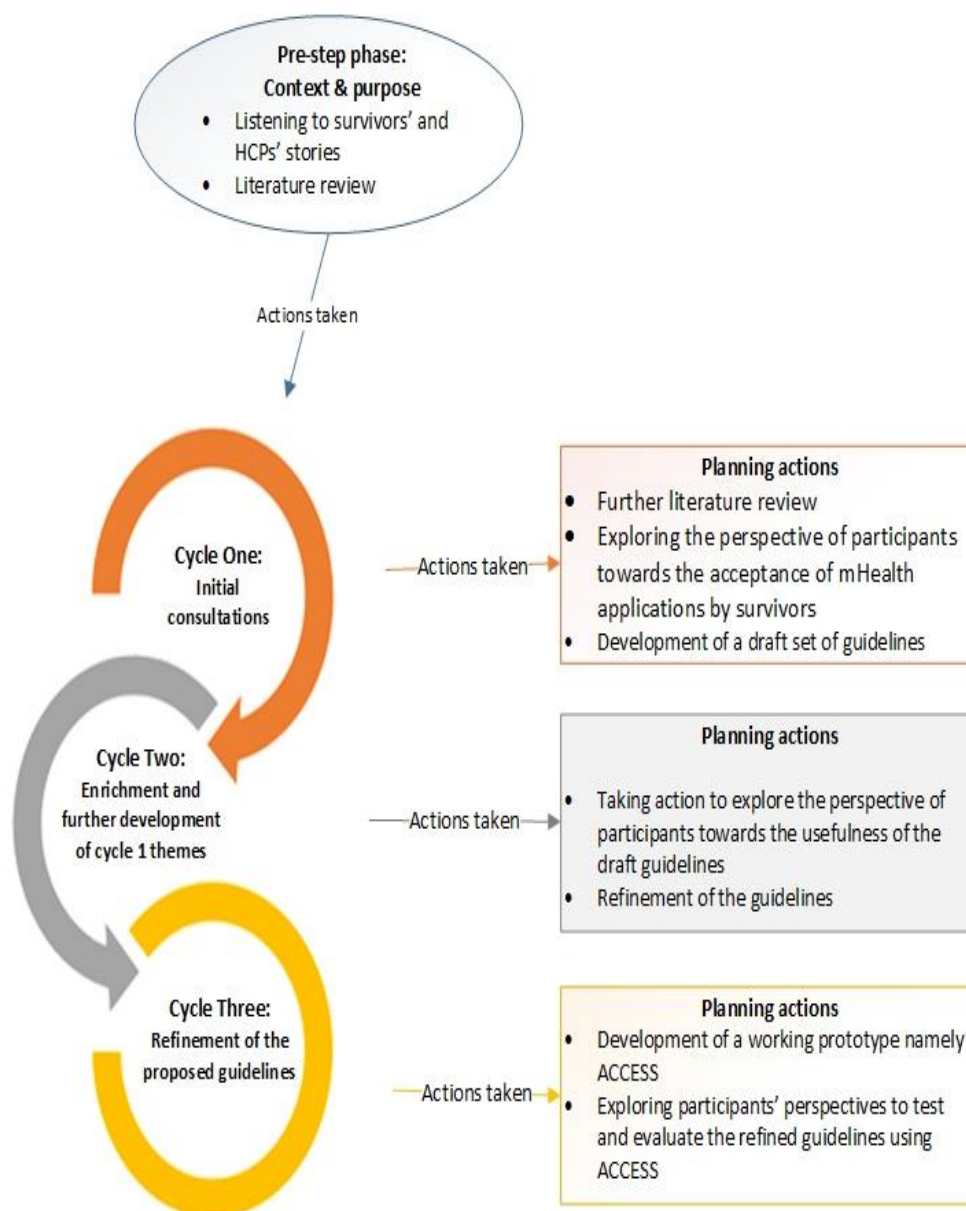


Figure 4.1: Three cycles and associated planning actions are undertaken in this inquiry

4.2 Pre-step phase: Context and purpose of this doctoral work

This phase involved gaining insight into the context and defining the purpose of this doctoral work with a focus on everyday concerns (see section 3.8.1) in the survivor community to address the uniqueness of the situation (see section 3.8.3).

To identify common concerns, as a carer, I was aware of and understood the roles and responsibilities that surrounded being a carer; however, I lacked an understanding of what it is like to be a survivor and what their lived experiences are. As such, I aimed to examine what survivors experienced, how their relationship with their environment changed over time, and how they described their relationship with their environment. I sought to understand their support needs to reintegrate into society. My position as a carer was considered to be that of an insider in the community and, therefore, provided an opportunity for me to know this community in depth. During this time, interactions became possible with survivors and HCPs, which allowed me to listen intimately to their stories and experiences. This enabled me to reflect on ways to construct this inquiry and generate practical knowledge. This is similar to what Coghlan (2016) highlighted, namely that action research should be constructed and based on what is deemed valuable to be investigated by people who have common concerns. Through shared interactions with survivors and HCPs in this phase and prior to initiating this inquiry, I observed that stroke, post-stroke complications and related requirements were common concerns to all. As such, the uniqueness of the situation was identified, and the context of this inquiry understood.

Through talking to survivors and HCPs while I was in the hospital with mum, listening to their stories and understanding important contexts, my initial concepts were formed, and these determined what actions to take. Over time, the stories, experiences and perspectives, as well as my personal experiences, provided insightful information which led me to postulate that mHealth applications may support self-management among survivors.

Interactions with survivors and HCPs provided me with insights into post-stroke requirements and made sense of the support that survivors need. I also realised that new technologies are already targeted at this population. This persuaded me to further explore and examine the usage of new technologies, in particular mobile technologies, in supporting post-stroke requirements. As a computer science student and researcher, I was aware of the novel ways new technologies can provide services to support users.

What I became aware of was users' attitudes towards the acceptance of these technologies.

Upon reviewing survivors' and HCPs' stories, a gap was identified which raised the following questions: How can new technologies assist the survivors' community? What are their opinions on new technologies? What is the survivors' acceptance of new technologies? Further, I realised that examining the literature and exploring other perspectives and experiences can deliver an insight into the topic and create a foundation to build on. In gaining knowledge of the situation, I realised that supporting survivors loosely relies on understanding the meanings that other researchers attach to their findings in similar contexts.

Therefore, I undertook an initial examination of the literature (synthesised in Chapter 2) to make a sense of post-stroke realities, looking at how survivors can manage post-stroke complications and the current role of mHealth applications in this context to acquire a broad understanding of the use of mHealth applications to support survivors' self-care. The findings from the literature assisted me in gaining insights regarding essential data on the topic, how significant it is to survivors to be supported in self-management, why a knowledge gap exists regarding mHealth technologies which have the potential for supporting survivors and informed the further development of this inquiry. I examined other researchers' findings which led to a clear conclusion about what is already known in this field. Therefore, the purpose of this inquiry was defined and the notion of an investigation to provide an in-depth insight into survivors' views of the acceptance of mobile-based applications was formed. Thus, in practice, the topic was considered a worthy and fruitful area for an inquiry.

4.3 Cycle one: Initial consultations: Exploring the perspective of participants on the acceptance and use of mHealth applications

4.3.1 Phase one – Constructing and planning actions

Upon construction of the context of the inquiry, the purpose of this inquiry was defined and survivors' post-stroke needs were identified as a common concern. The uniqueness of the situation became certain. Further, with the acquisition of broad understanding by examination of the literature, I became certain that there was potential for further investigation to explore survivors' perceptions that inform the practical knowing that could contribute to the aim of this PhD inquiry. To construct this knowing, I planned interactions with potential participants who could contribute to current knowledge to inform the next phase. Therefore, initial action was planned namely, exploring participants' perceptions of the use of mHealth applications by survivors, investigating how survivors' post-stroke needs can be addressed by such applications and more importantly what factors affect survivors' decisions to accept these applications for self-management.

4.3.2 Phase two – Taking actions

To interact with participants and explore their views to construct socially derived knowing, actions were taken to pursue focus groups and individual interviews with participants. The second characteristic of practical knowing (see section 3.8.2) requires researchers to explicitly explain how a collaborative inquiry was undertaken in terms of its social construction, by describing the situations in which it was constructed. In the subsections which follow, I, therefore, endeavour to detail the strategies and methods used in the first cycle to construct social knowing such as sampling and participants from each group who took part, how they were recruited, sample size and how data was collected.

4.3.2.1 Sampling

The purposive sampling method was initially employed to recruit participants. Purposive sampling or the judgment sampling method is a non-random range of samples with a purpose in mind (Tongco, 2007). It is a technique that researchers use in purposively choosing participants to meet predefined inclusion criteria for the study. To identify predefined groups – survivors, app designers, and HCPs – as potential participants, inclusion criteria were developed. These are provided in Table 4.1 along with rationale for each criterion.

Table 4.1: Inclusion criteria for each participant group

Inclusion criteria for survivors, app designers, and HCPs	Rationale
<p>Survivors:</p> <p>The older adult with stroke ≥ 55 years</p> <p>More than six months post-diagnosis</p>	<p>The age bracket of 55 plus years old is a concern for stroke risk in Auckland/New Zealand (Barber et al., 2016), with the same age range worldwide (Mozaffarian et al., 2016; Thrift et al., 2017). Further old aged survivors are high dependency on others for day-to-day activities, leading to poorer quality of life (Hogan & Siddharth, 2018). They need alternative ways to be empowered for their independence.</p> <p>Precipitous improvements tend to occur in the first six months (Kossi et al., 2016; Teasell et al., 2007). I was interested in that period when survivors were in the process of learning to live with stroke.</p>
<p>App designers:</p> <p>≥ 5 years experience in designing or developing mobile applications, specifically health-related</p>	<p>I sought to explore the perspectives of app designers who have enough experience in design of mHealth applications.</p>
<p>HCPs:</p> <p>≥ 5 years experience working with stroke survivors</p>	<p>I sought to explore the perspectives of HCPs who have enough experience in working with survivors</p>

I aimed for diversity in participants, particularly in the survivors' group, to capture different perspectives that would facilitate in-depth insights into how acceptance of mHealth applications could be increased. I aimed to recruit survivors who experienced different types of complications post-stroke (such as physical, communicative, and cognitive impairments) to investigate acceptance of mHealth applications in the context of those complications. For app designers, I sought those who have experience in designing mHealth applications to gain comprehensive understandings of how stroke-related applications can be specifically designed to improve UX and increase their acceptance. In sampling HCPs, I sought diversity in profession (such as OT, physiotherapists and speech-language therapists) to capture their perspectives in relation to the use of mHealth applications by people with stroke in consideration of each profession.

4.3.2.2 Recruitment processes

A flyer (see Appendix A) was developed to invite and recruit eligible individuals to take part. Once the flyer was developed, it was distributed to relevant people, using email, personal and professional networks. Initially, some challenges were encountered slowing the recruitment and ultimately the research process, such as the holiday season and waiting for appropriate people to contact me. Different strategies were used to overcome these obstacles, which are explained in the sections below.

4.3.2.2.1 Survivors and HCPs

Organisations such as the Stroke Foundation of New Zealand and TalkLink Trust were contacted to approach target populations. Having indicated their willingness to cooperate, I emailed their chief executive officers (CEOs) the invitation pack which included the flyer (see Appendix A), information sheet (see Appendices B and C) and consent form (see Appendices D and E) to be further distributed to potential individuals. Information sheets were produced in two different formats, one for survivors (see Appendix B) and one for HCPs (see Appendix C), to provide potential participants with general information about the inquiry. The information sheet for survivors had to be designed in a way that was easy to read and understood (e.g., using appropriate font

size and line spacing) due to possibility that some potential participants would have communication impairment. The contact details of some survivors and HCPs who expressed an interest were forwarded to me by CEOs and I contacted them to ensure they had received sufficient information about the inquiry. If those potential participants remained interested in taking part, mutual agreement upon time and date to meet face-to-face for an interview was arranged with those who met the inclusion criteria.

The invitation pack was also emailed to mum's HCP team, first, to invite them to take part, and second, to ask them to refer this inquiry to their stroke patients and their colleagues. I followed up via email to confirm 1) their willingness to take part; 2) whether they knew survivors who might be willing to be involved. Following these virtual communications, I scheduled an informal meeting with the OT (member of mum's HCP team) to discuss this face-to-face. Consequently, in the meeting, while she stated that the team is very busy and not able to get involved, she agreed to be the main liaison and keep me informed of any individuals who express their interest. In the end, only one HCP showed interest in being part of this study via this means of recruitment.

I also approached survivors and HCPs in the hospital (with permission from the hospital) to which mum was admitted. I shared information about the inquiry with survivors admitted to, and HCPs working in the ward, providing them with the hard copy of the invitation pack to offer them an opportunity to be involved in the inquiry. One of the HCPs in the hospital referred me to a former colleague who was working in a local stroke community organisation. I contacted her and following communications via emails, I was invited by her to present my inquiry in weekly meetings that were held in the three local stroke community groups, namely Community Rehabilitation (CoRe) at ADHB, Takapuna Stroke Club and the Stroke Support Group in Warkworth. In these centres. I delivered a 15-minute presentation weekly over four weeks to invite potential participants attending these groups. In the presentations, I provided survivors and HCPs with information such as the aim, purpose and objectives of the inquiry followed by a 5-minutes Q&A session. Hard copies of the invitation pack were available to pick up by

those who were interested. Attendees were also asked to introduce and recommend this research to people they knew who may have met the inclusion criteria.

At this point, I engaged in a snowball sampling method meaning an interested person/participant provided me with details of another participant, who in turn offered details of the next participant, and so on. Therefore, the sample group grew (Oliver & Jupp, 2006). This strategy was found to be an efficient and effective technique supporting the recruitment process. It also helped me to ensure that there was diversity in post-stroke complications and level of impairment in the survivor participants and diversity of profession in HCP participants.

While I was aware that it would be challenging to get survivors involved in this inquiry due to the vulnerability and impairments caused by stroke, surprisingly, survivors once engaged were very willing and cooperative. The credit goes to the snowballing method that assisted me in finding good leads to potential participants, within diverse geographical areas.

4.3.2.2 App designers

Using my existing professional network, the flyer was initially emailed to app designers on the staff of the University of Auckland who appeared to be topic experts and were considered to be reflective thinkers on their design experiences. The flyer was also sent via the information and communications technology (ICT) department; and the AUT Learning Transformation LAB (altLAB) centre at Auckland University of Technology (AUT) to those who appeared to have experience in designing mHealth applications (not specifically for survivors) inviting them to take part in this inquiry. Subsequently, some app designers contacted me and I confirmed their eligibility. Following phone conversations, I emailed the invitation pack which included the flyer (see Appendix A), information sheet (see Appendix C) and consent form (see Appendix D) to each interested party to ensure they reviewed all information prior to the interview.

Two other (anonymous) companies involved in designing applications were referred by one of my colleagues. I, therefore, contacted those companies to introduce

my inquiry over the phone. CEOs showed a willingness to help me, therefore, the flyer was sent by email at their request. Some of their employees responded by replying to my email and I emailed them back the invitation pack with the relevant information. Some of them requested more details, such as when and where the interview would take place. I provided them with answers to any questions they had over phone calls.

4.3.2.3 Sample size

I initially aimed to include 15 participants from each participant group (survivors, app designers and HCPs). I estimated this number would find an equilibrium between a comprehensive and thorough understanding of participants' perspectives and a poor and unbalanced sample group, reducing the risk of shallow analyses (Saldana, 2015). Data saturation is a popular method for choosing a sample size in qualitative studies. In qualitative research, the idea of saturation is used to identify the point at which additional data gathering no longer yields new knowledge or insights. It means that the data that have been acquired to this point is sufficient to answer the study questions or objectives (Braun & Clarke, 2021). It is crucial to remember that saturation does not always imply that all available information has been gathered. Instead, it means that the researcher has reached a point where collecting more data is no longer likely to produce appreciably new insights.

While data saturation is a valuable criterion it was not considered suitable for this study because of 1) in the context of this study, data is continually evolving, with new insights and perspectives emerging throughout the analysis process. This could be due to factors such as ongoing participant interactions, or changing social or cultural dynamics. In such cases, data saturation may not be a suitable concept, as new data may continue to contribute valuable information and insights even after the initial stages of analysis. 2) this study applies reflexive thematic analysis involving an interpretive or constructivist approach, where I actively engage in sense-making and interpretation of the data. In these cases, the goal may not be to achieve data saturation but rather to explore the nuances, patterns, and multiple perspectives within the data. This exploratory nature of analysis may require ongoing data collection and analysis, without

a fixed endpoint of saturation. 3) the concept of data saturation assumes that researchers can objectively determine when no new information is being revealed. However, researchers' biases, preconceptions, and prior knowledge can influence their judgment on data saturation. Unconscious biases may hinder the identification of new insights or perspectives, leading to premature conclusions about data saturation. 4) The concept of data saturation may not account for contextual factors such as sample size, participant characteristics, data collection methods, and research settings which can impact the availability and saturation of data. Therefore, it is crucial to consider these contextual factors when applying the concept of data saturation.

Instead of saturation, and consistent with my aims and purpose I drew on the concept of Information Power to determine sample sufficiency (Malterud, Siersma, & Guassora, 2016). American Heritage College Dictionary defined *power* as “the ability or capacity to perform or act effectively” (American Heritage, 1993, p. 1072). Therefore, when combined with the word *information*, power represents ‘the ability or capacity of information to construct effective knowledge’ seen here in the context of *information power*. In other words, an inquiry with more information power requires a smaller sample size as a result of the volume and diversity of information the sample holds.

Malterud et al. (2016) reasoned that information power is influenced by five aspects namely; 1) the inquiry aim(s), meaning the narrower the inquiry aim(s), the fewer the sample size; 2) the sample specificity, meaning the less specific the participants’ characteristics with respect to the inquiry aim(s), the greater the sample size; 3) the established theory, meaning the more established the fundamental theory, the smaller the required sample size; 4) the quality of dialogues, meaning a form of power that is determined by the poorness or richness of the dialogue - poorer dialogue in the conversations/interviews, required greater sample size; and 5) the analysis strategies, meaning an inquiry intending for in-depth analysis will require a smaller sample size.

Malterud et al. emphasise that while these aspects can inform a preliminary approximation of sample size for study planning, the suitability of the final sample size

should be assessed continually during the inquiry process. Drawing on the notion of information power to inform sample size estimates, I determined that a target sample size of “n=15” per participant group would have the potential to achieve high information power because 1) the aim of the inquiry is narrow – development of a set of guidelines to assist app designers; 2) I aimed for sample specificity by recruiting participants who have a comprehensive knowledge and experiential base; 3) I employed interpretivism as theoretical stance to underpin this inquiry; 4) I aimed to strengthen conversations in the interviews by for example paying greater attention to participants’ point of view, and/or trying not to interrupt participants while they talked and 5) I aimed to vividly describe the analysis strategies. However, as advised, I aimed to continuously assess as the inquiry progressed.

4.3.2.4 Data collection

As acknowledged earlier in this chapter, section 4.3.2, this inquiry used two techniques in cycle one to collect data: a) focus group interviews were used with app designer and HCP participants; and b) individual interviews were used with survivor participants because I was aware that it would be challenging to undertake focus groups with survivors due to their health-related issues. Individual interviews were also used as a follow-up technique to further explore the views of app designer and HCP participants. Both techniques are discussed below.

In this doctoral work, interviews (focus group and individual) were undertaken, starting with open-ended questions to explore participants’ perspectives on the acceptance and use of mHealth applications by survivors. Open-ended questions such as ‘what do you think about the role of mobile technologies in our lives?’ enabled participants to express their thoughts and promoted rich communication between participants and myself and enabled participants to introduce and discuss their views rather than give a simple answer to a closed question.

4.3.2.4.1 Focus group interviews with app designers and HCPs

Focus group technique has been regularly employed by sociologists to gather data (see, for example, Bogardus, 1926). A definition of a focus group interview was provided by D. Morgan (1996) as a “research technique that collects data through group interaction on a topic determined by the researcher” (p. 130). Focus group discussions allow participants to share their diverse and similar perspectives by offering a central focus on a specific topic. Focus group methods enable equal participation among all people involved in the discussion, to discover new views. In focus groups, discussions are flexible, allowing conversation to direct rich data collection (Quinlan, Babin, Carr, & Griffin, 2019).

Focus group interviews were undertaken to explore app designers’ and HCPs’ perspectives in cycle one. A focus group protocol (see Appendix F) was developed to ensure that discussions ran as planned, and that good research outcomes were attained (Fraser & Fraser, 2001). For a focus group interview, a sample size of six was initially considered, as recommended by Fraser and Fraser (2001). However, ultimately three groups of six, five, and two app designers; and two groups of three HCPs were recruited to take part in cycle one. This was to ensure a diverse range of ideas, perspectives, points of view, and experiences would be found in each group. While focus group interviews were scheduled at the convenience of participants, it was challenging to coordinate specific times and days to attend focus group interviews because all recruited participants were working and committed to deadlines.

To undertake focus group interviews, communicative spaces were created. The communicative space concept refers to creating a space in which participants could undertake communicative action and share their experiences or discuss common concerns in a purposeful way (Kemmis et al., 2013). Habermas and McCarthy (1984) described communicative actions as actions oriented to mutual understanding and unforced agreement regarding what to do. I entered into this inquiry assuming that, in such a collaborative study, creating communicative spaces helps equitable and discursive speeches to occur so that each participant’s voice can be heard; as such, the

uniqueness of each voice or view is acknowledged. I was also aware of the participatory nature of the communicative space concept that leads to solutions that are likely to have meaning for all participants.

To create communicative spaces, conceptual and physical aspects, as outlined by Singhal (2003), were considered. Conceptually, a communicative space provides a conversational arena in which each participant's voice can be heard by facilitating the liberty to speak up. Participants develop as an issue is initiated for discussion, though communication is pointed towards reaching mutual understandings and agreement (Kemmis, 2006). Physically, spaces and times are arranged to enable participants to come together to take part in the discussion (Singhal, 2003). These aspects are discussed in the context of the undertaken focus group interviews.

4.3.2.4.1.1 Physical communicative space

To create physical communicative space for app designers and HCPs, participants needed to feel comfortable entering the interview space, therefore, it was essential to locate supportive meeting spaces. On this basis, the following choices were made:

a) Physical communicative space for app designers

To undertake focus group interviews with app designers, the human-computer interaction laboratory (HCI Lab) at AUT was chosen, as the place was accessible to all participants. Participants who drove declined my offer to pay for the car park, which somewhat demonstrated their engagement in the project. Moreover, the HCI Lab was a space in which participants felt comfortable, as it was a safe, big space and always available. The space also had a meeting room-style table and big whiteboard which bolstered the openness of communications. Mutual agreement on undertaking focus group interviews after working hours was achieved. Meeting requests were sent to app designers to ensure they were reminded of the time prior to the interviews. Refreshments were provided. Although at first, it was tempting to undertake interviews in the app designers' workplaces, it soon became obvious that those workplaces would have been a cause of distraction.

b) Physical communicative space for HCPs

To undertake focus group interviews with HCPs, a community health centre was chosen because it was convenient for all. The centre also offered free parking for practitioners and visitors, which was convenient for all. It was still challenging to organise a specific time for focus group interviews because all participants were part-time practitioners. Communication was undertaken by email and mutual agreement on specific times and days was reached. Meeting requests were then sent to all participants and accepted by all to ensure they were reminded of the time prior to the interviews. The centre had a big space in which patients perform rehabilitation activities. We rearranged tables and chairs to create a relaxed communicative space. Drinks and snacks were provided during these events.

4.3.2.4.1.2 Conceptual communicative space

To describe the creation of conceptual communicative spaces, I use the theory of interpersonal relations introduced by Schutz (1958). According to Schutz's theory, three dimensions of interpersonal relations are regarded as appropriate and useful for explaining people's interaction: inclusion, control, and openness. These dimensions can be applied to evaluate group dynamics (see Figure 4.2) and may be used to define three phases that participants proceed through to develop effective participation.

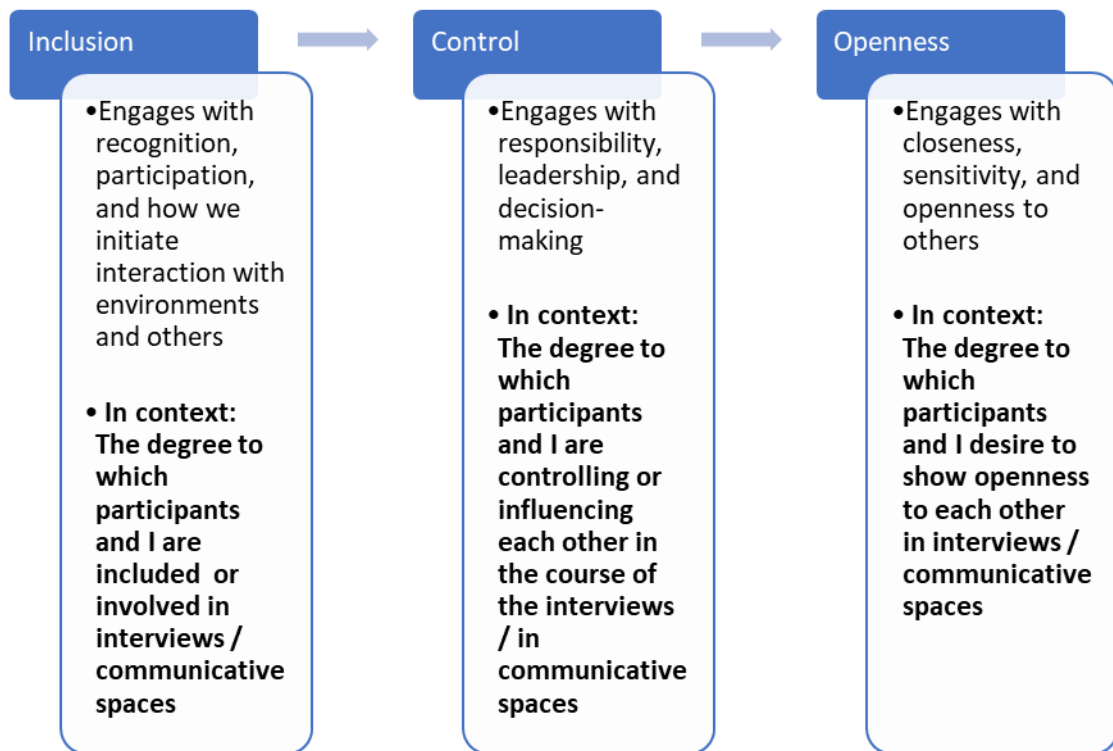


Figure 4.2: Three dimensions of interpersonal relations adapted from Schutz (1958)

a) Inclusion phase

In the **inclusion phase**, the app designer and HCP participants were observing the location and finding their places, questioning the aim of the inquiry, asking about the interviews and what commitments were required, what the inquiry is looking to find out, reading the information sheet, completing the demographic form (see Appendix G) and signing the consent form. Participants were provided with a very general sense of the topic for research, for example, by being participants who were invited to a focus group on the acceptance of mHealth applications by survivors.

To respond to participants' questions, I briefly shared the outcome of the literature review (fully described in Chapter 2). I also described the nature of the focus group and action research process (around 10 minutes). Subsequently, participants could collaborate and enter exploratory discourses. This also allowed me to explore participants' expectations of this collaborative inquiry. App designer participants shared concerns about mobile applications and what requirements need to be considered while designing an application. HCP participants shared concerns about survivors' conditions

and how their conditions affect their behaviour. This opened up common spaces for meaningful dialogue. Triggers for the group discussions were the disclosure of each participant's beliefs and opinions about their experiences. As an insider and a member of the survivors' community, I shared my interests, backgrounds, and experiences as a carer. I aimed to encourage participants to share experiences, tell stories with no fear of censorship and feel comfortable. I was also aware of acknowledging my participants' values. Participants came together with different cultural backgrounds, viewpoints, gender, and diversity of experiences. I needed to ensure that participants felt comfortable sharing their perspectives and that their value was acknowledged by me. This helped participants to consider each other's perspectives and find mutually shared concerns and points of view.

b) Control phase

As we entered the **control phase**, participants were confident enough to argue with and challenge each other (Schutz, 1958). A challenge of focus group interviews is that some participants dominated discussions while others diminished into the background (Stewart & Shamdasani, 1998). During this stage, however, all participants seemed to overcome this challenge and felt comfortable discussing concerns about the challenges they experienced. Their engagement was one of intent, listening and supporting one another's views and concerns as they participated in a communicative space that held shared and common meanings. To generate practical knowledge, I was aware that I needed to pay attention to each participant's perspective and place ample focus on the distinct aspects of each situation. Relating to these aspects identified the uniqueness of the real-world situation. I explored each experience reflected by participants to extract the common experiences and contributing factors. Seeking to understand any patterns of meaning and experience resulted in valid discussions. In this inquiry context, these discussions opened up the exploration of participants' perspectives on how they viewed mHealth applications' acceptance among survivors. This produced knowledge that may not otherwise has been acquired. In my aim to lead the discussion to reach a conclusion, I did not encourage or support participants to

accept the same conclusion but rather sought to reach a decision through dialogue on multiple realities. I was aware that reaching conclusions would occur through discussion grounded in reasoned argument. HCP participants did not always reach agreement on mobile technologies as an effective way to provide ongoing support for their patients. However, HCP participants saluted others' opinions identified in the literature review and, in turn, were directed to reflect critically on their own practices.

Using the outcome of the literature review as a naturalistic approach triggered the dialogue and gave the topic of discussion to the group. This seemingly offered a starting point for all participants to think about and build their own views. This naturalistic approach allowed the group members to share their opinions, thoughts and discuss the topic collaboratively. As a result, I found this approach has been effective. While some participants supported the results of the literature review and some did not, this range of views allowed me to record the pathways of participants' thoughts and feelings through their discussion. Since the group discussions were undertaken with a variety of participants from different specialist areas, extensive field notes were taken that constituted the third source of data in this inquiry (Mulhall, 2003).

c) Openness phase

In the **openness phase**, participants' exchanges develop interdependent patterns in which each participant's identity remained confirmed while they also complemented one other (Srivastva, Obert, & Neilsen, 1977). Each participant's identity is located in their social situations and experiences that are shared, comprehended and acknowledged, and can be voiced by each individual. For these communicative spaces to be functional, I was aware that discussion needed to develop in a way that allowed participants to complement each other and confirm one another's identities and, thus, the viewpoints of each participant could be voiced. Where appropriate, verbal feedback was provided by me during focus group discussions, to assure participants that their contributions were relevant and useful to the inquiry. The aim was first to create a relaxed and open environment, such that participants felt comfortable contributing openly to the discussion. Second, the intention was to create an environment in which

participants felt their identities were confirmed and complemented. This was particularly the case with the HCP group when the discussion was about participants' role in motivating survivors to use mobile-based applications. Overall, in the focus group interviews with both app designers and HCPs groups, as interviews progressed participants started to persuade and support each other, contributing to discussions in a concerned way while also sharing a commonality in the concerns being discussed.

At the end of the focus group interviews, participants acknowledged that a group discussion in such a space enabled their voices to be captured. One app designer stated that he liked the way this discussion was undertaken; he would undertake this approach in his next project. However, within these group communicative spaces, some app designer participants remained silent during the group discussions as compared to an individual discussion in which they became spoken. This happened in the inclusion phase; when we entered to control phase, app designer participants felt more comfortable and opened up to discussion. In the openness phase, they were completely engaged in the discussion and provided valid viewpoints. I also felt heard, and I learned from the participants. This learning situation, which I experienced as effective, exceptional, or personally meaningful, led to significant learning and personal growth. To assess the uniqueness of a situation, I gained individual learning which enhanced the integration of the experiences of myself and others. Further, this integration was extended to assessing the circumstances under which survivors' personal preferences would be interpreted uniquely in each situation. As indicated by Lonergan (1992), any inquiry output should be made complete by adding insights to the present situation. This was achieved by relating their output to my own experiences to build valuable insights which made the output concrete and complete. All app designers and HCP participants were invited to take part in cycle two at the end of their interviews. They were also offered an opportunity to participate in follow-up individual interviews in cycle one.

4.3.2.4.1.3 Further procedures

A moderator namely Sue Carlton who was introduced by one of my former colleagues assisted with each discussion and encouraged the contributions of the group

members to ensure there was a clear direction maintained during the interviews. An outspoken participant may take over the entire discussion (Stewart & Shamdasani, 1998). Therefore, the moderator and I made sure to interrupt any dominant participant by asking other participants to add their opinions. In addition, I moderated the group dynamic and process to ensure the objectives were addressed. The moderator was also assigned to take notes of important points during discussions, to ensure that I did not miss any key points, which in turn, increased the credibility of the outcomes. Moderators need relevant skills to keep the discussion on track and maintain its direction and have the responsibility of ensuring the discussion proceeds smoothly (Krueger & Casey, 2014). This was a challenging phase of this inquiry as it was difficult to find a moderator with the appropriate level of ability; nevertheless, she was found with relevant experiences. The moderator completed a confidentiality agreement form (see Appendix H) to confirm her obligation and commitment to maintaining confidentiality.

All focus group discussions were audio-recorded so that the richness and volume of the information were captured as intended, all were transcribed and subsequently analysed. Upon completion of focus group interviews, I followed up with individual interviews with consenting participants. These followed up on the focus groups' outcomes. This was to explore and investigate certain opinions or experiences in more depth, as well as to generate stories or conclusions that supported the continuity of participant experiences over time. This approach had several benefits for this inquiry: first, to assess the credibility of the outcomes. Second, to further develop insights where necessary. Finally, to assist with interpreting focus group data.

4.3.2.4.2 Follow up individual interviews with app designers and HCPs

Individual interviews were selected to follow up and assess the perspectives of app designer and HCP participants based on their individual experiences (Kvale, 1996). A conversational approach was applied in each interview. Under this free-flowing approach, participants were free to reply when they wished to do so and were also free to open a discussion and initiate new points by adding them to the discussion. Conversational approach, in cases like this, creates an opportunity for discourse

between researchers and participants as they are challenged to make ongoing sense of what they are talking about, which subsequently leads to an interactive discussion (Van Enk, 2009). Such an understanding of interviewing as interactive discussion fits well with the epistemological stance of this inquiry.

As part of planning the individual interviews, the interview protocol (see Appendix I) was used as a guideline. Follow up interviews were scheduled at the convenience of participants and carried out with three app designers and four HCPs who expressed their willingness to be interviewed.

Like focus group interviews, communicative spaces were created. While, at first, it was not clear how creating communicative spaces for individual interviews would work, this approach had been a success for focus groups. Many dedicated communicative spaces are seemingly designed for group discussions and did not suit individual interviews as they felt formal.

4.3.2.4.2.1 Physical communicative space for app designers and HCPs

One of the app designer interviews was undertaken after working hours in the participant's office, which was located in the Auckland CBD. As I was aware that he was very busy with deadlines, I endeavoured to save his time. The other two app designer interviews were undertaken in coffee shops which participants were close to. Although coffee shops are always crowded and noisy, we agreed on a quieter time, finding spaces that were less noisy. Drinks and a light lunch were provided. Meeting requests were sent to ensure app designer participants were reminded of the time prior to the interviews.

Two of the HCP interviews were in the participants' homes because they were only available over the weekend. These were in family home settings. The other two HCP interviews were undertaken over lunchtime in the participants' workplaces. Their workplaces were both located in a big, park-style location that was convenient for all. The interviews took place in a large backyard in which a small restaurant was running. Lunch was provided to keep it informal. Similarly, meeting requests were sent to ensure HCP participants were reminded.

4.3.2.4.2.2 Conceptual communicative space

In the **inclusion phase** of interviews with app designers and HCPs, first, participants read the information sheet, completed the demographic form and signed the consent form. Second, transcriptions from preceding focus group interviews were collaboratively reviewed. This reminded them of where they had got to and triggered further discussion. In the **control phase**, the app designer and HCP participants were more confident than they were in the focus groups. I believe this was because they were aware of the discussion topic, and although most points had already been discussed in the focus groups, this was a chance for them to speak clearly on their perspective in depth. Both app designer and HCP participants were also more comfortable. This seemingly was because of the nature of one-on-one interviews. In the **openness phase**, the app designer and HCP participants, and I, had shared dialogue that led to a decision confirming and certifying what we achieved in the focus group interviews. All app designer and HCP participants were also offered an opportunity to participate in cycle two.

4.3.2.4.2.3 Further procedures

Like focus groups, all follow up interviews were audio-recorded and transcribed for the analysis.

4.3.2.4.3 Individual interviews with survivors

Similarly, Individual interview method in the context of conversational approach was used to ensure rigour in outcomes through seeking a detailed holistic description of real-world situations from the lived experiences of all survivor participants. Individual interviews encouraged survivor participants to feel comfortable sharing their experiences, leading to mutual concerns being discussed. Practical knowledge would not be possible without the engagement of participants whose knowledge was grounded in and through their experiences.

Interviews were scheduled at the convenience of participants and involved visiting survivors in their homes. This was because their homes were considered

accessible and safe environments for survivors, and I could more easily open channels for communication in that setting. Interviewing survivors at their homes also assisted me in gaining an understanding of their living situations from an insider perspective. Some interviews took place at the weekend. Individual interviews were carried out with twelve survivors who showed their interest and met the inclusion criteria. Like focus groups and follow up interviews, communicative spaces were created.

4.3.2.4.3.1 *Physical communicative space*

I aimed to create a physical communicative space in which survivors could feel comfortable and safe entering the interview space. As explained above, all individual interviews with survivors were undertaken in their homes at their preferred time because it was convenient for them and they felt safe in their own homes. Further, I was aware that it was difficult for them to get out without assistance. These participants had their carers or family members present at home which also made them feel comfortable during interviews. Responding to survivors' situations required effort on occasions. One interview was rescheduled because the participant's Roger Pen was not working properly. A Roger Pen is a hearing aid device that helps the user to hear and understand more speech over distance. I managed to borrow one for her and the interview was undertaken. These efforts were fruitful in that they resulted in keeping the interviewee comfortable with their participation. All survivor participants were reminded over the phone one day prior to their interviews.

4.3.2.4.3.2 *Conceptual communicative space*

To create conceptual communicative spaces, I followed the same strategy that was undertaken in the focus group and follow up interviews. This was to choose spaces that provided a discursive field or environment in which an issue is shared for discussion. Communication is encouraged to find relational understandings and agreements that fully hear participants' voices. I use the same three dimensions of interpersonal relations of Schutz (1958) explained in section 4.3.2.4.1.2 (inclusion, control and openness) to describe the process.

a) Inclusion phase

For interviews with survivors, the **inclusion phase** involved participants questioning and asking for example about the project and its purpose, and why I am doing this study. During this phase, participants read the information sheet, completed the demographic form (see Appendix J) and signed the consent form. I then briefly shared some of the findings from the literature review with respect to factors that may influence survivors' acceptance of mHealth applications, in response to survivors' questions. This provided them with a picture of what we were going to discuss and initiated the dialogue. In this phase, I also shared my background and personal experiences as a carer. I did this for two reasons. First, participants were from different cultural backgrounds, viewpoints, and a diversity of experiences. Knowing that I was from a different culture may give them a sense of their cultural differences are understood and comfortable to share their experiences. Second, I wanted to assure them that I understood them as a member of their community. This helped them to feel comfortable to be open about their situations and engage in the discussion.

b) Control phase

In the **control phase**, survivor participants needed more time to learn their role as co-producer, but they became more comfortable and felt certain enough to be able to assess the discussion and cautiously challenge the interpretation provided by me. In this phase, participants were asked to share any experiences if they would like to do so, and I listened to them. It was like I handed control over to survivors; first, I made them feel comfortable, and second, I enhanced their confidence. Next, participants were asked to explain their experiences of how stroke happened and its impact on their lives. I aimed at creating a space to obtain their subjectively relevant statements with minimum interference and offering a naturalistic way of thinking about the given topic. However, with a little encouragement, participants became surprisingly adept at exploring their own discourses and assigning collective meanings to them, which also indicates the positive character of the communicative spaces that were built. Many of the participants felt free to disagree that mobile applications could be an alternative

option for them to improve their healthy life. However, they disclosed they felt confident expressing that opinion as they did not sense they were being coerced to accept or align with any particular opinion. The openness and freedom to speak and voice their opinions during an interview indicated that a communicative space had been created through this action research, as pointed out by Kemmis (2006). The communicative spaces evident in these interviews also showed the collaborative nature of this approach. Furthermore, they led to the disclosure of distinctive insights, understanding, and knowledge that possibly would not have been conceivable otherwise.

c) Openness phase

In the **openness phase**, the inauguration and creation of a communicative space was made apparent by the interpretation and understanding shared by participants (Habermas & McCarthy, 1984). In this phase, survivor participants shared common concerns in that they were survivors of stroke living in similar situations. Participants were all concerned about the subject being discussed. Survivors' experiences and perspectives depended on their situations, interests, and concerns, even though these can vary over time in diverse circumstances. Shared understanding and interpretation were harder to reach where diverse age ranges and cultures were involved. In this phase, I sometimes asked personal questions such as 'How long you have been in New Zealand?' to develop common ground on which participants from different cultural backgrounds could explore shared experiences. I also kept a record giving a specific structure to the extracted data. To do this, I recorded the personal experiences of survivors as well. This helped me to acquire considerable knowledge of their experiences as survivor participants and enabled me to confirm participants' identities.

To develop practical knowledge, I reflected on and conceptualised this useful, unique yet real-world knowledge. Putting the core focus on the real-world experiences of participants allowed me to integrate their personal experiences with the objective of proposing a set of guidelines for app designers. After the interviews ended, all survivor participants were invited to take part in cycle two. Some participants wanted to provide support if needed and offered to stay engaged in this project.

4.3.2.4.3.3 Further procedures

All participants were assured of confidentiality, therefore, none of the participants is identified by their real name in this inquiry. Each participant was given a pseudonym to ensure participants' confidentiality. Like focus groups and follow up interviews, all individual interviews were audio-recorded, and recordings were not commenced until consent to record was given. All interviews (focus groups and individuals) were transcribed by myself for the analysis which, scholars suggest, helps researchers engage more with data (Lyons & Coyle, 2016). This is further discussed in section 5.3.1.

4.3.3 Phase three – Evaluating actions

Upon completion of data collection, I realised that the quality of each interview dialogue was good, and the data collected were valuable and of interest. Further to this, I realised that how many interviews are held with each participant as well as the time taken for each interview can affect information power (Onwuegbuzie & Leech, 2007).

Practical knowing was constructed by analysing the findings using *reflexive thematic analysis* method, which is fully explained in the next chapter (see section 5.3). The evaluation and reflection of the findings led to a draft of a set of guidelines. The inquiry then moved on to the next cycle – the examination of the draft guidelines to test their usefulness. The next section describes the second cycle, which involved taking action to examine participants' perspectives regarding the draft guidelines.

4.4 Cycle two: Enrichment and further development of cycle 1 themes: Exploring the perspective of participants towards the usefulness of the draft guidelines

4.4.1 Phase one – Constructing and planning actions

The second cycle began once practical knowing was established in the preceding cycle and was used to develop a set of guidelines that could assist app designers. In this

cycle, the plan was to engage again with participants to explore their views on the draft guidelines, which resulted in the enrichment and further development of themes, which were constructed in cycle one and enacted in the draft guidelines.

4.4.2 Phase two – Taking actions

4.4.2.1 Sample size and participants

All participants in cycle one were invited to take part in cycle two. Of these, four survivors, two app designers, and two HCP participants positively responded to the invitation. Of these participants, some were not able to continue. These were: one survivor participant who was admitted to hospital and so could not take part; one app designer who moved overseas before engaging in the cycle; and a HCP who was not available for data collection at the scheduled interview time. I followed up on this last case by email; however, I did not receive a reply.

4.4.2.2 Data collection

4.4.2.2.1 Individual interviews

Individual interviews with a conversational approach were undertaken at a time and place convenient to the participants.

4.4.2.2.1.1 Physical communicative space

d) Physical communicative space for survivors

Survivor participants were interviewed in their homes at their preferred time. The interviewees were reminded over the phone one day prior to their interviews.

e) Physical communicative space for the app designer

The app designer participant was interviewed in his office. A meeting request was sent and accepted with mutual agreement on the date, time, and venue. A prior reminder notice was automatically sent.

f) Physical communicative space for the HCP

The HCP participant was interviewed over lunchtime in her workplace, in the backyard in which a small restaurant was located. Light lunch was provided. A meeting request was sent and accepted with mutual agreement on the date, time, and venue. She was automatically reminded prior to the interview.

4.4.2.2.1.2 Conceptual communicative space

a) Inclusion phase

Participants and I entered the inclusion phase with prior knowledge of the discussion topic. Participants were informed in the individual and focus group interviews undertaken in cycle one that they would be approached again and invited to share actionable knowledge. In this cycle, after participants read the information sheet, completed the demographic form and signed the consent form, I shared the draft guidelines to explore participants' views and to understand whether the guidelines met survivors' needs.

b) Control phase

When the discussion was initiated, participants and I immediately entered the control phase in which participants felt confident enough to lead the discussion and indeed I did feel that the discussion was controlled by participants. I was listening and exploring participants' perceptions. Participants seemed they know what they wanted. This was an invitation to the openness phase in which participants and I sought to understand and interpret what was shared.

c) Openness phase

The shared dialogue led to a decision that confirmed minor refinements of the draft guidelines were required. As such, the draft guidelines were first collaboratively examined, participants and I shared our perspectives, and we agreed on the common points where the draft guidelines needed to be refined. The findings from this cycle

resulted in the enrichment and further development of identified themes from cycle one that are incorporated in the findings in Chapter 6.

4.4.2.2.1.3 Further procedures

Similar to cycle one, all participants, in this cycle, were assured of confidentiality. All interviews were audio-recorded and transcribed by myself for the analysis.

4.4.3 Phase three – Evaluating actions

The process of the evaluation is presented in section 5.4. In this phase, the HCP and survivor participants contributed a constructive proposal: that the integration of the guidelines into an application design would be a more effective way to test and provide insights into the usefulness of any draft guidelines. Upon completion of the data collection, the draft guidelines were refined to respond to participants' views. In line with the proposition put forward by participants, a software prototype was developed (ACCESS) which integrated the guidelines into the design to test their credibility. This prototype was developed and used in the third cycle to evaluate the usefulness and credibility of the refined guidelines.

4.5 Cycle three: Refinement of the proposed guidelines: Evaluation of the proposed guidelines using ACCESS

4.5.1 Phase one – Constructing and planning actions

The third cycle involved the evaluation of the proposed guidelines. Drawing on the findings from cycle one, a set of guidelines was developed and refined over three cycles. In the process of developing these guidelines (discussed in Chapter 7), I was asking myself 'is it useful?', 'am I covering all aspects of the good design of application for survivors?', and 'how can I make sure that the usefulness and credibility of the guidelines are ensured?' In this cycle, I needed an effective way to illustrate the guidelines to my participants and the participants' proposition of integrating the guidelines into an application design seemed practical and would support this process. Thus, the initial scopes were defined (provided below – section 4.5.2.1) and I decided to

develop a software-based prototype considering the most important areas that shaped the guidelines. The development of a prototype was not the central aim of this PhD project. However, it was considered to be a practical and effective way to evaluate the refined guidelines in action.

4.5.2 Phase two – Taking actions

This phase involved first, the development of the prototype, ACCESS, with the integration of the guidelines into the design to perform the constructed plan - exploring participants' views on the guidelines. Second, conducting individual interviews focusing on the constructed plan.

4.5.2.1 Development of software-based prototype

To evaluate the proposed guidelines, with the integration of most of the important aspects of the guidelines, a working prototype application was developed. The findings in cycle one (reported in Chapter 6) highlighted that survivors might be interested in using mobile applications if such applications enable them to connect to other survivors and the stroke community. Thus, the prototype developed had qualities similar to a social networking application, allowing users to connect with each other and share information, although this prototype was designed to provide other functions as well, such as reminders.

For the purpose of developing a prototype, a group of three bachelor's degree students, namely Andrew Salim, Yue Dai, and Iiisaane Siua, who were starting to do their research and development (R&D) project, were assigned to help me in designing the prototype. The R&D project is a 30-point paper which is delivered over a period of two semesters at AUT. Students must work with an academic mentor in choosing a project to work on with a client. Here, I was the client for the group and my prototype was their project.

I became involved in designing interactive content using HTML5 Package (H5P) to provide academic information to students. I was a member of the design team and

learned a lot from this exceptional experience. The knowledge I acquired from this experience enabled me to better understand how to design my own prototype. I shared my knowledge with the R&D group all through the process of prototype development. I need to acknowledge that I was awarded a summer research award at altLAB. altLAB is a centre that provides the AUT community with a range of professional learning knowledge to support educational practice. Designing the interactive content was one of the projects that was conducted in the centre.

The objective of the prototype was to serve as a test case to determine the usability requirements of the refined guidelines. The prototype was developed over a year involving a lot of communications, and many meetings and discussions. Initially, a paper-based prototype was developed simply because we sought to make sure that it would meet survivors' needs. Some examples of these pages are available in Appendix K. Once the paper-based prototype was confirmed by the group, the development of the actual prototype was initiated. Appendix L illustrates the main aspects of the proposed guidelines that were considered and applied to the design of the prototype. In response to survivors' views, the initial scopes of the project defined in phase one included:

1. The prototype shall allow users to communicate with other potential users;
2. Users will be able to connect with the medical team through a blog;
3. Users will be able to access their medical information;
4. Users will be able to utilise the prototype with one hand; and
5. The prototype must have an eye-tracking feature.

4.5.2.2 Sample size and participants

Once the prototype was developed, the survivor, app designer, and HCP participants who took part in cycle two were invited to explore the prototype and evaluate how the guidelines were working in practice. However, the HCP participant was not available to take part due to her personal commitments, and one survivor

participant had unfortunately passed away by the time the prototype was completed. The rationale for choosing the same participants was to show them that, first, their shared views were considered in the development of the prototype; and second, they had already been exposed to the guidelines in cycle two and therefore they were the best candidates to assess them in practice.

4.5.2.3 Data collection

4.5.2.3.1 Individual interviews

Similar to cycle two, I organised the interviews using a conversational approach at locations and times preferred by participants. R&D team members attended the interviews to respond to any queries that may arise with respect to the prototype.

4.5.2.3.1.1 Physical communicative space

Survivor participants were interviewed in their homes and the app designer participant was interviewed in his office. One of the R&D team members organised transportation.

4.5.2.3.1.2 Conceptual communicative space

Survivor and the app designer participants were asked first to read the information sheet, complete the demographic form, and sign the consent form. Following that they were invited to explore the prototype considering the applied guidelines and share their opinions. As noted earlier, these participants were already involved in this study. At the beginning of the interviews, I introduced the prototype and briefly explained the aim of the prototype.

1. The survivor participants had an opportunity to explore the application. As survivor participants started to use the prototype, they found it confusing. However, as soon as they were guided by the R&D team, they felt confident in using the prototype. It then seemed that participants were controlling the discussion. I found myself in the situation of observing participants, to interpret and understand what was shared by everyone in the interview. This allowed me

to observe that each participant had a unique view and distinct understanding of the same application. The uniqueness of each view was recognised. Field notes were taken for later analysis.

2. In the case of the app designer participant, the interview was smoothly undertaken. This was simply because the participant was aware of mobile application designs. He was confident enough to control the whole discussion. He offered his knowledge and views, a shared understanding was achieved, and actionable knowledge was acquired. In a relaxed and open environment, a mutual agreement was reached.

4.5.2.3.1.3 Further procedures

Interviews were all audio-recorded; however, two of the audio files were damaged and could not be opened. Fortunately, I had my own field notes which proved valuable. The analysis of the findings from this cycle resulted in the further development of identified themes which ultimately led to a minor refinement in the proposed guidelines. Chapter 6 reports the findings from the three cycles.

4.5.3 Phase three – Evaluating actions

Upon completion of the data collection, the evaluation and reflection of the findings (see section 5.5) led to a minor refinement of the proposed guidelines (presented in Chapter 7). The proposed guidelines were developed over the three cycles, congruent with the iterative nature of the applied methodology, permitting refinement of the guidelines in response to participants' views.

In undertaking this inquiry, ethical values were considered. The next section engages with the ethical dimensions that were applied in this inquiry.

4.6 An action inquiry is valued and ethical

This section is linked to the fourth characteristic of practical knowing (see section 3.8.4) which underlines the importance of undertaking an inquiry that ensures its

participants are protected and valued. Implementing ethical action in any practical inquiry is important to comply with research values (Coghlan & Shani, 2005). The research approach must be ethical because constant reflexivity and compassion are required during the research. In this case, participants were regarded less as subjects and were said to be partners in the inquiry (Coghlan & Brannick, 2014). The major principles within this inquiry over three cycles were democracy and humanity, which included respect for the individuals who participated in the inquiry, a duty of care to participants who were vulnerable, along with efforts to minimise any risk factors (Rowan, 2006). The ethical aspects developed while interacting with participants involved in the inquiry were identified by means of a phase review. The concept of phase reviews included looking for ethical considerations at every stage of this inquiry. The interaction framework related to ethical practice by encouraging full and frank discussion and by seeking consent from the participants, who were deidentified in the analysis of the data.

4.6.1 Ethical action inquiry in context

An ethics application was conditionally approved by the Auckland University of Technology Ethics Committee (AUTEC) (reference number 17/364) on November 9, 2017 (see Appendix M). The final approval was granted on December 1, 2017 (see Appendix N).

Brydon-Miller, Rector Aranda, and Stevens (2015) acknowledged an issue with regard to seeking ethical approval for an action research inquiry. Researchers are required to highlight the purpose of the research, actions to undertake, and the methods for gathering data and participants beforehand, which conflicts with the collaborative, developing process of the research. Actions were chosen after reflections on the data collection had taken place, the consequence of which cannot be foreseen beforehand.

In the process of developing the ethics application, I realised that there could be potential safety risks while I was interviewing participants at their homes. For this

reason, a researcher safety protocol (see Appendix O) was developed to submit to AUTEK. This protocol indicates that, for the researcher's safety, the researcher must let a 'buddy' know if they are interviewing a participant at their home, and the 'buddy' must monitor the researcher and make sure that the researcher returns safe and sound. In this inquiry, my sister was my buddy. During this inquiry, whenever I was organising an interview at a participant's home, my sister was provided with the physical address, time, and day of the interview. She was, therefore, aware of the schedule and checked on me until the interview had been completed.

Another ethical concern was the role duality for me as an insider researcher, as discussed by Holian and Coghlan (2013), since my personal experiences extended my knowledge of the situation in the survivors' community. Action researchers are responsible for ethical actions (Coghlan & Shani, 2005) and so, although I could not formally use my personal experiences as input in this inquiry, I have to acknowledge their impacts as contributions to my understandings and reflections throughout this inquiry.

Confidentiality may not always be assured in a practical inquiry approach, although special care would be given to maintaining the privacy and other requirements of participants by the negotiation and consensus-building that eliminates objections and is preferred as the best way forward (Williamson & Prosser, 2002). To support the ethical duties of researchers, Kirkup and Carrigan (2000) stated that the names of participants should be disguised to ensure ethical integrity and that the privacy of participants is protected. Therefore, participants' details, including names and addresses, will remain confidential or have been altered. This was a crucial part of the research as some of the participants recruited were reluctant to participate or share their experiences with the group or me unless confidentiality was guaranteed. For example, during an interview, a HCP sought clarity of confidentiality before proceeding to share experiences in working with survivors, highlighting their responsibility for maintaining confidentiality in their HCP-patient interactions.

A further ethical concern highlighted in this inquiry was that confidentiality cannot be guaranteed in focus group interviews. From my research experiences, while I had the opportunity to collect rich information from different perspectives due to the diversity of participants, it was difficult to maintain participants' confidentiality because I was unable to control what associated members did or said. To account for this, two consent forms were designed in this inquiry: one was designed for focus group interviews (see Appendix D) and one for individual interviews (see Appendix E) to make explicit the boundaries of confidentiality for focus group participants.

The snowball sampling method adopted in this inquiry highlights another ethical consideration. The strategy associated with this sampling is grounded in the concept that a 'relationship' or 'connection' subsists between the first sample and others in a particular community, acknowledging that a series of recommendations will be made to a wide range of friends or members of a community (Berg, 2004). While it was instrumental in gaining trust, through an acquaintance or peer referral, rather than a formal referral, it became difficult to ensure confidentiality between participants. While this created potential issues of concern in terms of trust, there was little choice except to create and maintain mutual trust among these participants.

4.7 Trustworthiness of this PhD work

As discussed in Chapter 3, this inquiry used the characteristics of *practical knowing* to ensure quality outcomes. In quantitative research, trustworthiness is described as validity and reliability. While qualitative scholars do not use instruments with standard metrics to achieve validity and reliability, in qualitative research trustworthiness is considered by establishing criteria in the research to ensure it is achieved (Connelly, 2016). Congruent with the epistemological stance taken in this inquiry, Ballinger (2004) proposed a comprehensive set of criteria namely *transparency, reflexivity, and utility* for researchers working from relativist positions (see Table 4.6 for the definitions).

Table 4.2: Trustworthiness criteria, adapted from Ballinger (2004)

Adapted criteria in this inquiry	
Transparency	The degree to which all aspects of the inquiry process are clear and comprehensive
Reflexivity	Thinking analytically and critically about what the inquiry is about, the actions taken and the justifications for taking those actions in the inquiry
Utility	The degree to which the inquiry has an influence either practically or theoretically

I endeavoured to address **transparency** by focusing on the presentation of outcomes and such issues as logic, clarity, flow, and internal consistency throughout the thesis. I further endeavoured to ensure that, in the writing, the outcomes are explicit. This thesis provides justifications for theoretical, methodological, and analytical approaches adopted throughout the entire inquiry, so that target audiences can comprehend how and why such choices were made. Clarity on the methods and procedures used was also maintained. This thesis provides as much detail as possible about what, why, where, when, and how data was collected and analysed, to establish trustworthiness. This inquiry attempted to be explicit in involving interpersonal participation and the way action research reproduces collaboration among the participants and me as an insider researcher.

To apply **reflexivity**, I endeavoured that the intended target audiences are informed about standpoints, so they are able to maintain their subjectivities. Reason (2006) stated that the researcher needs to be conscious of choices and must define them well for those who are engaged in the research, including those to whom the research outcome is presented in written form. The effectiveness of involvement in the data is maintained by paying attention to reflexivity on findings and issues of interpretation and presentation of data (Bjorkman & Sundgren, 2005). I endeavoured to remain reflexive throughout, including the extent to which I attended to my own experiences in my analysis and interpretations.

To maintain the **utility** of the data, I endeavoured to ensure the uniqueness of the situation was reflected, and each lived experience was voiced and interpreted. Meanings emerged from this reflection and interpretation, and actionable knowledge was constructed. A set of guidelines was accordingly developed with a focus on utility.

4.8 Summary

This doctoral work is aimed at developing guidelines to assist app designers in designing effective stroke-related mHealth applications. To do this, I interviewed participants to investigate their experiences of accepting and using such applications by survivors and comprehend survivors' expectations. The findings which emerged from these interviews contributed to the development of the proposed guidelines. This chapter discussed the three cycles undertaken in this inquiry and the associated methods that were undertaken in each cycle. These three cycles were in line with the action research cycle model proposed by Coghlan and Brannick (2014) comprises planning and constructing, taking action, and evaluating phases. Transparency, reflexivity, and utility were applied to ensure the trustworthiness of this inquiry. Lastly, this inquiry also demonstrated ethical values by upholding the privacy and confidentiality of participants.

The four characteristics of practical knowing were considered to provide quality outcomes of this inquiry as practical knowing of:

Experiences and perspectives of participants on the acceptance of mHealth applications by survivors to improve their well-being following a stroke

The rationales behind the choice of methods associated with each cycle were discussed in this chapter, providing a deeper understanding of the process that went into the critical choices made within this inquiry.

Chapter 5: Data Analysis

5.1 Introduction

The previous chapter introduced the sampling, recruitment and data collection methods associated with each of the three cycles. Upon completion, thematic analysis was adapted to analyse and interpret the data gathered in each cycle. This chapter outlines the method for the analysis as well as the rationale behind it. The following sections respectively present the method, its process, and the strategies used in each cycle providing insight into how the data was understood, interpreted, and communicated to inform the next cycle.

5.2 Pre-step phase: Context and purpose

In this phase, I solely endeavoured to understand the context and derive a general sense of the purpose for this doctoral work. Therefore, no finer analysis was carried out.

5.3 Cycle one: Phase three – evaluating actions

In the first cycle, thematic analysis was used to evaluate and reflect on participants' experiences and perspectives (Braun & Clarke, 2006). Braun and Clarke have recently given a new name to their approach: Reflexive Thematic Analysis (RTA) to emphasise: 1) the active role of researchers in the knowledge construction process; meaning analysis of data is influenced by researchers; and 2) that themes are constructed rather than emerge from the data (Braun & Clarke, 2019a, 2019b). RTA is regarded as a reflection of researchers' interpretive analysis of a data set, as such, researchers are "storyteller, actively engaged in interpreting data through the lens of their own cultural membership and social positionings, their theoretical assumptions and ideological commitments, as well as their scholarly knowledge" (Braun & Clarke, 2019b, p. 848). This method allowed analysis of data from multiple participants and various groups to be synthesised into an actionable outcome. RTA is an approach used

to identify, analyse, generate and report themes occurring within data (Braun & Clarke, 2006, 2019a).

Braun and Clarke, in their 2006 paper, originally regarded RTA as a flexible analytical approach, meaning it is not constrained by aligning with any specific epistemological and ontological considerations (Joffe, 2012), rendering it a flexible method offering potential benefits to a wide range of studies. However, in the hermeneutics vein discussed in section 3.3, the RTA method fitted perfectly into this inquiry as this analysis was undertaken through engagement between interview transcripts and myself, participants and myself, and also through the interaction between participants. So, meanings and practical knowledge, as such, were constructed from these interactions. Furthermore, Braun and Clarke, in their recent 2019 paper, defined RTA as a merely qualitative approach, and so using RTA was deemed suitable within an inquiry with a foundation based on constructionism (Braun & Clarke, 2019a, 2020). Consequently, RTA is consistent with the epistemological and theoretical foundations of this doctoral work, and as such, an appropriate method to choose.

Further, employing RTA with a data-driven or inductive orientation meant the data itself is used to derive the analysis structure so that themes are constructed from within the data. The study of Frith and Gleeson (2004) indicated that inductive analysis is aligned with constructionism, and in this manner can be linked to the adopted epistemology.

RTA is an approach that allows researchers to analyse qualitative data that consider participants' experiences and perspectives in association with a given topic (Braun & Clarke, 2019b). As such, it can be used for themes where necessary to "describe the 'lived experiences' of particular social groups" (Braun & Clarke, 2019b, p. 850). While I aimed to prioritise participants' own accounts of their experiences, experiential orientation was considered for data interpretation to emphasise meaningfulness and meanings as ascribed by participants.

The six-step framework proposed by Braun and Clarke (2006 & 2019a) was adopted to describe the analysis process as it provided clear guidance for performing RTA. The six steps are:

1. Data familiarisation
2. Initial codes generation
3. Initial themes proposition – categories
4. Themes review and refinement
5. Themes definition – key themes
6. Report production

The process of analysing the data thematically following each of the six steps is presented in the subsections below.

5.3.1 Data familiarisation

Aligned with the prior discussion, section 4.3.2.4.2.3, familiarising myself with gathered data occurred initially while I was performing the interviews, followed by their transcriptions. Therefore, as an integral part of the interviews, I acquired prior knowledge of the data and analytical views I was to analyse (Braun & Clarke, 2006). Listening to the audio recordings several times before doing actual transcription helped me to remain abreast of the data. Scholars recommend that the researcher should transcribe data personally (Pope, Ziebland, & Mays, 2000). Although the transcribing process was time-consuming and challenging (Lyons & Coyle, 2016), it was a good way for me to further familiarise myself with the data. Researchers who transcribe the interviews themselves, facilitate the efficient capture of the data while simultaneously providing a basis for the rest of the analysis (Braun & Clarke, 2006). The total amount of time for each group of interviews transcribed in cycle one is presented in Table 5.1. In total, the individual interviews and focus groups took 17 hours and resulted in 520 pages

of transcriptions. Table 5.1 has been created as an example to demonstrate the effort invested in the process of reflection.

Table 5.1: Total amount of minutes, words, and pages of transcriptions – cycle one

	Survivors			App designers			HCPs			
	Minutes (M)	Words (W)	Pages (P)	Minutes (M)	Words (W)	Pages (P)	Minutes (M)	Words (W)	Pages (P)	
Focus Group Interviews	-	-	-	162.68	23,710	77	73.49	10,119	29	
Individual Interviews	482.31	77,194	280	105	13,945	43	165.65	24,705	91	
Total M/W/P	482.31	77,194	280	267.68	37,655	120	239.14	34,824	120	Grand Total 989.13/ 149,673 /520

In the course of this phase, notes of a reflexive nature were taken and ideas for coding were developed as Braun and Clarke (2006) advised. I went back to these notes during the subsequent steps. An excerpt from my reflexive notes is presented in Figure 5.1.

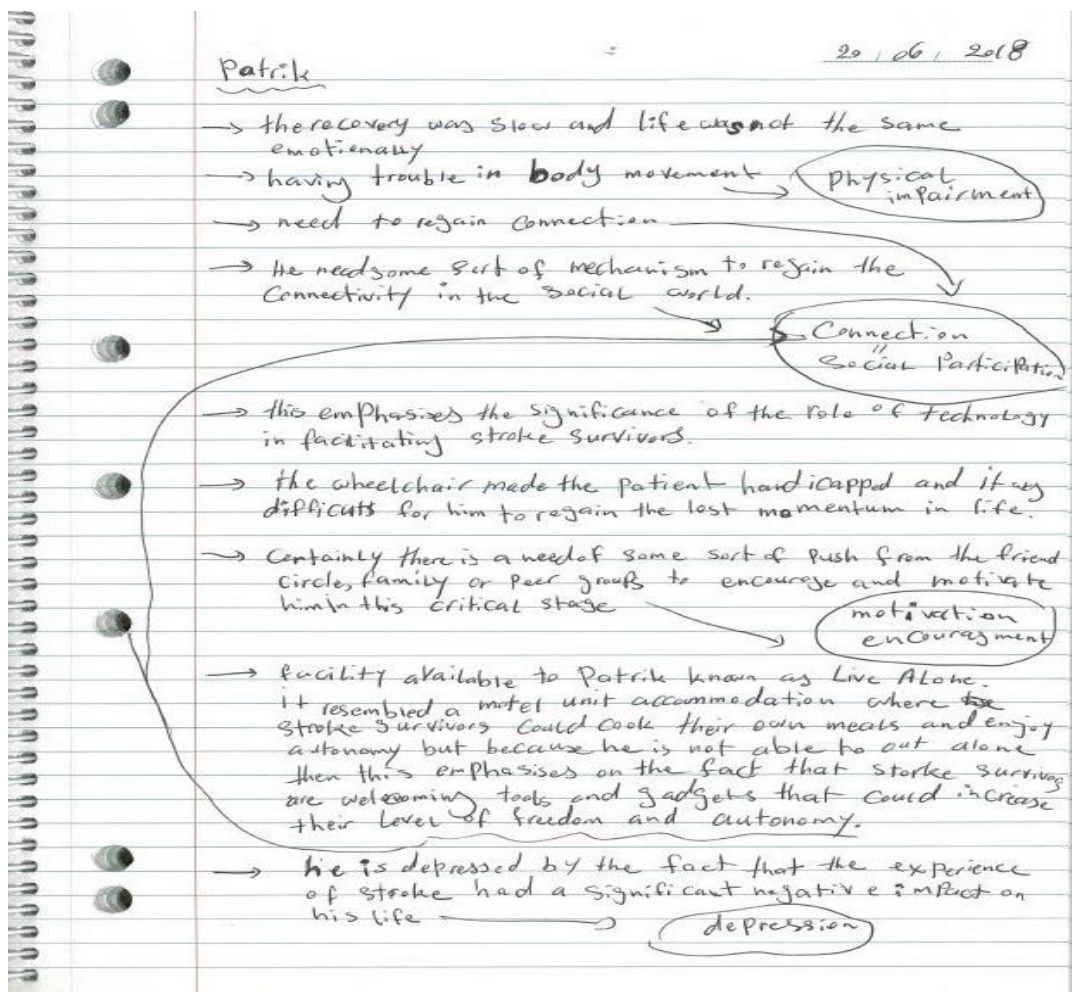


Figure 5.1: An excerpt from my reflexive notes

5.3.2 Initial code generation

I experimented with the use of card indexes to record my data. However, in this inquiry, I decided to use interactive technologies - a software programme - to analyse this material. In this respect, I started to familiarise myself with NVivo. NVivo is a qualitative data management software tool that I used in this cycle to support the analysis process. It was effective in organising the interview transcripts. It also allowed me to examine patterns of codes within the data, including relationships between codes, sequencing, and co-occurrences. As a novice using NVivo, I endeavoured to be cautious about each action I took. Using NVivo, I first created three groups namely: survivors, app designers and HCPs. Then I imported all transcripts into each relevant group and I read carefully the entire data set on two occasions.

The reason to carefully read, I knew it was crucial to an awareness of the context in which transcripts are read. Consistent with the adopted epistemology, meaningfulness was the dominant criterion in the coding process. From the onset, it was important to decide what I regarded as pertinent in terms of identifying '*meaningful units*'. The most pertinent data was the text that referred to what was actually participants' views on mHealth technologies for survivors, survivors' experiences, concerning new technologies (e.g., survivors using their mobile device to collect information for their health concerns) and so I set out to capture all participants views as relevant as possible to their actual lived experiences. While notes for each transcript had been generated from recordings, I now returned to the original transcripts and codes, namely words that captured the qualitative richness of meanings (Boyatzis, 1998). Reading notes and then back to the original transcripts brought me to quickly realise that this was suited to my way of working and seemed to ensure the rigour required for coding.

On the occasion of the first readings, in each transcript, I worked through the entire text and attended to each data item with equal consideration identifying meaningful units, namely interesting features of the data that may be informative in generating themes. For each meaningful unit, I underlined the relevant words, namely underlining the actual words in each meaningful unit that I felt highlighted or emphasised relevant meanings. Then, I created a code as a word or words, that captured the essence of each meaningful unit. In this way, the initial coding was started. I identified and coded the findings of each group of participants separately, and with the result, I was able to carry out a comparative analysis of the data. The comparative analysis assisted me in identifying similarities in codes across three groups of participants. For example, codes 'physically weak' or 'memory issues' identified in app designers' findings were akin to codes 'ability to use' or 'cognitive ability' identified in survivors' findings, reflecting on complications that survivors were experiencing after stroke. This concurred with and informed the notions of the app designers and HCPs' findings in recognising and supporting survivors' perceptions. Figure 5.2 presents an excerpt of the early stage of the coding process in NVivo.

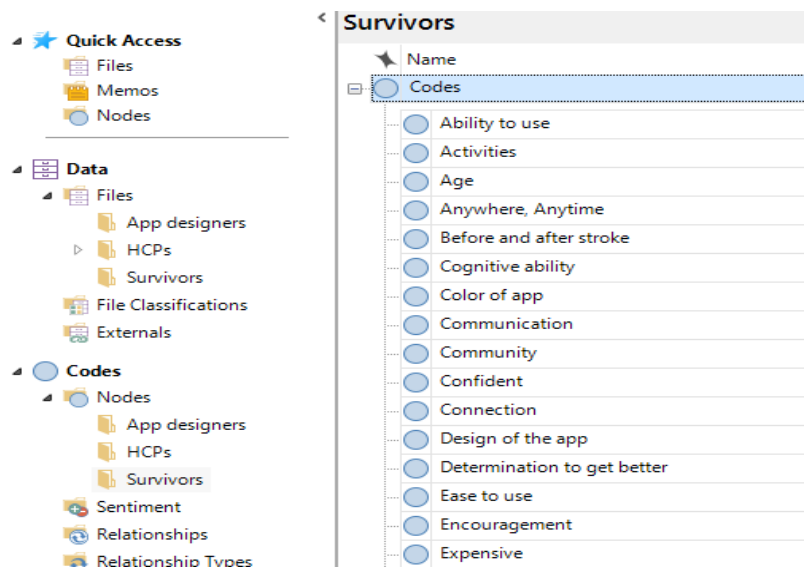


Figure 5.2: An excerpt of the coding framework in NVivo

I now had a good overall sense of how meaningful units should be coded. All meaningful units were coded based on the perceptions I brought to what was being articulated by interviewees and within the context of having by now a good degree of comprehension of all transcripts. I identified as many codes as possible, although it is apparent that the coding process itself is regarded to interpretation.

On the second reading, I went through each transcript intending to interpret the identified meaningful units to examine whether codes offer sufficient details to inform of the underlying commonalities among data items with respect to the subject of the inquiry (Braun & Clarke, 2012; Braun, Clarke, & Weate, 2016). In the process of interpretation, here I constantly moved between small and large units of meaning to determine the meanings of both. For example, when I read a sentence, as my eyes moved across the words, I made a first guess about what the words implied and so I started with a preliminary interpretation of the words. From that preliminary interpretation, I constructed an interpretation of the sentence as a whole. Using the sentence's interpretation, I looked back at the individual words to determine whether my original interpretation made sense. If not, I revised it and I subsequently also revised my interpretation of the sentence based on new meanings of the words. I did this with each sentence until I was happy with my interpretation.

Moving to the next sentence sometimes made me revise my interpretation of previous sentences. I continually revised the smaller units in this manner and refined my current interpretations of the larger units of meaning which, in turn, often led me to new and improved interpretations of the larger units of meaning. Mostly, this process was intuitive, and I was hardly conscious of it but, when interpretation became difficult, I had to do the same thing more slowly and consciously. I moved back and forth between the smaller and the bigger units in a constant improvement of my interpretation of both.

The benefits of this method of interpretation were that it 1) provided me with an opportunity to review my work continuously reconsidering meaningful units and codes, and 2) helped me to rigorously interpret interview transcripts. This method of interpretation also assisted me in realising that the context may determine that some meanings are unlimited. The specific meaning of a word depends on the implied meaning of a sentence however that can depend on the meaning of the paragraph within the context of the whole transcript. An example of my interpretation of a text selected from interviewing a participant is presented in Table 5.2.

Table 5.2: An example of my interpretation process – cycle one

A meaningful unit from a participant (Focus group 1, Jason - app designer)	Code on the first reading occasion	My interpretation	Code on the second reading occasion
<p>“What happens is, the reason they use blue is because it works culturally across everywhere in the world. And then it’s a neutral colour. It’s not really masculine or feminine, and at the same time it projects calmness and friendliness.”</p>	<p>Colour</p>	<p>Looking at the words in the first sentence, for example, ‘blue’, my first guess was that ‘blue’ as an individual word has a meaning. Then I started with my preliminary interpretation that ‘colour’ has something to do with the context of this research. My interpretation of ‘culturally’ was that colour may culturally have different meanings. The next words in the first sentence ‘across everywhere in the world’ reinforced this view that the interpretation of each colour has different meanings worldwide. From these preliminary interpretations, I constructed an interpretation of the sentence as a whole. My interpretation was that 1) colour is an important dimension of the overall design of mobile applications and 2) using them correctly is, therefore, important.</p> <p>Thus, colours have to be evaluated in a different way. App designers have to consider the effect of colours on survivors’ decisions on using mHealth applications for developing user-oriented mHealth applications. Accordingly, it is necessary to refer to colour psychology for mHealth application issues. My finding was that the value of colour psychology for applications is important rather than only considering best practices for overall app design. In the context of colour psychology, I am referring to the study of users’ perspectives on how they perceive colours in their culture. With those interpretations of the sentence, I looked back at the individual words and determined whether my original interpretation made sense. Then I went on to the next sentence, improving my interpretation of the previous sentence. In the second sentence, ‘masculine or feminine’ further reinforced and improved the interpretation of the first sentence, my current interpretation being that people of different cultures have different perceptions and understanding of how different cultural values may differentiate one community from other communities. The words ‘calmness’ and ‘friendliness’ also made me revise my interpretations, which in turn led me to further interpretations of those small units of meaning which indicate that the study of colour psychology helps to develop mHealth applications with user-friendly interfaces.</p>	<p>Cultural colour</p>

Through this recursive process, iterated interpretations of meaningful units, examinations of codes and my further familiarisation, I was able to identify which code was conducive to interpreting a theme, which can be redefined, and which can be discarded. Table 5.2 provided a good example of redefining a code. While in the first reading I perceived the participant is generally referring to the use of 'colour' in applications that should be eye-catching and attract users to accept, it was more appreciating and respecting users' cultural beliefs, values and perceptions that affected their preferences and expectations from mHealth applications. For this reason, the code was redefined to 'cultural colour' and felt to be better suited to the development of a theme.

Cayne and Loewenthal (2018) stated that the personal experience of researchers should be used to purposefully understand the research subjects, assist with emergent creativity and new knowledge from valid insights. Given that, I used my personal experiences to better understand the data and express found phenomena further in the findings and discussion chapters (Chapters 6 and 8).

I was also careful to maintain the context of meanings, as Braun and Clarke (2006) advised. To account for this, a description was provided for each code, which helped in retaining the contextual details of each code. Table 5.3 illustrates an excerpt of the codes list, including descriptions of each code. Once items were identified as meaningful units and assigned codes, the development of themes was initiated.

Table 5.3: An excerpt from the codes list and their associated descriptions

Codes	Description
Ability to use	Ability is a state of being able; chiefly physical or mental capacity to do something. Individuals who seem to be physically weak, and do not have the ability to hold or use objects, need assistance
Access to updated relevant info	Ability to gather information which individuals looking for
Cognitive ability	It is a mental capability that involves the ability to rationalise, conceive, problem-solving, think abstractly, comprehend a complex idea, learning new things, remembering, concentrating, focusing or making a decision that affects individuals' daily life
Depression	It is a mental health disorder that is characterised by persistently depressed moods and lack of interest in participating in activities, originating major challenges in individuals' everyday life
Eyesight	It is related to visual complications such as central vision loss, partially lessened vision, complete visual loss, blurring, visual procession dysfunction, or ocular movement dysfunction
Fatigue	Involves feelings of shortage of energy or tiredness. It is not the same as simply feelings of sleepy or drowsy. When someone is fatigued, they are not motivated and have no energies. Being sleepy might be one of the symptoms of fatigue, but it not the same thing
Monitoring	This type of application creates a platform that helps users to track their activities, progress as well as HCPs monitor their patients' health across multiple areas, including blood pressure, temperature, and weight. The alert functionality sends a notification to JPs about at-risk patient
Reminders	This type of application reminds users on time and day for performing daily activities such as taking medicine, the dose and the time-of-day users need to take
Socialising	It involves people's involvement in social activities that provide interaction with others in the community. It is an important dimension of a determinant of health and keeps people in touch with other people
Stress	Involves feelings of emotional tension. It can come from thoughts that make individuals feel frustrated, angry, or nervous. It is the human body's response to pressure. It is usually triggered when an individual experiences something new, unexpected or that threatens her sense of self, or when individuals feel they have little control over situations

5.3.3 Initial themes proposition – categories

In this phase, initial codes were sorted into broader categories, called themes. This step involved collating all potential codes (Braun & Clarke, 2006) – in other words, combining codes and considering themes that describe their close relationships. I combined codes according to specific themes that defined their commonalities and addressed similar issues (Attride-Stirling, 2001). For example, the codes 'ability to use' and 'eyesight' (see Table 5.3) address physical complications that survivors are experiencing and, therefore, I placed them into a theme of post-stroke physical complications while also acknowledging the privilege of the codes identified in survivors' findings in constructing themes.

I analysed all codes and reflected upon how different codes may merge to form themes. This process involved thinking about the relationships between codes and how they had been defined as an initial theme, which led to the formation of initial themes. For example, codes such as 'cultural colour', 'simplicity', and 'customisation' that related to the design of mHealth applications were placed in an initial theme 'the app design-related factors' which identified them as having commonalities and that they contributed to the elements associated with a good design.

After pooling all codes into initial themes, the differences between, similarities in, and relationships among codes were examined. After examining these relationships, codes remained duplicated where necessary, that is, where they were placed into different themes. Some codes still stayed in the same group because they shared the same meaning or addressed the same issues. For example, the 'connectivity' code was initially grouped into the theme 'connecting', which defined survivors as willing to use an application that facilitates a connection among survivors for social engagement. This code was also recognised as an encouragement element in survivors' capability, which indicated that if survivors are involved with social participation (connectivity), they may regain the self-efficacy that leads to empowering survivors to manage their condition. Ultimately, survivors' acceptance of such applications rises and, therefore, the code was also grouped into a 'post-stroke psychology complication' theme.

Once codes were placed into initial themes, all codes were studied again to ensure accuracy and to check for further similarities and overlaps. This time, the process was carried out by assessing codes and themes against the meaningful units. The process of grouping codes was now about reflecting on how they related to the initial themes. The meanings of new themes were not the identified codes – they were newly emergent due to their associations with other themes.

Overall, the process of creating initial themes involved assigning and re-assigning the codes and sorting tentative themes. As a result, packing and unpacking existing themes, detaching them, and packing them differently provided potential interlinks among clusters. At the end of this cyclic process, the initial themes that had been

identified across three groups of participants were proposed. However, I remained uncertain as to whether the themes that had been identified should be held as they were, or were required to be polished or even abandoned. The next step aimed to review the proposed initial themes against meaningful units to see whether themes fitted together or further refinement was necessary.

5.3.4 Theme review and refinement

Once initial themes were established, they required recursive reviewing in a further phase to ensure their fitness (Braun & Clarke, 2006). All initial codes were reassessed once their distribution into groups of themes was complete. The aim was to identify whether codes formed a coherent pattern that correctly reflected a theme's meaning within the data (Braun & Clarke, 2019a).

In the course of this review process, I identified some inadequacies in the initial themes across three groups of participants, which required changes. As a result, some codes were retained because they showed similarities with other codes and some codes were allotted to new themes. For example, codes for 'digital literacy' and 'language barriers' (identified in the survivors' group) were initially placed into the theme; 'individual characteristics are key elements' (see Figure 5.3). This was because I categorised them as features or qualities that typically belong to individuals, or that serve to identify individuals. However, in the context of the usage of mHealth applications, these two codes reflected the qualities of being able to access applications, therefore, they were allotted to a new theme, namely 'access to mHealth applications'. I also found that there were themes that shared the same context, leading to some themes being combined. For example, I found the theme; 'the app design-related factors' was more contextually related to 'access to mHealth applications' which generally means that if the design of an application is easy to access, then accessibility of such an application improves.

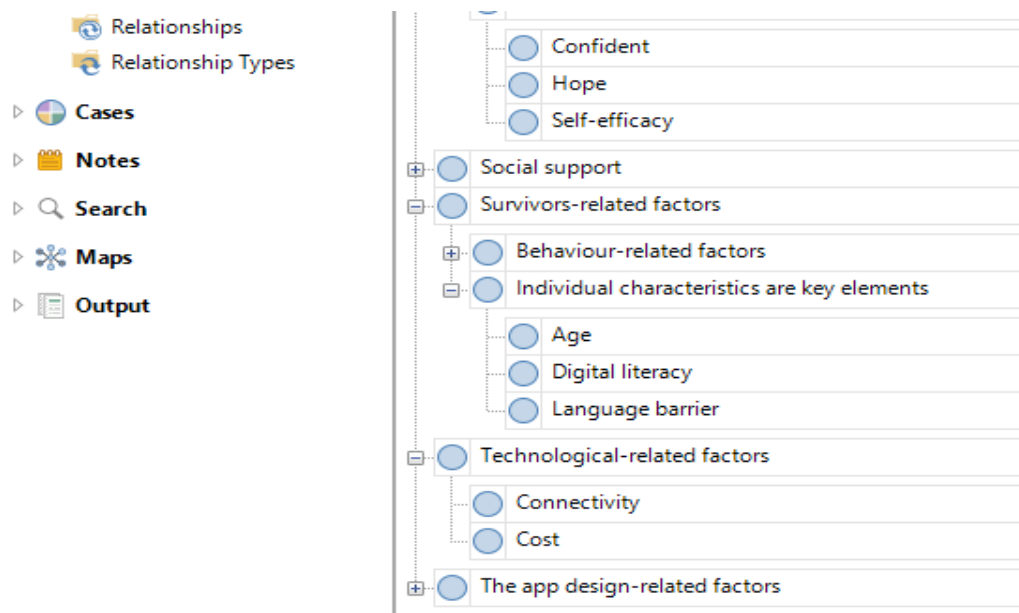


Figure 5.3: An excerpt of defining themes

During this process, some codes were deleted or relocated, as well as some themes being deleted or renamed, and new themes created. Themes were again further reviewed against meaningful units and rechecked against the raw data to ensure that conclusions were firmly grounded (Braun & Clarke, 2006, 2019a). Constantly returning to the raw data is a key principle of RTA and assures this research remains grounded in reality (Joffe, 2012). Constantly reviewing codes and initial themes ensured that the final codes were placed into themes broad enough to reflect participants' experiences and yet capture the ideas that existed in the data.

More importantly, I found that majority of initial themes across three groups of participants shared similarities in meaning, context, characterisation, and classification. For example, I found a theme named 'post-stroke physical complications' identified in findings from survivors that had similarities in context with the theme named 'experienced physical inability' identified in findings from HCPs. Both themes reflected upon post-stroke difficulties survivors face. This informed the notion of combining themes across three groups of participants, which resulted in having themes that I define as synthesised themes of three groups of participants. These themes were identified as key themes and categories constructed from the data as a whole.

5.3.5 Theme definition – key themes

With the initial themes established, sorting them into key themes with clear definitions was the aim of this step. The process involved sorting initial themes into key themes, by considering how they might be identified as key themes that fitted into the story as a whole. The conceptualisation of key themes was achieved through repeatedly reviewing initial themes against the codes and data and recombining them where there was a relationship between themes. Relationships were found among contrasting themes as well as similar themes. Initial themes comprised a diverse number of codes; single codes, multiple codes, some small, and some large, and during the process of sorting into key themes, I realised that some codes were specific, and others seemed general. By working cautiously, I found that key themes were constructed gradually in relation to initial themes which combined and merged as their common meanings became apparent.

I specifically endeavoured to identify what was of concern in terms of the research questions (Braun & Clarke, 2006), consequently identifying the status of the key themes as categories. Using this analytic process, I determined what aspects of the data the key themes individually captured, regarding context and meaning, by always returning to and looking at important data areas in relation to the research questions. I also came to the view that key theme names should be clearly identified, to give the readers a sense of what the themes are saying, as Braun and Clarke (2006) advised.

The final stage reviewed key themes against codes as well as meaningful units for the last time to ensure the credibility of the outcomes. Proceeding again with caution, some key themes were again rearranged for accuracy, while others were renamed with minor adjustments implemented. This defining of the key themes was not only based on codes but now also on how themes related to one another and supported each other across three groups of participants. Recognising the statements that key themes made individually while considering how they dovetailed into the whole story of the data was the outcome of this work.

5.3.6 Report production

Having established all the themes, the writing-up of a report regarding the findings of cycle one completed this process. Findings are presented as three key themes, namely: qualities promoting acceptance of mHealth - desired applications; post-stroke capability of survivors; qualities influencing survivors' possibilities for access to mHealth applications and their supporting categories. Key themes and categories are deepened and further developed in the next cycles.

To confirm the findings, their coherence and consistency, and the presence of interesting key points of the data within these themes (Braun & Clarke, 2006), the outcomes of this cycle are provided in the next chapter, section 6.3, and structured around the three key themes with their associated categories.

Using the guidelines proposed by A. Tong, Sainsbury, and Craig (2007) to ensure transparency, the analysis outcomes are expressed in detail in Chapter 6. Direct quotes accompanied by pseudonyms are included in the write-up to support the analysis, as suggested by King, Cassell, and Symon (2004). The outcome of this analysis process is an interpretive report in which I theorise and structure arguments for the importance of the themes obtained in this inquiry as well as their broader meanings and propositions in relation to contemporary literature.

5.4 Cycle two: Phase three – Evaluating actions

Similar to cycle one, the RTA method was used to reflect these findings. While the analysis process involved continual moving back and forward concerning the whole data set, meaningful units, and the analysis of the data (Braun & Clarke, 2006, 2019a), it is also acknowledged the involvement of the six-step framework used in cycle one. However, this time the process involved a non-computerised approach, meaning I created a journal. The reason for this was first, the small sample size in this cycle which was more manageable compared to cycle one. Second, this reflective journal was a process of writing that helped me to manage my ideas in a concrete form and led me to

a more profound examination of what I was thinking, helping me to clarify my views and find gaps in my understanding. Lastly, a written record was effective in my continual reflection on what I had discovered. Figure 5.4 shows an excerpt of my journal.

Meaningful units	Codes	Explanation	Categories	Themes
"we use different colours but at the same time we consider our audience when we choose colour palette for design", App designer transcript 2	Accent Colours	are colours used in quite small quantities to lift or do add punch to colour scheme and should be in a complementary colour.	[Existing category] Design of interface	Themes (3) realities influencing survivors possibilities for access to mHealth applications
"in virtual reality you do not have your hands or anything", App designer transcript 4	Eye-tracking	is a sensor technology that enables an application to determine what the user is looking at - the gaze point.	"	"
"font size is first thing we consider in design", App designer transcript 4	Good font size	an easily legible font size for body text as used for elderly people usually ranges > 16 points	"	"
"we always make sure that the apps are simple to navigate and use", App designer	Simplifying interface	visual representation of an application interface that removes unimportant elements and make it simple less complicated and less cluttered.	"	"

Figure 5.4: An excerpt of my journal

5.4.1 Data familiarisation

In the second cycle, I felt more confident with the context of data analysis due to the experience I gained from the previous cycle which assisted me to accelerate the process this time. I took notes while I interviewed participants as well as audio-recorded all sessions which helped me with identifying and marking preliminary ideas for codes

even before I started to listen and transcribe the records. The notes also assisted me to make sense of the data as I transcribed. Listening to the recordings and transcribing them enabled me to become further familiar with the data. This time, I was also searching for specific topics that may be relevant to my previous findings in cycle one. As this required me to transcribe those segments of the interviews that are relevant to the topics, I, therefore, took Braun and Clarke's (2006) advice: "What is important is that the transcript retains the information you need, from the verbal account, and in a way which is 'true' to its original nature" (p. 88). I have listed preliminary codes in the journal, along with an explanation of each code to ensure maintaining the contextual details of each code (see Figure 5.4).

5.4.2 Initial code generation

Following the same strategies, I used in coding the data in cycle one across the three groups of participants I additionally used the notes I took during the interviews. These helped me to realise that some initial codes could be recognised during the data collection before I even started listening and transcribing the interviews. In this step, I read the transcripts on three occasions with specific intentions:

1. The first reading was carried out with the intention to identify any meaningful units and codes which may be relevant to the themes grouped in cycle one. The reason was simply to look into resemblances and similarities between findings of both cycles to support and deepen what had already been found.
2. The second reading was carried out with the intention to identify new meaningful units and themes to augment understanding of the phenomenon.
3. The third reading was carried out with the intention to interpret both resembled and new meaningful units/codes.

Similar to cycle one, the coding process involved interpretation of meaningful units and an example of my interpretation of a meaningful unit is provided in Table 5.4.

Table 5.4: An example of my interpretation process – cycle two

A meaningful unit from a participant (Ataahua – stroke survivor)	Code on the second reading occasion	My interpretation	Code on the third reading occasion
<p>"I think it is ok. It is great if I see a real app. I did not use an app before".</p>	<p>Proposition of creating a prototype</p>	<p>Looking at the words in this meaningful unit, for example, 'think', my first guess was that 'think' defines the participant's perception. My preliminary interpretation was that 'think' is about the participant's mind towards the topic and has something to do with the proposed guidelines. My interpretation of 'ok' was that the participant is expressing agreement or acceptance of the proposed guidelines. That is the participant's mind towards the guidelines was positive. The next word in the sentence, 'if' represents a view of introducing a conditional clause that is a contribution to a perception that the participant would rather something else. 'Real app' is actually existing as a thing. From these preliminary interpretations, an interpretation of the sentence as a whole was constructed. My interpretation was that the participant would like to see how the proposed guidelines are working in practice, therefore, my perception was that it is important to integrate the proposed guidelines into an app to illustrate how they are working. The second sentence, 'I did not use an app before', supported the notion that the participant has no idea what the proposed guidelines look like and perhaps integrating the proposed guidelines into an app seemed a rational choice. My interpretation was that the value of designing a prototype is that participants could provide me with their actual perspectives rather than imagine what the proposed guidelines would look like. With those interpretations of the sentences, I looked back at the individual words and see whether my original interpretation made sense. Then I came up with the interpretation of unfamiliarity of the participant with mHealth applications and the participant made a proposition of creating an app with the integration of main features of the proposed guidelines.</p>	<p>Proposition of creating a prototype</p>

Having completed the readings, coding and interpreting, 1) I was able to identify which code needs to be redefined, which can be discarded, and which is conducive to defining a theme. Table 5.3 provided an example of a meaningful unit that is conducive to communicating a story. 2) I ended up with codes that resembled cycle one and codes that were new. For example, 'accent colours', 'good font size', and 'simplifying interfaces' were all codes that were relevant to an existing category, 'design of interface'. An example of a new code was 'eye-tracking' which defined a component that facilitates user interface that survivors who are experiencing physical complications such as weakness in arms may find useful. Therefore, I considered it as a component of an interface design and placed it into the category 'design of interface', as shown in Figure 5.5. I also coded for as many interesting themes as possible and provided a description for each code as I proceed so I would not lose the context.

5.4.3 Initial themes proposition – categories

Once I coded all my data, I aimed to group them into initial themes across three groups of participants. While codes identified interesting remarks in the data, themes were comprehensive and involved effective interpretations of the codes and the data. I started with examining the codes and their related meaningful units and subsequently attempted to allocate the codes in comprehensive themes that define something engaging about the data. For example, I combined the codes 'multi-language option', 'voice activation' and 'gamification to motivate' into a single theme called 'good design of applications'. The process of searching for themes was iterative and I moved codes back and forth in an attempt to form distinct themes. Using sticky notes in coding helped me to visualise the association between codes and themes. At this stage, some codes did not fit together with other codes, as a result, some codes became themes themselves for example 'eye-tracking' because they were independently significant.

5.4.4 Theme review and refinement

I studied all the relevant meaningful units and codes to investigate whether they defined the theme; whether there were inconsistencies and/or themes overlapped. In

cases of inconsistencies within a theme, I divided the theme to create more distinct themes and moved some codes into existing themes (created in cycle one) where they fitted better. I kept reviewing themes until I felt that I had a set of themes that were distinctive and coherent; subsequently, I underwent the same process once more concerning the entire data set. I studied all data once more and considered if the themes satisfactorily characterise the engaging themes in all interviews. In this process, I discovered themes supporting the themes that had already been identified in cycle one, as well as new themes. This step was a cyclical process, where I went back and forth between meaningful units, codes, and themes until I felt that I coded all the pertinent data and had adequate and consistent themes characterising the data accurately.

5.4.5 Theme definition – key themes

In this round, I named and described each theme I had identified in the previous step. What I learned from the preceding cycle was theme names are best to be engaging and descriptive. In the description of the themes in this cycle, I did not just portray what the themes were concerning, but I also portrayed what was interesting concerning the themes and why it was interesting as Braun and Clarke (2006) advise: “identify the essence of what each theme is about” (p. 92). In describing the themes, I identified which story each theme told and how the stories related to the themes identified in cycle one as well as creating new themes. For example, ‘gamification’ and ‘eye-tracking’ were identified as new themes. However, I decided to place them into the existing category namely ‘design of interface’ because both themes refer to components of good design, which contribute to a good UX. At this point, I found myself able to tell coherent stories about the themes identified in cycles one and two. This was a result of identifying the evidence that supported and further developed themes and associated categories identified in cycle one.

5.4.6 Report production

The write-up of the results is presented in section 6.4. I used the identified themes as a basis for the concluding report where readers can go to the inclusive account of what this work involves.

5.5 Cycle three: Phase three – Evaluating actions

Like cycles one and two, the RTA included the six steps used to study the data.

5.5.1 Data familiarisation

Becoming familiar with the data collected from the survivor participants happened while I was interviewing them. I was provided with a chance to listen carefully and take notes, which became my only source of data since audio records were damaged.

Becoming familiar with the data collected from the app designer participant happened 1) while I was interviewing the participant and 2) listening several times to the audio record and reading the transcript.

5.5.2 Initial code generation

This step started with coding meaningful units and ended by collating all codes and relevant meaningful units, which led to the identification of codes that were found to resemble those codes identified in cycles one and two. As examples; 'decent colour', 'simple to use', 'eye-tracking feature' and 'reminder feature' are all examples of pre-existing codes that were relevant in cycle three. During this process, I also became aware that findings of this cycle further deepen the outcomes of cycles one and two.

5.5.3 Initial themes proposition – categories

This step involved searching for themes. In this step, looking for themes was somewhat like coding my codes to find similarities in the data across two groups of participants (survivors and the app designer) as well as over three cycles. I ended this

step by collating all the coded data relevant to the identified themes in previous cycles, therefore, I considered them as repeating the same themes and stories. For example, codes such as 'decent colour' were found to fit into the existing category – 'design of interface'. However, a code called 'security issues' became an interesting topic and therefore became a theme itself.

5.5.4 Theme review and refinement

This step involved checking whether identified themes are representative of what the codes seemed to be communicating. I sought to reflect on whether identified themes inform convincing stories about the whole data in three cycles and began to outline the nature of each theme and the association among the themes in all three cycles. I decided here to collapse the majority of themes together and place them in themes that have already been identified in preceding cycles.

5.5.5 Theme definition – key themes

This step involved defining themes which required me to think about a comprehensive analysis of each theme. I asked myself what story each theme communicated and how each theme fitted into the complete story concerning the data across three cycles, defining the 'essence' of each individual theme and creating informative names for themes. Similar to cycle two, this step identified themes that supported existing themes. RTA method is a continual process that involves going back and forth between steps of data analysis as needed until the researcher is convinced with the final themes. However, undertaking this analysis further assisted me to realise that I was going back and forth between cycles of data analysis as well, as I sought to identify themes that may support and confirm what I have found in preceding cycles. This cyclical process identified themes that supported three key themes and categories identified in cycle one, which informed the conclusions I made and gave me the confidence to acknowledge that what was found in cycle one is rigorous and substantive and supported by the outcomes of the cycles two and three.

As such, it makes sense to acknowledge that a degree of deductive analysis was also used since the meaningful units in cycles two and three were coded in a way to see whether they fit existing themes constructed in cycle one. In other words, while this inquiry originally used inductive analysis, the analysis in cycles two and three included a deductive process to make certain that the codes contributed to constructing themes that were meaningful to the existing themes, and to make certain that the meanings that were accentuated were relevant to the existing themes. I found using deductive analysis was appropriate in the context of the adopted methodology – action research – where the evaluation phase paves the way for a further cycle of constructing, planning, taking, and evaluating action, meaning a further cycle is constructed and planned based on the preceding cycle’s findings and its outcomes are meaningful to the findings of the preceding cycle.

5.5.6 Report production

Write-up was integral in the whole analysis process over three cycles. Write-up involved weaving together the analytic narrative to articulate to readers a persuasive and coherent story regarding the findings and contextualising it with respect to existing literature. The next chapter is allocated to present the results of the three cycles.

Chapter 6: Findings

6.1 Introduction

Drawing on thematic analysis I constructed three key themes and 17 categories, each of which is described in detail in this chapter. As described in Chapter 4, three groups of participants took part in this inquiry including survivors, app designers, and HCPs. As an insider of the survivors' community, over three cycles, I interacted with participants in the context of communicative spaces, capturing and analysing shared understandings. Participants collaboratively shared their experiences; as such, knowledge was socially constructed. Given that, this doctoral work aimed to privilege the survivors' perceptions in constructing the themes. This chapter is organised around themes that were developed from survivors' perceptions, with data from app designers and HCPs drawn on to deepen and enrich the identified themes, while acknowledging the uniqueness of each participant group's perspectives.

This chapter is structured into three main sections that align with the three cycles of research undertaken to achieve the aim of this PhD inquiry. The first section presents findings from cycle one, initial consultations, which involved capturing participants' experiences of the usage of mHealth applications by survivors. Findings from each participant group are presented separately with key themes and associated categories discussed in-depth with supporting data. The draft guidelines were then generated from the findings of the first cycle (see Chapter 7). The second section presents findings from cycle two, capturing participants' views on the draft guidelines developed which informed further thematic and guideline development. In this section, the themes refined through cycle two are presented. The third section presents the findings from cycle three, reporting the evaluation of the guidelines used in a working prototype, namely ACCESS. The findings from this final cycle informed the final outcomes of this doctoral work.

Across the three cycles, three overarching themes were constructed including 1) qualities promoting acceptance of mHealth - desired applications; the first key theme relating to these indicators, includes four categories: ‘connecting’, ‘reminding’, ‘monitoring’, and ‘being informed’. 2) the second key theme, which is related to the post-stroke capability of survivors with regard to the use of mHealth applications, produced four categories: ‘physical’, ‘emotional’, ‘psychological’ and ‘medical’ complications. Each of these post-stroke complications minimises survivors’ capability in performing daily activities, including the use of mobile devices and applications. 3) the third key theme exposed was qualities influencing survivors' possibilities for access to mHealth applications, and this is supported by nine categories: ‘digital literacy’, ‘social support’, ‘technological support’, ‘language barriers’, ‘affordability’, ‘design of interface’, ‘engagement’, ‘motivation’ and ‘security’.

All the themes appeared to be interconnected. For example, the category ‘psychological complications’ is interrelated to the ‘connecting’ category with the contention being that survivors need engagement through social connections to help address post-stroke complications. Key themes and associated categories are all relevant to the first research question: “What are the factors that affect the acceptance of mHealth applications by survivors?”. Figure 6.1 shows a thematic map that illustrates the three key themes, associated categories and their relationship to each other developed over three cycles.

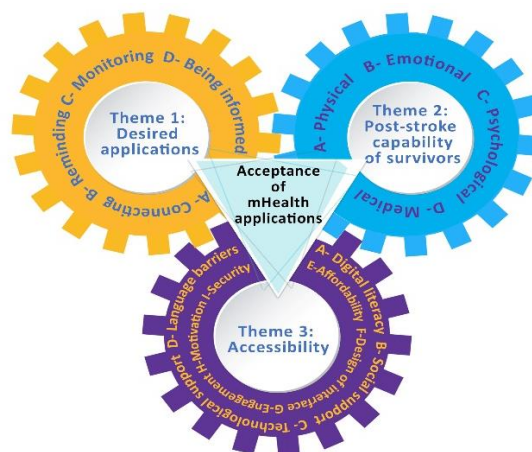


Figure 6.1: Thematic map

6.2 Cycle one – Initial consultations: Exploring the perspective of participants on the use of mHealth applications by survivors

6.2.1 Participant characteristics

Twelve survivors, 13 app designers and six HCPs participated in cycle one and shared their views that contributed to the development of the key themes and categories. This sample size was deemed sufficient for information power given 1) the achievement of the aim of this inquiry – the draft guidelines were developed; 2) the specificity of characteristics of each group of participants; 3) strong dialogue in the interviews; 4) sufficient information the sample held and 5) in-depth data analysis. Further, diversity in this inquiry sample on post-stroke complications of survivors, experiences of app designers and HCPs profession was achieved. Table 6.1 provides an overview of participant characteristics for survivors.

Table 6.1: Participant characteristics – survivors

	Pseudonym	Age	Gender	Ethnicity	Living Situation	Date of Stroke
Individual interviews	Anika	75	Female	Indian	Alone	2011
	Ataahua	55	Female	Māori	Alone	2014
	Charlotte	64	Female	New Zealand	Alone	2013
	Drewet	55	Female	NZ European	With family	2016
	Ella	56	Female	NZ European	With family	2011
	Jack	70	Male	New Zealand	With family	2012
	Kerl	80	Female	New Zealand	With caregiver	2009
	Lui	57	Female	Malaysian	With caregiver	2015
	Patrik	67	Male	NZ European	Alone	2010
	Sophie	76	Female	New Zealand	With caregiver	2016
	Stella	56	Female	European	With family	2016
	Yu Yan	75	Female	Chinese	With family	2007

Note: Participants were asked to self-identify their ethnicity and living situation, thus all identified ethnicities and living situations are summarised here.

Table 6.2 provides an overview of participant characteristics for app designers. Of the 13 app designer participants, n=3 accepted to participate in the follow-up individual interview.

Table 6.2: Participant characteristics – app designers

	Pseudonym	Age	Gender	Ethnicity	Profession	Duration of Profession
Focus Group 1	Bohuslava	32	Female	Ukrainian	Digital Designer	10
	Isla	22	Female	New Zealand	Digital Designer	5
	Jason	24	Male	Pakeha/European	Designer/Educator	5
	Nicolas	37	Male	Latino	Designer and Researcher	5
	Peyman*	32	Male	Indian	Digital Designer	7
	Vibuma*	49	Male	European	Digital Producer	9
Focus Group 2	Adelmo*	47	Male	Māori	Digital Producer	18
	Deigo	37	Male	Latino	Designer and Researcher	5
	Ganna	33	Female	Syria	Digital Designer	8
	Hossein	33	Male	Iranian	PhD student/Digital content creator	10
	Lucy	23	Female	New Zealand	Digital Designer	5
Focus Group 3	Ari	24	Male	European	Designer/Researcher	5
	Liu	34	Male	Chinese	Digital Developer	6

Note: Participants were asked to self-identify their ethnicity and profession, thus all identified ethnicities and professions are summarised here.

*Consented to take part in a follow up interview

Table 6.3 provides an overview of participant characteristics for HCPs. Of the six HCP participants, n=4 accepted to participate in the follow-up individual interview.

Table 6.3: Participant characteristics – HCPs

	Pseudonym	Age	Gender	Ethnicity	Profession	Duration of Profession
Focus Group 1	Adelajda	50	Female	Polish	Physiotherapist	9
	Amelia*	44	Female	British	Physiotherapist	5
	Natasha	61	Female	Chinese	OT/Physiotherapist	20
Focus Group 2	Agusia*	58	Female	NZ European	CEO, Speech-Language Therapist	30
	Annabel*	41	Female	Māori	Physiotherapist/ Community Stroke Advisor	5
	Sophia*	59	Female	Indian	OT/Rehabilitation specialist/conductor	21

Note: HCPs could identify with more than one profession; participants were asked to self-identify their ethnicity and profession, thus all identified ethnicities and professions are summarised here.

*Consented to take part in a follow up interview

6.2.2 Findings from stroke survivors

Figure 6.2 provides an overview of key themes and categories constructed through cycle one. These will be discussed in more depth below.

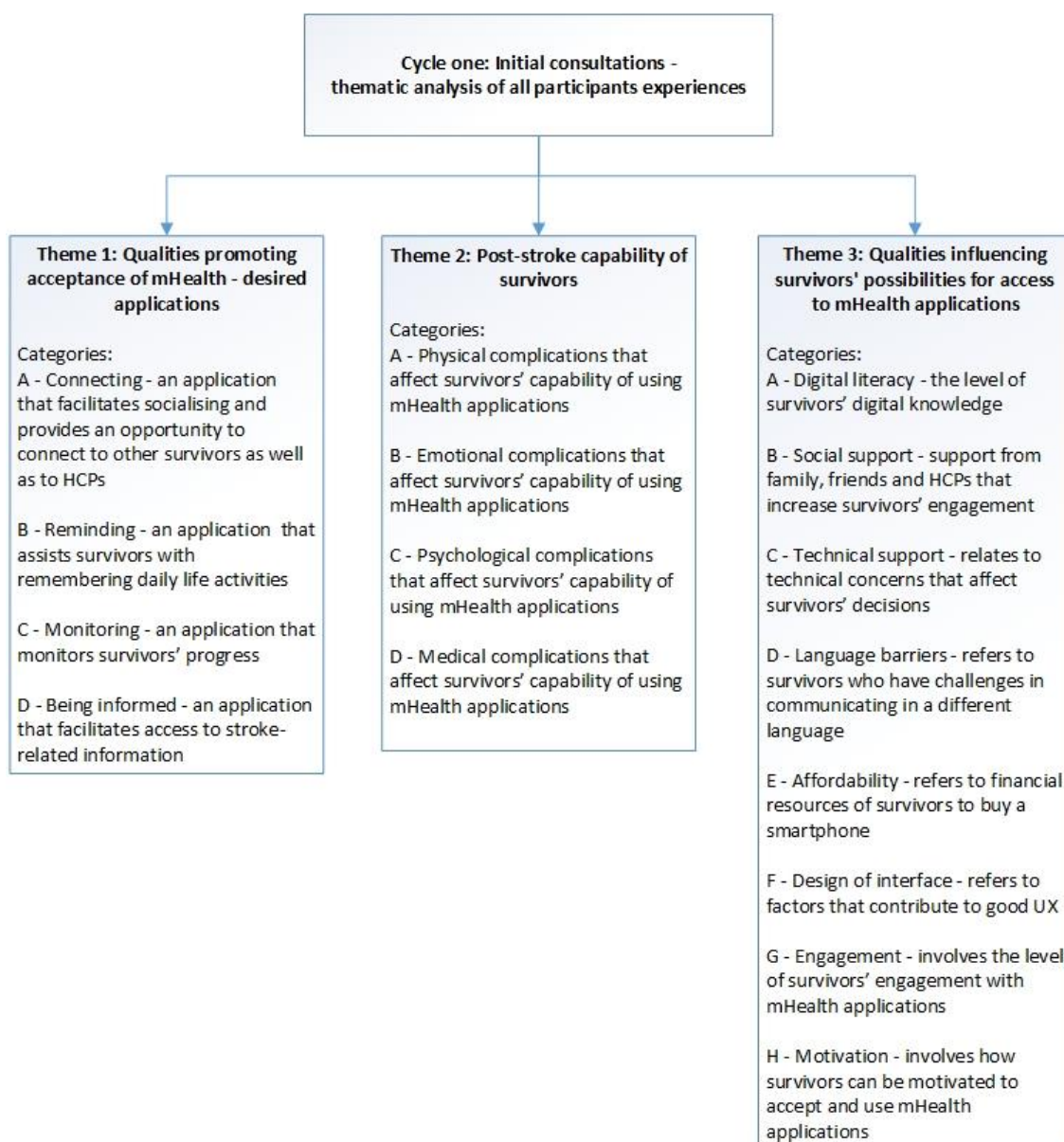


Figure 6.2: Key themes and associated categories proposed in cycle one

This section presents key themes relevant to survivors' experiences after a stroke with a particular focus on key factors that affect their potential interactions with mHealth applications for self-management purposes.

6.2.2.1 Theme 1: Qualities promoting acceptance of mHealth - desired applications

Findings from survivor participants highlighted that they experience a range of post-stroke complications which were formative to what types of applications or applications' functions they perceived would be helpful to them. This theme involves the key type of applications and functions survivors believed could deliver the support they need to address challenges post-stroke. As a result, overarching findings were that four types of mHealth applications are preferred by survivors, leading to their acceptance. Survivors shared their willingness to use an application that assists in:

1. Connecting – facilitates socialising and provides an opportunity to connect to other survivors;
2. Reminding – assists them in remembering daily life activities;
3. Monitoring – monitors their progress; and
4. Being informed – facilitates access to stroke-related information.

These four types of applications are outlined in detail below.

6.2.2.1.1 Connecting – An application that facilitates socialising and provides an opportunity to connect to other survivors

The findings revealed that survivors indicated a preference for an application that could help them connect with other survivors and support their social engagement. Survivors were aware of the recovery process and sensed the unknown length of time for recovery, suggesting social participation is what they need to feel autonomous. One survivor stated that she was still feeling weakness in her feet, and she had it in mind that the recovery might take years and that she would need to depend on others, restricting possibilities for her and leading to less social participation.

My left leg is weak ... I do not know how long, but I am sure will take long to be the same person I was. Friends coming and helping me. Sometimes I need to hang out to feel independent. (Stella)

Lack of social participation appeared to contribute to feelings of uselessness and depression. Survivors emphasised their dependency on others lessened their level of socialising and contributed to negative feelings. These negative thoughts led them to feel emotionally disturbed and drained, which in turn contributed to a depressed state of mind. For example, one survivor described her active life before stroke, to emphasise the impact of stroke on her negative thoughts that now contributed to her post-stroke depression.

I always was an independent person, I raised four kids; I used to do everything. I was socially so active, they always ask me to organise community events and now I have someone coming to cook and cleaning for me. This makes me feel useless, this is sad. Sometimes I feel I am not getting better [which] makes me feel depressed. (Sophie)

This feeling of depression can develop due to the isolation and lack of post-stroke socialisation. Sophie's comments suggested that stroke resulted in a social disconnection which led to a reduction in self-efficacy; that is, she believed there were no possibilities (no hope) for the future. Survivors all shared their views of socialisation and many stated they need to feel socially welcomed and involved. A virtual community was believed to be one solution to address this concern. Jack shared his views on socialisation in the context of mobile applications:

Yes, just connection app I think, you know they might produce all sorts of benefits, just you are not alone in the world, there are other people in the same situation, it might be an issue about people that they had a bad attack, have trouble, lose mobility like your mum. So, you know just a support, or is that all sorts of help, even a friendly voice. (Jack)

This was reinforced by another survivor, Stella, who echoed this view and tried to describe it in the form of a website that could highlight the significance of connectivity between survivors.

They can go to that website, so something local like that could be developed. So, I have had a stroke but healer is just around the corner. Just had a stroke, just that little network of neighbours who might of be in the same condition, you know, and doing something to get better.

Just motivation, I think the app should be a page that I recommend you can list or take details of other stroke survivors. (Stella)

It appeared that survivors looked to a community to be motivated to continue with their recovery process. Stella made her point that sharing, for example, positive experiences of performing exercises designed for arm augmentation, can be motivating for others with the same condition. Intuitively she held the belief that the success of a survivor increases the possibility of repetition of the same behaviour by others. Shared aspirations can contribute to collective forms of motivation increasing survivors' willingness to participate in rehabilitation to further recovery. This taps into and emphasises the strengths of peer-to-peer learning or consequences of human behaviour as motivating factors. Another survivor also reinforced the motivation aspect in the context of mobile applications:

As well ... So, I need, something, some app you know, to connect me to other stroke survivors to chat to motivate each other. (Ella)

Furthermore, Stella stated that the focus should be given to facilitating a connection among survivors when designing the application. This resulting connectivity has the potential to contribute to the mitigation of the impacts of social isolation. These findings showed that connectivity among survivors may create a way to deal with the grief through the acceptance of their condition, acceptance of a new way of life, and a feeling that they are not alone as there are possibilities in their futures.

6.2.2.1.2 Reminding – An application that assists survivors with remembering daily life activities

Another type of mHealth application that was perceived to be potentially helpful was those incorporating a reminder feature.

Some survivors experienced memory problems following stroke and so had a tendency to forget important day-to-day activities such as appointments, taking medication and exercises. As a consequence, they often relied on reminders for key self-

management activities, making a reminder function an important feature in applications that could support survivors.

Of course, I need someone to remind me. If I use an app I rather something have this option. (Kerl)

I surely need to be reminded about my pills. (Jack)

My grandson usually reminds me of my exercises when I have new exercises. You know they are new, I can't remember how exactly I should do it. (Jack)

These responses highlighted the importance of integrating a reminding technique into the design to enhance the acceptance of mHealth applications. Further, integration of reminding technique may slightly reduce the post-stroke burden on survivors' families, friends, carers and HCPs.

6.2.2.1.3 Monitoring – An application that monitors survivors' progress

One aspect of mHealth applications which seemed to be key to increasing survivors' willingness to accept mHealth applications was a monitoring function.

That would be nice if someone helps me with daily exercises. I go to my community for group exercises, but we have one trainer. She can't monitor our activities all the time. (Sophie)

Survivors would like to ensure they get the best out of rehabilitation activities and to be more involved in managing their post-stroke conditions to optimise their health outcomes. They shared their experiences of doing exercises and stated that they were not sure how they were doing with them and would benefit from being able to monitor their progress. mHealth applications were considered to have the potential for supporting this and facilitating self-management.

The quote from Lui below highlighted the significance of monitoring her progress in assisting with better recovery. This promoted the idea that integrating monitoring features into the design of mHealth applications could further increase their acceptance.

Look, people want to get better soon. My sister monitors my progress and passes it on to my GP. I need my GP to monitor my progress personally, but I need to wait for our next appointment. Sometimes she calls me to check on me. I like it. (Lui)

These statements emphasised the importance of connectivity between survivors and their HCPs. The idea of virtual connectivity and the importance of supporting and monitoring survivors' progress in a connected context can change the way social bonds and networking are perceived.

Regular meeting with my doctor helps me to get advice but she is not with me all the time to help me better. (Sophie)

Survivors' input suggested monitoring their progress may result in positive health comes, indicating the integration of monitoring features in the design may have a positive impact on survivors' wellbeing, which highlights the potential mHealth offer.

6.2.2.1.4 Being informed – An application that facilitates access to stroke-related information

Access to health-related information was considered important for survivors. Participants stated that they wanted to be updated with the latest stroke-related information. Relevant information can assist survivors with new remedies and information which may contribute to better managing their conditions. Therefore, an application providing such facilities was perceived as desirable:

Would be ideal if I get updated with new information about my stroke ... seeing this information on my mobile gives me a hope that I might get better. (Drewet)

In this quote, Drewet suggested that survivors would welcome a connection to relevant information about their condition. This reinforces survivors' preference for an application that enables them to virtually engage with their society. Drewet's statement also highlighted his health belief, which describes his personal beliefs in the effectiveness of being updated with new information towards improving his health

status. This health belief can result in motivation to try alternative ways to get better, including mHealth technologies.

6.2.2.2 Theme 2: Post-stroke capability of survivors

This second theme refers to the complications that survivors experience after a stroke which they perceived to affect their post-stroke capability for being receptive to and capable of using applications. The post-stroke capability of survivors is classified into four core areas: physical, emotional, psychological and medical. These four core areas and how they were perceived to potentially impact the acceptance of mHealth applications are discussed below and defined in Appendix P.

6.2.2.2.1 Physical

Findings showed that many survivors are not easily able to physically hold or use objects, such as a mobile phone. Survivors often seemed physically weak due to impairment caused by the stroke, such as paralysis on one side of their bodies. One survivor shared her experiences:

When you've only got one hand, you're using it all the time. It's the same when you grab your keys, put them down to get something else and you run out the door. But I, um, had them in my hand [laugh]. I can't feel my left arm. It's difficult to grab my phone with one hand and open it with the same hand. I don't know how to fix it. (Charlotte)

This particular experience revealed that individuals with stroke suffer from a limitation of motion in their body parts impinging on their performance of daily activities, including using their mobile phone, hampering the possible use of health applications delivered through mobile devices. This suggests that survivors need support and the key focus of the design for stroke-related applications should be centred on survivors' individual needs and simplify the design as much as possible to increase their utilisation.

Eyesight issues were identified by survivors as an infuriating physical complication, which may contribute to survivors' unwillingness to use mHealth applications. One survivor stated:

Your eye ... your eye was an indication that you know that this could happen. I was falling last week [laugh] when I tried to take my medicine. What do they call it? They said neural plasticity of my eye was damaged [laughing]. Because I can't see very well, I try not to go out. I feel lonely. I feel depressed. I have a friend she coming to see me. (Lui)

This survivor's experience showed how visual complications after stroke can contribute to a sense of social isolation and depression, potentially impacting their participation in rehabilitation. In addition, the experiences of Charlotte and Lui suggest that different features need to be explored for integration into the design to develop applications to 1) address a range of post-stroke complications and 2) promote acceptability of such applications.

6.2.2.2 Emotional

Post-stroke depression can decrease hope and contribute to survivors' reduced desire to get better and to making fewer attempts to do so. As a result, survivors are less likely to attempt to get the support they need, including support through digital modes such as mHealth applications.

No, I can't do that because I can't walk. Sometimes I am not in a good mood, because – it's everything is an effort. Everything is too hard, and I got angry why. And it's easy to say, "oh blow I give up!" I think I am not able to continue like this. ... I am not sure; I did not know why and how to fix things. And one of the things that happened post-depression ah post ... post-stroke, was depression. ... I could not see any point in doing things. I did not know what will happen. (Patrik)

Survivors' experiences indicated that physical impairments affected their mood and emotions and could contribute to major mood disturbances post-stroke. Patrik's experience highlights the complexity of mixed emotions, including anger, sadness, and frustration. This is likely to contribute to uncertainty and a low level of confidence. The

lack of confidence can contribute to survivor dependency which is the most challenging aspect of post-stroke life contributing to the development of severe depression.

6.2.2.2.3 Psychological

Survivors experienced various psychological complications that contributed to lack of social participation and reduced likelihood of seeking self-management interventions for wellness. Post-stroke complications such as the lack of motivation can influence survivors' self-efficacy with performing daily living activities, like using mobile phones. Self-efficacy refers to survivors' beliefs about their abilities to perform daily activities or to do what is needed to better health outcomes. Survivors acknowledged that they believed they were unable to get better. For instance, a survivor shared:

I was socially very active I was able to manage multiple tasks, but you know I believe I can't get out of this now. This is where I stuck, I was given some exercises to do but I feel I am not able to do those. Depression, lack of motivation, and the body give up, so the mind gives up, then nothing matters. I have ... um this feeling since I left the hospital. (Ataahua)

In Ataahua's case, quoted above, it appeared depression, motivation and self-efficacy are all related and seem to exert influence on each other, resulting in a negative cyclical effect. This negative effect can make it challenging for survivors to give their best effort to their wellness which could contribute to their recovery. Another quote from Ataahua (below) did highlight the importance of shared experiences that motivated her to keep going, suggesting motivation is one of the keys.

My friend is visiting me every week. She had a stroke 12 years ago. She is fine now. Listening to her experiences encourage me to do the same exercises. (Ataahua)

This quote from Ataahua reinforces the need for survivors to connect with one another. The power of peer-to-peer learning and its apparent relationship with motivation highlights that connection to the community may be a powerful way for survivors to empower themselves as they move towards managing their condition, on the increasing path to their own sense of self-efficacy.

6.2.2.2.4 Medical

The primary factor highlighted in this category was post-stroke fatigue, which was perceived as a barrier to functional recovery and, most likely, to the use of mHealth applications. Survivors reported substantial fatigue which they report as contributing to functional limitations.

I am left-side paralysed. Seizure makes me completely still. I find that really, I have a lot of fatigue I get quite tired ... if I overdo it, I'm in need for several days so I just have to try to pace myself and not do too much. (Ella)

Ella added that post-stroke fatigue affects her competence to perform daily activities:

I can't focus on doing a thing like my phone. I try to ask for help, and I can't explain myself and, um, the biggest thing I had, after all of this, was fatigue and felt down. (Ella)

Another survivor with post-stroke fatigue disclosed:

Fatigue is just such a big thing and ... I really struggle with fatigue because ... people say comments flippantly like ... "oh yeah who doesn't get tired?" but I really get tired I can't move around, and I believe I can't get better. (Ataahua)

It appeared Ataahua feels constantly weary, tired, and lacking energy, suggesting it may be linked with the depression she experiences, meaning it may be psychological fatigue.

Drewet added to this:

And being tired ... makes everything harder, even talking over the phone – emotions... emotional control ... hard. Just feel like ... um ... and so ... you actually have to do it you have to succumb to it – and let yourself sleep. (Drewet)

Drewet's experience reinforced that post-stroke fatigue is a severe complication that limits survivors in being active and staying focused. Survivors need to work harder to do things that seem automatic beforehand.

The experiences of these three survivors suggested that fatigue is related to functional disability, leading to low engagement with daily activities including interacting with mobile devices. Drewet (quoted below) acknowledged his awareness of existing fatigue-related applications but no knowledge of their functionality, suggesting promoting such applications may contribute to survivors' willingness to adopt them.

My cousin told me that there are some apps that can help us with my fatigue, but I do not know what is that and how that can help. (Drewet)

All survivors' experiences shared above indicate that survivors need post-stroke ongoing support and mHealth applications have shown the potential to facilitate it in different settings.

6.2.2.3 Theme 3: Qualities influencing survivors' possibilities for access to mHealth applications

Drawing on findings a range of qualities were identified that were formative to what factors would be influential to accessibility to mHealth applications. This theme involves five key categories that were perceived to have major roles in survivors' accessibility to mHealth applications. These five categories include digital literacy, social support, technical support, language barriers, and affordability of smartphones which are discussed below.

6.2.2.3.1 Digital literacy

Survivors shared their views in relation to the use of mobile technologies and stated that they are too old to use such technologies. This perspective highlighted the point that some survivors may have poor knowledge concerning the use of mHealth applications.

I wish I could I'm too old for this technology, I just want to get better. It is too much; you know I can't play with it by myself because of my age. I have no one to help me. Just I can't handle it. (Kerl)

Kerl reported that she does not know how to use mobile devices, suggesting some survivors may have low level of digital literacy and they might not be interested in improving digital literacy. Survivors need help in this regard as shared by Kerl in the quote above.

I have a normal mobile, um I just use it when my son calls me. My sister helps me with shopping. He is a busy man; he would help me. He has a family; he can't be here all the time. He does not buy a new mobile for me; he knows I do not know how to use it. (Lui)

Lui's quote echoes Kerl's statements and reinforces the notion of lack of digital literacy in some survivors. This low digital literacy among survivors further highlights that survivors may have poor ability to find, assess, and understand information to address their health issues. These insights bring the digital literacy aspect to attention and raise the importance of app designers considering this in applications design.

6.2.2.3.2 Social support

This finding highlights the role of social support in the acceptance of mHealth applications. Many survivors received intensive care after stroke and some also received professional care in their homes. However, it was suggested that the support from family members and friends is an important aspect of care and might also serve to encourage and support survivors in using new technologies. While Anika reported having the support she needs, she also pointed out her keenness in trying new ways of obtaining the support that would mean survivors are looking for alternative ways to be less dependent on their families and friends:

Yeh, I appreciate any type of help. I have family and good friends to support me, but they have their own life I do not want to disturb them. Sometimes I feel they feel sorry for me, and I hate it. I do not blame them; they have their own stuff to do. Any help that aids me to be less dependent on my friends I would love it. (Anika)

Anika's statements highlight family members as carers may also suffer from post-stroke challenges while they are taking care of the survivor, therefore, they may also need support. In this case, mHealth applications can help family members to understand post-stroke life and challenges to assist survivors in managing well with their conditions.

Survivors emphasised their willingness to utilise other ways of accessing the support they need:

Eh, well, I do not know, I want help. I need to feel supported [laugh]. I am living with my sister. She helps me with everything. She helps me to learn again [makes blending noise] how to cook. She is rock. She is sometimes tired. Anything that can help me to get a support in managing my life I will happily go with it. (Lui)

Lui suggested that if survivors feel confident that a particular source was supportive, they were interested to try it. However, if a feeling of despondency develops due to the lack of support after stroke, and leads to post-stroke depression, it contributes to reduced motivation to try new ways to get better. Therefore, the support provided by family and HCPs has the potential to increase the acceptance of mHealth applications among survivors.

6.2.2.3.3 Technological support

Survivors reported that they have also faced technological concerns that can be understood to contribute to the low acceptance of mHealth applications. Lack of internet connectivity was noted as a barrier to the use of mHealth applications.

I do not need that. We have to pay for the internet. Different rates I have a medium rate because I do not need it. It's slow sometimes Um ... I have my phone to call. My children always call me to check on me. (Anika)

Anika experienced poor internet connectivity, suggesting the internet connectivity aspect should be taken into consideration in the development of acceptable mHealth applications. Loss of or poor connectivity can contribute to survivors' unwillingness to engage with health applications. Therefore, mHealth

applications become less useful and less accessible if they require an internet connection to be able to use them. Some survivors may not have the internet and may have to pay high fees for a connection, which can be a deterrent exacerbating the financial difficulties they may already have due to their stroke circumstances. Anika's experience also suggests that some survivors may have fixed incomes and they cannot afford such expenses.

6.2.2.3.4 Language barriers

Language barriers may contribute to a reluctance to use mHealth applications. The findings revealed that survivors may have some regrets about not doing some of the activities they want to do, as they are not comfortable with leaving their homes due to their language difficulties.

I can't speak English so much. I love to go out I want to communicate with people, but my English is limited. Learning is hard. I do not know how these devices are working. (Yu Yan)

This also suggests that the language barrier can noticeably contribute to survivors' poor knowledge of technologies, or their digital literacy, as reported above. It appeared it is challenging for survivors to learn new things, indicating that mHealth applications should be designed as simple as possible so they are easy to use. Moreover, training survivors on how to use such technologies may improve their digital literacy.

6.2.2.3.5 Affordability

Affordability is perceived as a factor that impacts mHealth application uptake by survivors. The findings revealed that some survivors could not afford to buy new mobile devices such as smartphones and, consequently, they were not able to experience these new ways of delivering self-care interventions. With respect to affordability, a survivor stated:

If you lived on the pension, you'd have no show really – but you could get in the queue for the [ah], for the hospital. It's really about the money. Sometimes you can't afford even clothing, so I do not know what they are. (Sophie)

The finding clearly revealed that financial constraints seem to be a potential barrier that may increase the lack of incentive for survivors to engage with mHealth applications. The findings highlighted that mobile phones may not be affordable considering survivors' financial situations and that, in turn, could increase survivors' level of unfamiliarity with new technologies. As such, the survivors' acceptance of mobile-based interventions also depends on the survivors' financial situation.

6.2.3 Findings from app designers

This section discusses findings from app designer participants that enrich the findings from survivor participants. The findings from app designers helped to further develop the proposed themes in relation to the acceptability and adoption of mHealth applications among survivors. The first finding from app designers extends the second theme (see section 6.2.2.2) proposing that post-stroke complications are significant in survivors' consideration of mHealth applications and poor UX. The second finding deepens and develops the third theme (see section 6.2.2.3) proposing that accessibility to mHealth applications depends on several factors and adds further views considering interface design affecting accessibility. The third finding enriches the category regarding perceived affordability (see section 6.2.2.3.5), including that unaffordability can contribute to survivors' poor accessibility. These three findings are discussed below.

6.2.3.1 Finding 1 – Post-stroke capability of survivors

This finding extends the second theme, one that had been developed from survivors' perceptions. This finding further deepens post-stroke complications as factors that influence survivors' decisions in accepting mHealth applications. App designers stated that the post-stroke challenges survivors experience are the most significant factors contributing to the poor engagement with and the adoption of mHealth applications.

Stroke survivors are vulnerable and suffering many challenges. Some of them are physically weak or they have memory issues. These make them not engage with any apps. If they are not capable to use it, then

our job is hard to motivate them. Making apps in a simple way may help them. (Focus group 2, Adelmo)

How we can encourage them to use, is the most difficult part. My grandma had a stroke and she did not use her phone. I tried several times to show her how to use it. (Focus group 1, Bohuslava)

While these quotes add to the argument that the design of mHealth applications needs to consider a range of post-stroke complications, they also suggest that: 1) simplicity in design might be the key to the usability of mHealth applications; and 2) training survivors on how to use applications may help them to engage with mHealth applications. The need for training reinforces the potential power of peer-to-peer learning as it also facilitates connectivity among survivors. These two aspects are further discussed in the following section (see sections number 5 and 6).

6.2.3.2 Finding 2 – Design of interface

A potential barrier believed to play a significant role in the acceptance of mHealth applications is their interface design. Participants suggested that poor designs make mHealth applications hard to use and affect the user experience. Design issues highlighted by app designers included: 1) font size, 2) colours, 3) customisation, 4) efficiency and ease of use, 5) simplicity and 6) training.

1) Font size

All app designers emphasised the use of appropriate font size in mHealth applications, stating:

Large enough text so the text won't be so ... normally small. (Focus group 1, Jason)

Well, I use an ordinary font on my phone now, but if I didn't have my glasses, I couldn't see anything. Same for stroke survivors. So, font maybe could be just a bit bigger. (Focus group 2, Lucy)

It was perceived that large font size would be helpful and appropriate for survivors, especially for those who have post-stroke vision issues.

2) Colours

All app designers emphasised that the colours used in applications play an important role in how survivors engage with them. Two quotes from participants are provided below to highlight this point.

What happens is, the reason they use blue is because it works culturally across everywhere in the world. And then it's a neutral colour. It's not really masculine or feminine, and at the same time, it projects calmness and friendliness. (Focus group 1, Jason)

I believe the easier the more basic the better, just colours even maybe avoiding text you know because you don't want them to read maybe green and red as colours and just one or two options and that's it, simple you know. (Focus group 1, Nicolas)

The findings suggested that colour can contribute to the simplicity of the interface, for example, green is perceived as 'permit' or red as 'forbid'. Using colours instead of text can contribute to the improvement of UX. Further to this, it is also perceived that the main motive in designing applications must be a simple interface that can be easily understood. Some cognition is usually lost after surviving a stroke; colours may play a significant role in keeping users engaged. Using different colours can make it simple for users to identify each icon in mHealth applications. As such, colour is perceived to make mHealth applications easy to use and may increase their acceptance.

The quote from Jason (above) also highlighted the role of culture in designing applications. Jason underlined cross-cultural design, where the integration of different cultural values into the design can positively influence users' acceptance of mHealth applications. Jason's quote suggests that survivors with different cultures may have different values and understanding these values is essential when it comes to the design of mHealth applications. Colours may be valued differently in different cultures. That is, different colours may have different cultural meanings and associations for people which needs to be taken into consideration. For example, in western culture black is associated with death while white has that association in India.

3) Customisation

Lack of customisation is another perceived barrier in relation to design that was pointed out by all app designers. For example, an app designer shared the view that an application being personalised in a way that interests the user gives rise to easy navigation:

Therefore, having a personal layout make it easy to navigate, so people can go to whatever area they want. It is like personalising the interface based on what the user would like to have, and everything can be more accessible (Focus group 2, Deigo)

Another quote from app designers highlights the potential role that this aspect has in the design:

You can change the colours; you can actually tolerate them to your taste. (Focus group 1, Vibuma)

Customisation may prevent survivors from experiencing applications that have poor UX. Some survivors might be able to use the advanced level while some may just be able to operate at the beginner's level. Mobile applications should have a customisation feature that allows survivors or their trainers to adjust them as per their needs. This may result in a process whereby survivors can be engaged in the development of applications and have an opportunity to express the challenges they face. This finding also highlights the role customisation may have in meeting survivors' cultural preferences, meaning survivors will be able to tailor mHealth applications based on their cultural values.

4) Efficiency and ease of use

App designers also stated that mobile applications must be easily used, and pages must load quickly:

You have to have a quite obvious interaction, easy user interface and at the same time it has to be efficient. (Focus group 2, Adelmo)

It is more about usability and efficiency. (Focus group 2, Adelmo)

It should be easy to use and fast to open. (Focus group 1, Vibuma)

Can open up a page fast and easily. (Focus group 3, Ari)

The app should be ease to use and you don't need to have someone else to train you actually. (Focus group 1, Isla)

From these quotes, therefore, it appeared efficiency and usability become important in mHealth application creation. If mHealth applications take too much time to load and are not easy to use, survivors would not be motivated to use them.

5) Simplicity

Findings clearly corroborate the view that it is important to design mHealth applications to be as simple as possible for survivors. Therefore, integrating simplicity into the design evidently contributes to a good UX. It is evident that, while it is important to design user-friendly mHealth applications, it is also important to apply simplicity to the content of applications:

Everything is about designs: you don't want to go too flashy that loses the overall purpose of the app if you have too many things happening or at the same time you kinda get lost and unhappy. Mainly just simplifying the content so that's easy to understand. Using it is not difficult so. (Focus group 1, Isla)

Make it as simple as possible. (Focus group 3, Liu)

Simple design. (Focus group 3, Ari)

Keep it simple so front face has to be simple and friendly. (Focus group 2, Hossein)

Regarding this aspect, one app designer explained his opinion in a different way, saying that an application should not involve complexity. From this perspective, it is evident that 'perceived simplicity' can be seen differently:

Anybody that's designing their first app mostly, they just try to squeeze a lot of features inside the app where – which will cause complexity in the apps. (Focus group 1, Peyman)

Having complex instructions in the applications is considered as a hindrance. For example, survivors with post-stroke fatigue may be less compelled to engage if things are too complex. Therefore, mHealth applications must be easy to use so that they can deliver the services to survivors with minimal cognitive challenges.

6) Training

Another aspect that was cited by app designers was training. Findings largely suggested that survivors may need help learning how to use mobile applications.

Umm, if I were them, I have to be shown, I think, how to navigate and use it properly. (Focus group 1, Vibuma)

Survivors need a mechanism to help them learn how to operate an application. This partly places the burden of responsibility on survivors' families and HCPs to assist survivors in this regard, as findings from survivors reinforce social support is a facilitator. However, app designers potentially also play a role here. They need to get survivors and their families and HCPs involved in the design process to find out how to address this aspect of applications. Instructions on applications may serve as a guiding tool, and training should be given to help survivors with using applications.

6.2.3.3 Finding 3 – Affordability

The affordability aspect that was identified in the findings from survivors, was further enriched by all app designers who believed that cost is an important factor that may influence the use of mHealth applications by survivors. They voiced the cost of mobile devices as a concern and stressed that many survivors may face financial constraints that limit their interactions with new technologies, including mobile technologies. One app designer more specifically referred to smartphones as mobile devices that are well-suited to deliver health-related applications but costly:

Mobile phones are expensive for some people, in fact, smartphones. Health applications are compatible with new mobile phones. (Focus group 2, Ganna)

6.2.4 Findings from HCPs

This section provides findings from HCP participants that enrich and deepen the proposed themes that have been developed from survivors' perceptions. Key themes are reinforced and further developed by HCPs giving emphasis to the perceived factors that are significant in the acceptability of mHealth applications. Three findings were identified from HCPs' views which are discussed below.

6.2.4.1 Finding 1 – Post-stroke capability of survivors

This first finding from HCPs further deepened the second theme (see section 6.2.2.2), emphasising that post-stroke complications have significant roles in survivors' decisions regarding acceptability of mHealth applications. All HCP participants believed that post-stroke complications are the main reasons for the lower level of survivors' engagement in rehabilitation activities and these complications are more likely to contribute to the lack of survivors' engagement with and acceptance of mHealth applications.

Stroke survivors are less engaged with rehabilitation programmes because of issues they are experiencing after stroke. Some suffer from cognitive impairment and some suffer from physical impairment. (Focus group 2, Sophia)

Amelia shared her perception:

Challenges stroke survivors face are huge and prevent them to engage in day-to-day activities including rehab activities. Each of them experiences these challenges in different ways and understanding these challenges help us to assist them in the rehab programme. (Focus group 1, Amelia)

These statements further suggest that different types of post-stroke complications can be one of the reasons for low acceptance of survivors with mHealth applications. For example, Amelia's quote refers to post-stroke challenges which can limit survivors' engagement in daily activities, including engagement with applications for self-management. For instance, for a survivor with paralysis on one side of her body,

it is challenging to hold a mobile device and click on a small button on the application at the same time, contributing to her unwillingness to use it. Similarly, a survivor with depression is less likely to be willing to engage in applications that provide relevant support, and/or a survivor with cognitive issues may find it hard to stay focused on applications that require a series of actions. Therefore, having a good understanding of survivors' post-stroke complications and how they may impact engagement with applications will mean we are more able to design applications that support them in the context of those complications. App designers can gain an awareness of survivors' needs and integrate them into the design process to ensure that such needs are met. This finding also gives emphasis to the argument that survivors need ongoing support due to challenges they experience and the role that mHealth has in this context.

6.2.4.2 Finding 2 – Engagement

This second finding deepens and extends the third theme (see section 6.2.2.3) by adding further views considering accessibility to mHealth applications. Many HCPs shared the view that the traditional way of providing rehabilitation regimes is more effective than digital methods. They still think that survivors are more engaged in given activities while therapists are present. One of the HCPs who shared her opinion has been in the field since 1999 and has experience of working in different hospitals in the stroke rehabilitation ward and treating survivors with different types of complications. According to her, the role of therapists in survivors' health outcomes is considerable, as they provide the right instructions when needed.

Stroke survivors are more engaged in rehabilitation activities when we provide them with detailed instructions. They are more focused when we are around this makes them feel ... you know, trust and safe. Then the result is more effective. Our role is important. (Focus group 1, Natasha)

Natasha's statements suggested that actual (face-to-face) rehabilitation sessions either at home or in a stroke rehabilitation centre are more effective than mHealth applications. She reasoned that survivors benefit from detailed instructions direct from therapists, and that survivors are more focused when they are present. Natasha's

perspective also highlights that HCPs may be reticent in recommending mHealth applications to survivors and thus acceptance of mHealth applications is not just about survivors' acceptance, but also acceptance by those who support survivors.

In the line of having effective rehabilitation, another HCP had a different view:

Probably animated applications can show stroke survivors how to do exercises. This can motivate stroke survivors. There are a few of them that speech therapists use. (Focus group 2, Agusia)

Agusia's view suggested that stroke-related game-based applications where such applications can possibly provide instructions and motivation for survivors are new ways of getting survivors engaged. Agusia's view further enriched the notion that mHealth applications should support remote communication tools, such as video conferencing so that HCPs can instruct survivors from a distance to facilitate survivors' engagement.

6.2.4.3 Finding 3 – Motivation

Further to these findings, HCPs raised a potential point of concern to be addressed when it comes to mHealth applications development. A HCP participant, who was a former physiotherapist, pointed out that participating in rehabilitation greatly depends on the motivation of patients. This particular finding further deepened the third theme, adding that motivation is another aspect that can influence access to mHealth applications.

Stroke survivors like other patients need motivation to get through the recovery process otherwise they don't engage with rehabilitation. This makes stroke survivors fail to successfully recover or get involved in any activities (Focus group 2, Annabel)

Another HCP echoed Annabel's statement and noted motivation as key.

Motivation is key. I have seen many stroke survivors whose health got worse because they had no hope or better to say no motive to get better. (Focus group 1, Adelajda)

Adelajda and Annabel’s quotes suggested survivors’ way of thinking and perceptions of themselves after stroke and the world around them can influence their motives. In this respect, understanding post-stroke challenges could explain how survivors’ preferences towards certain mental constructs can enhance their ability to take goal-directed actions. That is, the focus should be on understanding what motivates survivors and addressing specific factors like their individual needs and goals.

The quote from Stella, a survivor, in section 6.2.2.1.1 reinforced survivors’ need for motivation, and mHealth applications having the potential to create an opportunity in this context. However, motivating survivors to use mHealth applications is a different story, one that app designers need to take into account.

6.3 Cycle two – Enrichment and further development of cycle 1 themes: Exploring the perspective of participants towards the usefulness of the draft guidelines

This section focuses on the findings constructed from participants’ perspectives on the draft guidelines. The findings enriched and further deepened the identified key themes and associated categories in cycle one.

6.3.1 Participant characteristics

As remarked in section 4.4.2.1, five participants who took part in cycle one, participated in cycle two (see Table 6.4).

Table 6.4: Participant characteristics – cycle two

Participant groups	Pseudonym	Age	Gender	Ethnicity
Survivors	Ataahua	55	Female	Māori
	Lui	57	Female	Malaysian
	Yu Yan	75	Female	Chinese
App designer	Peyman	32	Male	Indian
HCP	Annabel	41	Female	Māori

6.3.2 Findings from stroke survivors

The themes from cycle one had been used to construct guidelines, and that are addressed in Chapter 7. Participants with stroke provided no new input at this point. They stated that the draft guidelines seemed to be substantive. Survivors also added that they could not really provide comments or make recommendations since they were not really familiar with mHealth applications, emphasising unfamiliarity of survivors with new technologies and their poor digital literacy. However, they indicated that it would be good if the guidelines were presented in a practical design, so then they could understand what the guidelines could produce:

*I think it is ok. It is great if I see a real app. I did not use an app before.
(Ataahua)*

I do not understand how these are working really. (Lui)

Can you show me these? You are talking and looks good, but I cannot understand these in apps. (Yu Yan)

Unfamiliarity and poor digital literacy that were derived from this finding can be caused by 1) the language barrier some survivors face (e.g., Yu Yan remarked on this in her quote above). 2) Post-stroke complications such as depression can limit survivors like Ataahua to engage and ultimately get unfamiliar with such technologies. 3) Or survivors' unaffordability to have a smartphone. These raise a point there remains app designers should consider a range of factors in development of applications to improve survivors' engagement with and acceptance of these technologies.

6.3.3 Findings from app designer

On reviewing the draft guidelines, the app designer participant identified two further features that may be important in the design of intuitive UX mHealth applications to meet survivors' needs. The two newly identified aspects were eye-tracking and gamification.

6.3.3.1 Eye-tracking

The app designer suggested an eye-tracking feature as a solution that could be incorporated into the mHealth applications to contribute to their acceptability. Eye-tracking basically uses a light source directed to a user's eye to cause a visible reflection, and a camera to capture an image of the eye indicating the reflection. In other words, users use their eyes to navigate the applications. For example, survivors gaze at 'home' icon on the interface, then it will be clicked to get the user to 'home' page. The eye-tracking feature may be beneficial for survivors who are experiencing physical complications. For example, it is common to experience impaired dexterity and fine motor control or poor upper limb mobility which may prevent survivors from using mobile devices. The designer participant shared that facilitating interaction through gaze and eye-tracking in virtual reality contributes to good UX.

In virtual reality, you don't have your hands or anything, can interact, is weird, you can see anything. So, they came up with the idea, just look at something, and when – two seconds time passed, and you – as you look at it and it's clicked. You know what I mean? Even for those people, maybe these kinds of ideas of interaction could be a better solution. (Peyman)

Participants with stroke shared their experiences in relation to the post-stroke inability to use objects. This indicates that an eye-tracking feature may help to address these types of issues and increase survivors' willingness to use mHealth applications.

6.3.3.2 Gamification

Another aspect identified by the app designer as a solution to increase survivors' interaction with mHealth applications was gamification. The app designer believed that survivors may find it interesting to perform rehabilitation activities by using gaming applications.

Basically, it's gamification, but in a sophisticated way so you don't tell them to play, but they have to – they find themselves following certain rules to find those features, solutions and achieve the best outcomes. This motivates them to keep engaged with the app. (Peyman)

The quote from Peyman suggests that game-based health applications may serve to promote survivors' engagement in rehabilitation. Using game-based techniques to get survivors engaged further was remarked by Agusia, a HCP, suggesting integrating such techniques into design may be one of the prominent mechanisms to increase acceptance of mHealth applications.

6.3.4 Findings from HCP

The HCP participant found the draft guidelines practical. No recommendations were made since she supported that if the guidelines were applied in a design, survivors will more likely to accept mHealth applications. The participant also noted that it would be more helpful to see the guidelines in practice and determine the extent to which they are useful in real-time. She stated that it is like having a pair of shoes: no one can assess their comfort unless they wear them, and then the user can evaluate their usefulness.

Sound great. Would be more effective if you apply all these guidelines in an app to see how they are responding to the stroke survivors' needs. It is like buying shoes. If I buy them online there is no guarantee they fit. (Annabel)

This finding from the HCP indicates that HCPs also need to get themselves familiar with such technologies, leading to an increase in their understanding of the potential these technologies offer. Subsequently, they can encourage their stroke patients to use mHealth applications for self-managing.

6.4 Cycle three – Refinement of proposed guidelines: Evaluation of proposed guidelines using ACCESS

After minor refinements, the refined version of the guidelines became the outcome of cycle two. However, testing the usefulness of the proposed guidelines in practice was a concern raised by participants. To address this concern and aid further testing of the guidelines, a working prototype named ACCESS was developed using the guidelines version as developed at this stage.

The main aspects of the findings were integrated into the design of the prototype to demonstrate their functionality. The different types of post-stroke complications that survivors experienced were also considered in this integration process. For example, a 'reminder' feature supported survivors who suffer from cognitive issues; and an eye-tracking system was considered to support survivors who have physical impairments such as limb impairment. While the eye-tracking system may not be beneficial for survivors who are experiencing visual complications, voice recognition was an alternative option that could be offered to overcome this concern.

The working prototype was designed in the form of a social application according to survivors' preferences and used to examine participants' opinions on the application. The rationale behind the design was, first, to show participants with stroke that their preferences were the focus of this inquiry. Second, it could demonstrate that survivors may get the support they need by connecting to other survivors and their HCPs.

Congruent with cycles one and two, participants' views were explored to construct knowledge on how they perceive the proposed guidelines in practice, revealing their perceptions of the usefulness of the proposed guidelines. The following subsections present the findings of the evaluation of the proposed guidelines conducted using the ACCESS prototype. Appendix L provides more details with respect to the design of ACCESS.

6.4.1 Participant characteristics

Of those who took part in cycle two, two survivors and one app designer participated in the further evaluation of the guidelines applied in the ACCESS prototype (see Table 6.5).

Table 6.5: Participant characteristics – cycle three

Participant groups	Pseudonym	Age	Gender	Ethnicity
Survivors	Lui	57	Female	Malaysian
	Yu Yan	75	Female	Chinese
App designer	Peyman	32	Male	Indian

6.4.2 Findings from stroke survivors

Survivor participants were provided with the prototype and the reasoning behind the design of the prototype was also explained. Survivors were asked to use the prototype and share their experiences with respect to its usability. Both survivors were enthusiastic about the idea of having a social platform that enables them to be connected to other survivors and their HCPs, and to get the support they need. Both survivors acknowledged that sometimes it is challenging for HCPs to monitor their progress and provide them with professional instruction and advice. Such applications can mitigate the effects of this challenge.

Survivors also emphasised the benefits of having a customisation feature that enabled them to personalise the application as they wish. Survivors appreciated the eye-tracking, voice recognition ideas, reminder functions, and enjoyed the colours used as well as the keyboard layout. Their detailed opinions are provided below.

6.4.2.1 Font size

Survivors commented that the buttons and icons were large enough to understand and find. The chosen font size and style were suitable, big and bold, and cited as strengths of the prototype. Survivors found out how fonts can be customised from the settings window.

6.4.2.2 Colour

The colour of the homepage was blue. Both participants were fine with this colour but one of the survivors showed a little bit of interest in the addition of colours

such as green. The other survivor recommended the use of a bit of contrast. The colours on the background were also cited as easy on the eye.

6.4.2.3 Customisation

Another main strength of the prototype was the 'settings' button offering changes to different features like eye-tracking, notifications settings, fonts and themes. Personalising the language on the prototype had the highest degree of interest from both survivors. Both survivors agreed that this gives users the option to use the application in their own languages, such as Mandarin or Hindi. This feature was perceived to overcome possible language barriers.

6.4.2.4 Simplicity

Both survivors conceded that one of the significant strengths of the prototype was the user-friendliness and simplicity of the interface.

6.4.2.5 Notifications

Notifications were perceived as convenient, however, one of the survivors preferred the option which has a red circle that shows a notification by clicking on it rather than showing all the unread notifications. When I asked their opinion on the notification feature that allows notifications to be sent to the user from desired groups or friends, both survivors responded that it might be annoying if they were to sit and hear their phone go off just because so many users are joining. However, the notification option was also customisable.

6.4.2.6 Eye-tracking feature

Despite the non-functionality of the eye-tracking feature in the prototype, both survivors appreciated and expressed their interest in using the eye-tracking feature. Considering survivors' post-stroke complications, it is beneficial to integrate eye-tracking into mHealth applications.

6.4.2.7 Reminder feature

Both survivors appreciated the addition of the 'reminder' option. They said the 'reminder' feature in the prototype is innovative and different as it also shows the activities previously performed, avoiding concerns over repeated behaviour if a user logs in again later.

6.4.3 Findings from app designer

6.4.3.1 Further findings

The app designer noted that the sign-up page was simple; however, he stated that some survivors may not remember their ID numbers. He highlighted a concern about the security aspect of sign-up, login and how the application should deal with the risk of the theft of the ID number and danger of giving full access to a survivor's user account. Employing a face recognition feature might offer a solution.

The app designer also highlighted a concern with respect to facial recognition and eye-tracking, as these technologies necessitate appropriate lighting conditions. This concern, therefore, needs to be taken into account when it comes to the design of applications.

The app designer also revealed that most survivors do not like swiping or scrolling; therefore, arrows pointing up and down were used. This is also beneficial for those using the eye-tracking feature as they can gaze at the arrow to either scroll down or up when reading an article or checking the list of notifications.

6.5 Summary

This doctoral work explored the use of mHealth applications among survivors. The findings presented in this chapter highlight factors that contribute to the low level of acceptance of mHealth applications by survivors. In cycle one, three key themes and 16 categories were developed from the exploration of survivors' experiences that subsequently were deepened and enriched by app designers and HCPs. These themes

were further enriched and developed over cycles two and three. The three cycles resulted in three key themes and 17 categories.

Three key themes which articulate factors perceived to influence survivors' UX, decisions to accept and use mHealth applications include: qualities promoting acceptance of mHealth - desired applications; post-stroke capability of survivors; and qualities influencing survivors' possibilities for access to mHealth applications. The categories included: 1) the type of application – connecting, reminding, monitoring and being informed; 2) post-stroke capability of survivors – post-stroke physical, emotional, psychological and medical complications; and 3) accessibility to mHealth applications – digital literacy, social support, technological support, language barriers, affordability, intuitive design of applications (such as font size, colour, customisation, efficiency, simplicity, training, eye-tracking and gamification), engagement, motivation, and security.

Chapter 7: Practical Knowing and the Proposed Guidelines

7.1 Introduction

In this chapter, I present the practical knowing that developed from the findings of each cycle, along with the incorporation of my design experiences, all of which contributed to the development of the proposed guidelines for mHealth applications' design for survivors. I explored the experiences and perspectives of participants to find out factors that affect survivors' decisions to accept and use mHealth applications. The findings from each participant group were presented separately in Chapter 6. In that chapter, I used the key themes and supporting categories to present the findings from each group in each cycle. In the present chapter, I draw primarily from the key themes to present the practical knowing and the associated guidelines that emerged from the findings. I begin this chapter by providing an explanation of the process used to construct the guidelines. I then present the practical knowing and associated guidelines in each cycle providing insight into how the findings were understood and interpreted to inform the proposed guidelines.

7.2 The process of guidelines development

I aimed to develop measurable, feasible, achievable and actionable guidelines based on current and rigorous evidence. The intended scope for the proposed guidelines was to guide app designers in good UX design when designing applications for survivors so that they would:

- Improve the user interface in mHealth applications;
- Optimise the potential for mHealth applications to provide effective health care services;
- Encourage the acceptance and use of cost-effective health applications; and

- Structure and encourage survivors' participation in self-management interventions.

To develop actionable guidelines, the following four steps were taken:

1. To create good UX, app designers often refer to ten usability heuristics developed by Nielsen (1995) for designing graphical user interfaces. In addition, Hassenzahl (2003) argues that products have to provide both set of functional features and good UX to increase users' acceptance. Further, Alsswey, Umar, and Bervell (2018) state that users' behaviour towards acceptance is greatly associated with their preferences. Therefore, considering usability, functionality and behavioural aspects, I first drew on the practical knowing derived from individuals with a wide range of experiences, including survivors, app designers and HCPs in cycle one (presented in Chapter Six) to produce a list of key topics to be addressed within the guidelines. Table 7.1 presents examples of the key topics derived from the practical knowing.

Table 7.1: Examples of the key topics associated with three aspects

Aspects	Topics to consider	References	Supporting literature
Usability	Post-stroke challenges that survivors face make it difficult or limit survivors' ability to use mHealth applications	Cycle one - findings from survivors, app designers and HCPs (see Chapter Six - 6.2.2.2, 6.2.3.1 and 6.2.4.1 respectively)	E.g. (Brandenburg et al., 2017; Fletcher & Jensen, 2015; Rinne et al., 2016; Tang et al., 2016)
	Poor design makes mHealth applications hard to use	Cycle one - findings from app designers (see Chapter Six - 6.2.3.2)	E.g. (Aljaroodi et al., 2017; Allen et al., 2008; Fletcher & Jensen, 2015; Hamm et al., 2017; Micallef et al., 2016)
Functionality	Lack of connectivity	Cycle one - findings from survivors (see Chapter Six - 6.2.2.3.3)	E.g. (Eslami Jahromi, Farokhzadian, & Ahmadian, 2021; Qiu & Abdullah, 2021)
	Lack of knowledge of how to use mobile devices and their applications	Cycle one - findings from survivors (see Chapter Six - 6.2.2.3.1 and 6.2.2.3.4)	E.g. (Brandenburg et al., 2017; Fletcher & Jensen, 2015; McMahan et al., 2014; Micallef et al., 2016; Mohammadyari & Singh, 2015; Pustisek & Peternel, 2011)
Behavioural	Survivors' unwillingness has a huge impact on their behaviour to accept mHealth applications	Cycle one - findings from survivors and HCPs (see Chapter Six - 6.2.2.2.1, 6.2.2.3.3 and 6.2.4.1 respectively)	E.g. (Brandenburg et al., 2017)
	Lack of socialisation and motivation	Cycle one - findings from survivors and HCPs (see Chapter Six - 6.2.2.1.1 and 6.2.4.3 respectively)	E.g., (Burns et al., 2021; Chiu et al., 2020; Patomella, Farias, Eriksson, Guidetti, & Asaba, 2021; Sorensen, Pedersen, & Pallesen, 2019)
	Survivors hold diverse cultural values, beliefs and languages which are associated with their behaviour towards acceptance of mHealth applications	Cycle one - findings from survivors and app designers (see Chapter Six - 6.2.2.3.4 and 6.2.3.2 respectively)	E.g. (Alsswey & Al-Samarraie, 2020; Fisk, Czaja, Rogers, Charness, & Sharit, 2020)

2. Consistent with Strohmann, Höper, and Robra-Bissantz (2019) work, I also aimed to investigate the literature to gather existing evidence and evaluate its potential applicability to a good UX design. Thus, the second step in guidelines development was to examine the peer-reviewed evidence relevant to each of the identified topics in the previous step to identify application features that may be able to respond to the issues identified. I looked for whether there is known evidence that could be used to construct and support propositions in relation to the identified topics. This step resulted in identifying a wide range of relevant literature which were used in the propositions I made.
3. Aligning with Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) proposition, I aimed to create an artefact that provides a solution for a comprehended research problem. Such an artefact can be for instance a method, model, construct, instantiation, or social innovation (Peffers et al. 2007). In the context of this inquiry, the artefact was the design guidelines for mHealth applications. Therefore, the third step was developing guidelines relevant to each topic area drawing on a synthesis of my findings (cycle one - Chapter six), the most up-to-date evidence, and my own personal (as a family member of someone with stroke) and design (as a design researcher and practitioner) experiences. I started by reviewing the identified topics and then going through each topic to understand and examine whether topics are definitive and informative to inform propositions. In the process of examining, I constantly moved between topics and relevant literature (identified in step two) to determine the relevancy of both. For example, when I found '*post-stroke challenges limit survivors' ability to use mHealth applications*' an interesting and considerable topic, I went through the literature to find out what each paper found and proposed to address this issue. I made a first guess about what the topic implied which informed a preliminary proposal. I looked back at the topic to determine whether my preliminary propositions made sense. If not, I revised and refined them further, going back to the practical knowing that informed the topic and engaging with relevant literature. I did this with each topic until I was

happy with my propositions, feeling they are informative. This process was iterative, where moving to the next topic sometimes resulted in me going back to revise propositions developed earlier. Through this process, I was able to make propositions which were conducive to defining design guidelines.

4. The process of assessing the usefulness of the outcomes varies often from a single act of *illustration* (Walls, Widmeyer, & El Sawy, 1992) to prove that the ideas work, to *evaluation* (Eekels & Roozenburg, 1991; Nunamaker, Chen, & Purdin, 1990) of the developed artefact. I included both *illustration* and *evaluation* aspects to review and assess the usefulness of the guidelines. The final step was therefore iteratively reviewing and refining the guidelines to ensure they are measurable, feasible, achievable, and actionable for app designers and can be applied to the development of mHealth applications in the future. Consistent with the methodology applied, I shared the draft guidelines with my participants to get their opinions which resulted in refinement of the guidelines in cycle two to respond to their views. The guidelines were then applied in a working prototype to illustrate and evaluate their functionality in cycle three and check their usefulness. During the assessment process, I shared the developed guidelines with my supervisory team to receive their opinions, on digital content (for supervisors with relevant knowledge) and academic sensibility. Their feedback informed further refinements to the guidelines.

The following sections present the proposed guidelines for the UX design of mHealth applications, acknowledging while the proposed guidelines themselves are for app designers, I have also made broader recommendations where relevant.

7.3 Cycle one - Practical knowing and associated guidelines

The findings derived from the data provided an in-depth understanding of and insight into the existing landscape for the development of mHealth applications for survivors. In the following sections, I present guidelines derived from each of the three key themes. Guidelines related to the 'design of interface' category (accessibility to

mHealth application theme) are presented in a separate section to highlight the importance of this aspect of UX design for survivors.

7.3.1 Qualities promoting acceptance of mHealth - desired applications

7.3.1.1 Guideline #1: Social connection should be integrated into the design

Findings from survivors suggest that mHealth applications should enable survivors to connect with other survivors as well as their HCPs. As an example, I refer to Jack's quote (see section 6.2.2.1.1), who would like socially connected to the community. The idea is similar to a mobile social network such as WhatsApp (Al Ayubi, Parmanto, Branch, & Ding, 2014; Chung, Skinner, Hasty, & Perrin, 2017; Mendoza et al., 2017; Muntaner-Mas, Vidal-Conti, Borrás, Ortega, & Palou, 2017) where survivors with common interests can meet, creating opportunities for survivors to virtually connect and hang out with peers, share experiences, and motivate each other. My findings highlight that optimising social connections has the potential to improve mood and build self-efficacy.

In addition, the application should be able to create interaction between survivors and HCPs to facilitate monitoring survivors' progress and enable HCPs to respond to survivors like Lui's needs (see section 6.2.2.1.3). For example, video conferencing can work well for survivors, especially for those who are not able to go out and in situations where HCPs and health services are not easily accessible. Providing capacity to have a video chat with HCPs will not only be beneficial for survivors who are provided with the information they need but also HCPs, who will be able to monitor their patients and advise them accordingly. Virtual sessions can also include activities in which HCPs instruct their patients on how to perform specific exercises and monitor how they are performing them. The application could also have the capacity to record these sessions for later use. Video and audio formats were believed to work well for survivors, especially those with cognitive complications. As a result, with respect to consent, confidentiality, and other applicable rules and regulations, it is essential to take into account and abide by any applicable laws and regulations. This while guaranteeing

the participant's privacy and confidentiality, it also encourages trust and confidence while using virtual platforms for business or professional dealings. See section 7.5.1 for further information.

My findings also report that some survivors appreciate being reminded of their daily activities. Further, they suggest that some survivors experience poor cognition and memory, and lack focus. To respond to survivors' needs, a notification feature should be integrated into the design to support these survivors by reminding them of upcoming actions. Notifications are messages that an application displays to provide users with reminders, timely information, new arrivals, events, new releases, and communications from other people (Lin & Hertzum, 2020). Survivors can tap the notification to open their applications and take action directly from the notification.

One example of notifications relates to making an error, which is quite possible and a human trait. Sometimes errors might happen because of the failure of the mHealth applications. Whatever the reason for the occurrence of an error, handling these errors has a significant impact on the UX (Pearl, 2016), as poor handling of errors can make a user frustrated and can lead to them abandoning the application. A perfect example of this is the error screen of the Spotify application, which is not helpful in finding the answer to the question of what happened, as they simply state 'an error occurred' without any advice on the possible solutions to the problem. Therefore, I am proposing the following guidance:

- Create a platform to provide survivors with a connection to their society.
- Integrate an option that allows survivors to virtually meet peers, their friends, families, and HCPs.
- Make sure virtual sessions with HCPs can be recorded for later use. Sometimes, HCPs provide professional advice and survivors may be challenged with memory loss, which means they may forget what was discussed.
- Integrate an option that allows users to consent to recording the virtual session.

- Ensure both video and audio recordings are available for later use.
- Integrate an option that allows HCPs to upload stroke-related information to update survivors on a regular basis.
- Ensure to consider New Zealand privacy laws in order to include a thorough privacy policy including collection, storage, and use of survivors' data in the development of mHealth applications.
- Integrate reminding/notification techniques to assist survivors with upcoming activities they may forget including when pills must be taken when they have doctors' appointments, new messages are received or a new member joining a virtual group. In such situations, notifications make survivors feel that the application is designed and personalised for them and a little less dependent on their families or HCPs.
- Ensure reminding/notification has a silent mode to avoid annoying survivors.
- Ensure a notification such as 'An error occurred' is applied in the design. Tell survivors the reason for the error and make sure it is direct and understandable by the users of mHealth applications.

While social features in mobile applications can provide opportunities for connection and support, they may also present certain considerations for survivors. Some potential considerations:

- Lautenschlager, Cox, and Ellis (2022) stated people with communication disabilities or struggling with speech and language may find it difficult to socially interact. As such interaction with social applications may be challenging for survivors. Communication difficulties may make it difficult for them to explain themselves, comprehend others, or take an active part in conversations, which may make them feel excluded or alone (Tousignant et al., 2018). This can lead to the development of frustration, and anxiety (Ellis, Phillips, Hill, & Briley, 2019), or can lead to less participation in social interactions.

- Privacy issues may arise for survivors while sharing private information or having social interactions within social applications (M. Paul, Maglaras, Ferrag, & AlMomani, 2023). They could be reluctant to speak openly or divulge personal information because they worry about the security and confidentiality of their information. As a result, they might not be as ready to engage fully in the application's social elements and would feel less safe and secure there.
- Social features that allow users to interact with one another might make survivors feel a variety of feelings. Their emotional well-being may be negatively impacted by unfavourable or insensitive encounters, miscommunications, or a lack of support from other users (Fosslie, Duffy, & COVID, 2020). Moreover, it may lead to fear and anxiety (Chun et al., 2020) that may affect mental health. Given this, app designers should integrate social components into mHealth applications in a way to provide a secure and encouraging environment to reduce the likelihood of unpleasant emotional experiences.
- Using social aspects may present technological challenges for some survivors, such as navigating the interface, comprehending the functionalities, or using the application. Their capacity to fully exploit and benefit from the social elements offered can be hampered by a lack of digital literacy or physical limitations (H. E. Lee & Cho, 2019).

To address these challenges, app developers should consider providing easy user experiences, clear communication guidelines, privacy limitations, and options for customising settings to meet the needs and preferences of survivors. A friendly and inclusive social environment should be offered to effectively support survivors on their post-stroke journey.

7.3.2 Post-stroke capability of survivors

7.3.2.1 Guideline #2: Thumb zone

Due to physical impairments caused by stroke, survivors may hold their mobile devices with one hand. Therefore, there is part of the mobile screen which is a practically

effortless area for their thumbs. This is the area in which the user's thumb dominates. App designers must consider the thumb zone, which I call 'reachability' when they design mHealth applications for survivors. My suggestions are:

- Edge-swipe/gesture can be simple and an alternative solution for this issue.
- 'Bottom positioning' is another way to address reachability, i.e., repositioning controls at the bottom of the interface.
- The floating action button makes navigating controls easier.

7.3.2.2 Guideline #3: Integrate a voice user interface into the design

Some survivors suffer vision loss after stroke, which can lead to difficulties in performing daily activities such as reading, walking, watching television, including using mobile devices and applications. Vision loss includes visual processing issues, eye-movement problems, visual field loss, and other eyesight concerns (Shrestha, Upadhyaya, Sharma, & Gajurel, 2012). Survivors with visual impairments tend to have a low sense of sight and colour blindness and are unable to watch the mobile screens and control options in applications. Because of these visual constraints, survivors may be unable to see buttons, or use a touch screen to obtain, open, and run the functions of the mHealth applications. Abdolrahmani, Storer, Roy, Kuber, and Branham (2020) view voice activation feature as a valuable mode of interactions to tackle accessibility issues that users with visual impairment can benefit from. Therefore, to improve UX in the context of visual impairment, a voice-based user interface is recommended, which may optimise accessibility for survivors with visual impairment. This option would facilitate a hands-free and eyes-free way of interacting with mHealth applications.

However, the integration of voice recognition features in mobile applications can pose some challenges for survivors, especially for those who have speech difficulties due to their condition. Some challenges:

- Aphasia, a linguistic condition that impairs one's capacity for speaking, understanding, reading, or writing, may afflict survivors (Stefaniak, Geranmayeh, & Lambon Ralph, 2022). Because of this, it may be difficult for them to speak in

a way that voice recognition software can understand. The voice recognition system may have trouble comprehending their speech or produce inaccurate transcriptions (Chatzoudis et al., 2022), which could cause frustration and have an adverse effect on usability.

- Survivors may experience trouble pronouncing words and speaking clearly as a result of muscle weakness or control issues (Dixit, Sethi, Garg, & Pruthi, 2022). Voice recognition programmes frequently utilise regular pronunciation patterns (Chatzoudis et al., 2022). As such, it may be challenging for them to recognise variances or unusual speech patterns common in stroke survivors. This may lead to the development of incorrect transcriptions or misinterpretations of their speech.
- Survivors could struggle to recall words, arrange them in sentences correctly, or compose them. For voice recognition algorithms to properly understand spoken input, grammar and context are frequently crucial (Basak et al., 2023). However, survivors who have difficulty speaking may have problems with language processing, which could contribute into the development of errors in system's interpretation.
- Survivors may become exhausted or have reduced stamina, which may affect their capacity to participate in lengthy speech activities (Pang & Ruan, 2023). Voice recognition systems' constant speaking or dictation requirements might be emotionally and physically taxing (Blackley et al., 2020). This can make voice recognition features less useful and less widely used for survivors.
- In order for voice recognition systems to understand a user's distinctive speech patterns, they frequently need initial training or customisation (Tate, 2023). To increase accuracy and meet their unique needs, survivors with speech difficulties may need further training or system customisation. The onboarding process may become more complicated and take longer as a result.

Incorporating a zooming feature would also help survivors with vision issues to locate and enlarge information to see greater detail. Zooming can be activated by voice activation feature. To perform zooming, users first usually need to use two fingers and slide them in opposite directions. The zooming function may first need manual dexterity and fine motor abilities, which could be difficult for people with poor hand-eye coordination or motor control. Users often need to use two fingers and slide them in opposite directions to conduct zooming (Shao, Zhou, & Wang, 2023). Second, relying significantly on zooming might prevent the growth and development of visual scanning skills, which are crucial for concentration and general visual perception (Shiferaw, Downey, & Crewther, 2019). Furthermore, zooming may distort or pixelate photos, making it challenging for survivors to correctly comprehend visual cues. Finally, frequent use of zooming functions might cause eye fatigue and strain (Kaur et al., 2022), especially for survivors who may already be sensitive to light or have visual problems. Consequently, even though zooming has some advantages, it is crucial to take into account any potential downsides and determine whether it is appropriate for each survivor individually.

As such, app designers should consider this guideline, alongside guideline #11 which proposes integrating the eye-tracking feature into mHealth design for survivors. I, therefore, propose the following guidance:

- Consider integrating a voice user interface to empower voice interactions between survivor and device – that is, an interface that allows survivors to interact with a system through voice commands and where the voice operator can be activated when it hears the user’s voice.
- Consider integrating the zooming feature to facilitate reading interfaces due to the limited screen size of mobile devices.

Given the complexities and possible unintended effects of these features described above, app designers should consider the specific sub-group of stroke

survivors they are designing for and ensure their design mitigates these effects to the extent that is possible. In addition to speech recognition, it is crucial to take into account other or alternative input methods. Options like text input, gesture-based user interfaces, or pre-defined selection menus can be part of this. Giving survivors a variety of input options will be enabling them to select the one that best suits their skills and interests. Furthermore, by including survivors in user testing and getting their feedback during the design and development process, it will be possible to pinpoint particular problems and make adjustments to improve the speech recognition capabilities' usability and accessibility for this target population.

7.3.3 Qualities influencing survivors' possibilities for access to mHealth applications

7.3.3.1 Guideline #4: The level of survivors' digital literacy needs to be assessed

Digital literacy is associated with the individual characteristics of the user and is perceived as one of the keys to the poor accessibility of mHealth applications, contributing to poor UX. My findings highlight that level of digital literacy has the potential to affect the way survivors interact with new technologies. Conversely, research has found that acquiring digital literacy skills facilitates their use (Mohammadyari & Singh, 2015). Digital literacy is perceived as the skills or ability to use mobile devices or applications, requiring both cognitive and technical skills. In the mHealth context, I refer to literacy as the knowledge of how to use mobile devices and their applications; the ability to find, appraise, and comprehend information; and applying that knowledge to addressing a health problem.

Digital literacy also appears to contribute to unfamiliarity potentially contributing to low intention to use mHealth applications for the provision of healthcare services. Survivors who rejected mHealth applications have been found to be older adults who expressed fear of new technology (Y.-H. Wu, Damnée, Kerhervé, Ware, & Rigaud, 2015). My findings also revealed that survivors' lack of knowledge may have influenced their decisions. Literature supports the idea that lack of knowledge of

mHealth applications negatively affects their use by survivors (Brandenburg et al., 2017; Fletcher & Jensen, 2015; McMahon et al., 2014; Micallef et al., 2016; Pustisek & Peternel, 2011). However, these studies did not specifically refer to the digital literacy of users. Since mHealth applications are now considered to be a new approach for supporting survivors to improve their health outcomes (North, Wilkinson, & Bourne, 2014), finding a way to overcome barriers such as poor levels of digital literacy is crucial.

To develop mHealth applications for survivors, app designers first have to comprehend, assess, and consider the different levels of digital literacy survivors may have. Moreover, survivors experience different post-stroke complications, thus each survivor has a unique situation and comes from a different background and educational level. Involving survivors in the design process will allow app designers to gain insights that could then be used to better tailor the design of such applications to survivors' needs and expectations, to improve UX and increase the acceptance of applications.

Training could also be given to help survivors using applications. HCPs and family members may assist by providing survivors with training and encouragement to use mobile technologies. Further, virtual connectivity among survivors (see guideline #1) may contribute to the development of a peer-to-peer learning environment that can help survivors improve their digital literacy. Training can also be delivered through tutorials embedded in mHealth applications to provide relevant information that assists survivors with using available features in applications. One recommendation is that survivors might appreciate an interactive tutorial. Zapata, Fernandez-Aleman, Idri, and Toval (2015) undertook a systematic review of usability of mHealth applications examining the usefulness of tutorials incorporated within mHealth applications, which reported positive outcomes. In addition, Alam, Hu, Kaium, Hoque, and Alam (2020) suggested that employing training increase acceptability. Furthermore, survivors may be keen to use mHealth applications if they are provided with proper support and assistance in using them.

Further, the content presented on mHealth applications should be well turned-out, clear, relevant, and easy to understand due to the fact each survivor may not have

the same cognitive level or may not be digitally literate. Developing an application should not just be about minimising content, but it should also be about creating innovative and new ways of incorporating information technology in time, place, and user-sensitive contexts. Videos are recommended but should be planned carefully to meet survivors' needs. The content should be minimal and relevant so that survivors do not miss the main message. My findings show that some survivors experience post-stroke challenges such as low focus and as a result, they can get irritated with a lot of content, which could discourage them from using the application.

My experience staying in hospital offers that while survivors actively seek resources, inventions, or interventions which offer pertinent and valuable content to enhance their health outcomes they also seeking a user-friendly nature and ease of comprehension and perception. This reflects how the usability of mHealth applications might influence their affordance. The term "affordance" was first used in the area of human-computer interaction (HCI) to refer to the perceived characteristics of objects that indicate how they can be utilised or interacted with them (Norman, 1988). Norman (1988) underlined that users' perceptions of affordances are influenced by their prior information and experiences.

In 2013, Norman further outlined and improved the idea. He admitted that the word "affordance" had been erroneously used and misunderstood in the original edition (Norman, 2013). True affordances, according to him, are an object's physical characteristics or traits that naturally and directly indicate various uses for the object. Norman distinguished between "real" affordances and "perceived" affordances. Real affordances are the object's actual physical characteristics that allow certain behaviours, whereas perceived affordances are the user's subjective perception of those characteristics in light of their prior knowledge and experiences. Additionally, Norman developed the idea of "signifiers" signals or indicators that instruct users of how to interact with an object. He argued signifiers can be tactile, aural, or visual in nature and aid in bridging the gap between an object's actual affordances and its perceived affordances by the user. Norman sought to give app designers a more precise grasp on

how people interact with products and teach them how to design for intuitive UX by elaborating on the idea of affordances and introducing signifiers.

The affordance idea essentially refers to how much the usability of apps might influence how people readily embrace and use them. It can specifically look at how survivors' perceptions of the characteristics of mHealth applications, affected by their prior knowledge, can affect their adoption of these applications. It emphasises the idea that low levels of digital literacy may lead to lower acceptance rates. As such, the following guidelines are proposed:

- Use an appropriate design approach, such as a user-centred design method, to work collaboratively with survivors in each phase of the design. This can include holding workshops, sharing ideas, getting opinions, making decisions about any changes, involving in an iterative and extensive assessment, and testing usability of applications.
- Incorporate a built-in feedback mechanism. This allows app designers to continuously collect feedback from survivors to improve UX and increase survivors' intention to use the application constantly.
- Consider prototyping as an essential element for the development of mHealth applications because making changes to the applications consumes relatively less time. Prototyping helps app designers to identify the weaknesses of their applications at an early stage and allows them to refine the applications accordingly to respond to the needs of survivors who are not digitally literate.
- Ensure training is available either as an in-built feature or via people who are familiar with applications. Training can improve survivors' digital knowledge.
- Make simple and easy-to-use guidance available on how to use mHealth applications. No matter how simple an mHealth application may seem, app designers must never presume that all survivors can use it with no guidance.

- Integrate a user guide or instruction manual into the design in different forms to support diverse survivors' needs, using, for example, texts, videos, and illustrations. This will help survivors who have never used applications before.
- Integrate a feature into the applications which provides a way to answer users' questions, such as a 'help' option.
- Video content is a good option. It is helpful and may assist survivors with low digital literacy in doing the required tasks. Some survivors may have difficulty in reading; therefore, having video content can be extremely helpful for them.
- Audio content can also help survivors with physical impairments to listen easily.
- Ensure that content has understandability, legibility, clarity, readability, and relevance to tackle digital literacy concerns.
- Consider using surveys (Siedlecki, 2020) to gauge digital literacy. A survey may provide insight into how comfortable and tech-savvy survivors are. Questions may ask about a person's aptitude for using mobile applications, comprehending and utilising various capabilities, and carrying out fundamental digital operations.
- Researchers and app designers can learn more about survivors' level of digital literacy by watching them use mHealth applications early in the app development process through observation (Siedlecki, 2020). Aspects like ease of use, the ability to find and interact with certain features, and general comfort and confidence in using the programme can all be the subject of observations.
- Assessing survivors' performance on particular digital tasks within the mHealth application at an early stage of app development may help to determine their level of digital literacy (Oh et al., 2021). This may entail giving them varied tasks that call for them to interact with various features, using menus, entering information, or getting access to learning materials. Their level of digital literacy can be determined by how successfully they execute these tasks.

- Interviews or focus groups (Kvale, 1996; D. Morgan, 1996) might yield insightful qualitative data about survivors' experiences with digital literacy. Researchers and app designers can learn more about their degree of digital literacy and their demands by talking to them about their familiarity with technology, prior experiences with mobile applications, difficulties they've had, and solutions to those problems.

To gain a thorough insight of survivors' digital literacy, it is crucial to combine these assessment techniques. This creates an opportunity for a more thorough evaluation and makes it possible to customise interventions or other forms of support in order to improve their digital literacy abilities and maximise their use of the applications.

7.3.3.2 Guideline #5: Ensure social support is available

Survivors highlighted the importance of social support from HCPs, friends and families. My findings suggest that survivors with greater social support appeared more likely to seek healthcare services. Family relationships are the primary and often the most continuous form of social ties (Middlemiss et al., 2019). Undoubtedly, families have a propensity to provide substantial amounts of support in many areas of post-stroke daily life (Kurniawati et al., 2020), including encouragement to seek and use healthcare services. Therefore, survivors' families and HCPs are more likely to be able to encourage survivors in using rehabilitation facilities and promote digital interventions as continuously accessible healthcare services. Xie and Kalun Or (2020) pointed out that the involvement of HCPs is needed to promote mHealth acceptance, especially among the elderly. As such, I recommend the following guidance:

- Ensure survivors' families and HCPs are also involved in the design process. Make sure HCPs' experiences are considered in the process of design. As they are experts in working with survivors, their opinions are extremely important and should be considered so that an effective application is created. Involving them

in the design process also means that families and HCPs will be more prepared to provide survivors with real-life training and encourage them to use mHealth applications.

7.3.3.3 Guideline #6: Ensure accessibility to network or internet connectivity is not an issue and applications are responsiveness

I found internet connectivity has the potential to play a major role in how survivors interact with mHealth applications. Some survivors live in rural areas where there are excessive infrastructure constraints (Eslami Jahromi et al., 2021; Qiu & Abdullah, 2021). Some survivors may not be able to afford to pay for an internet connection. This would make survivors less willing to use the applications, which can contribute to low acceptance.

Responsiveness is also identified as a consideration when it comes to the development of applications (Islam, Islam, Munim, & Islam, 2020). The characteristics of responsiveness can be obtained through speed and timeliness characteristics (Forsgren, Durcikova, Clay, & Wang, 2016). My findings suggest that some survivors would like to complete their tasks as efficiently as possible without wasting much time. Some survivors may have a comparatively low tolerance level due to stroke, which means that they might not like it if the application is too slow, leading to dissatisfaction and low intention to use the application further. I, therefore, recommend the following guidance:

- Review whether survivors are likely to have standard and reliable internet connectivity.
- Integrate a system to deal with a situation where internet connectivity may be slow or lacking, for example, by enabling the mHealth applications to function without requiring internet connectivity.
- Have a system that does not run on the internet or can be preloaded so that survivors with limited or no internet connectivity can use mHealth applications.

- mHealth applications should be able to save data during offline use and upload the data once survivors go online.
- Design the application to switch among different wireless networks as survivors may constantly change their locations. This will enable applications on mobile devices to operate with no network interruption.
- Ensure all commands are executed and respond to users' requests quickly.
- In case of an application not being responsive enough, clarity of loading is needed. An 'empty space' while the content is loading can give survivors the impression that the application is frozen; hence app designers must make it clear that the application is loading content. Since applications are for survivors, having symbols is more appropriate than dialogue. When using animations or symbols, keeping longevity in mind is important. Overusing them can annoy survivors.

7.3.3.4 Guideline #7: Ensure that relevant mHealth applications have a multi-language feature

I found survivors, where English is a second language, experienced difficulties in communication, which could impact access to mHealth applications. Therefore, the reluctance to use mHealth applications may also be driven by language barriers for some, as also reported by Ross and Gao (2016). Language barriers prevent people from exchanging information and are further exacerbated by people who have weak comprehension of other languages. This inhibits people's ability to learn from one another weakening learning experiences (Blume & Board, 2013). This highlights that language barriers have the potential to impact the way some survivors relate to and learn from their environment. They may also limit some survivors' ability to improve their digital literacy. Since English is the predominant language on the internet and in the development of mHealth applications, barriers created through a lack of English fluency are barriers that accentuate poor digital literacy and ultimately widen the accessibility gap. I recommend the following guidance:

- Localisation – ensure mHealth applications can detect the native language of a user’s device and automatically display it. This is an optimal solution if app designers are looking to internationalise their applications on a large scale and make their applications available in multiple languages. As a result, survivors who use the applications in their native language, are supported to get familiar with such technologies in a convenient way, potentially improving their level of digital literacy and usability.
- Applications on small scales – consider creating several content sections under one menu bar for each language. With applications providing two or three language alternatives, the users’ experience will remain acceptable. The only impediment is that, upon opening the application, survivors instantaneously see that several languages are available. To overcome this, make use of some icon features and customise them. However, the language of mHealth applications will still be the one set by the app designer in the back office, in the general settings tab. For example, if app designers set their applications to English, automatic messages and navigation elements will be in English, regardless of their content.
- Consider customising mHealth applications’ menu even further. Icons can direct users to a given language. The content for that language can be listed under a separate menu.

While multi-language features in mobile applications can be beneficial for reaching a diverse user base, there are some points to consider:

- For survivors who have aphasia or other language problems, using multi-language features may be challenging (Kottilingam, 2020). The application's numerous language options can make it difficult for survivors to access and comprehend the material because of the confusion they cause.
- It can be more mentally taxing for survivors to switch between languages within applications, especially if they have cognitive problems or trouble processing information. Other languages' material may be more challenging for them to

process and grasp, which could develop fatigue or overload them and degrade their UX.

- It is possible that the application will not support the specific language(s) that some survivors prefer or require, which would limit their access to useful information and services. This may result in unpleasant feelings of exclusion or insufficient support.
- To enable multi-language capabilities, information must be properly localised and translated, which can be a difficult and time-consuming process. Inaccurate translations or cultural quirks that are not properly taken into account may have an impact on the reliability and quality of the content for survivors.
- Technical challenges can arise while adding and maintaining multilingual features for mobile applications. To ensure proper translations and language support, it could be necessary to provide more tools, knowledge, and updates. The complexity of managing numerous language versions can make it more difficult to design and maintain applications, which could result in problems with performance, compatibility, or stability.

The language requirements and cognitive capabilities of the intended user group should be carefully taken into account by app designers to reduce these challenges. The UX can be improved by presenting alternatives for clear and basic language, providing language customisation facilities, and assuring accurate translations. Furthermore, taking into account the accessibility of professional language assistance and including survivors in the testing and feedback procedures can help address potential language-related issues and enhance the application's overall usefulness.

7.3.4 Design of interface

My findings provide valuable insights into optimal interface design for mHealth applications, suggesting good design increases the accessibility of mHealth applications which may contribute to their acceptance. Kaufman (2016) stated that a good

application design helps in increasing UX. As a member of the design team at altLAB, where I was awarded a summer research scholarship, I am aware that the design of mHealth applications is an extremely complicated process and, hence, it must be carried out effectively and carefully by app designers to create good UX. My findings indicate that the main design-related factors include font size, colours, customisation, and simplicity. However, I incorporated my design experience/knowledge as well in the guidelines proposition to guide app designers on how the design of mHealth applications can be inclusively improved.

7.3.4.1 Guideline #8: Make use of appropriate font size and accent colours with respect to frequency and proximity

My findings suggest that choosing an appropriate colour is an important element of good design which is supported by the literature (Khan & Donthula, 2019), especially when it comes to the culture of users. It has been argued the design of mHealth applications should be in line with cultural expectations that prompt user satisfaction and reduce resistance to use (Fisk et al., 2020), especially when users are elderly (Alsswey & Al-Samarraie, 2020). In this respect, the study of Aljaroodi et al. (2017) pointed out that various cultural aspects should be considered in the design of the mHealth application. Aljaroodi et al. referred to 'colour' and its integration into the design. They discussed how different colours may have different meanings in different cultures. For example, white colour is usually used in bridal dress in most countries worldwide and defines happiness, however, it is used as mourning clothes in India which defines sadness. The idiosyncrasy of design colour preferences and cultural meanings ascribed to different colours is likely to affect the way users interact with mHealth applications.

This inquiry points out that individuals of different cultures have different perceptions, cognitions, and values (Hofstede, 1998). Culture shapes one's behaviour, thought and experience (Kinzler & Spelke, 2011), which ultimately affect one's interaction with devices or applications. Comprehending how various cultural values may weigh upon users' acceptance of technologies is an important aspect for app

designers to consider (Alsswey, Al-Samarraie, El-Qirem, Alzahrani, & Alfarraj, 2020). New Zealand is particularly known as a multi-cultural with all cultures and religions being accepted and treated with respect. Therefore, care must be given to everyday phrases, images, icons, and colours used. For instance, the UX design of mHealth applications that involve images, music, and videos that are possibly not relevant to the Muslim or Hindu cultures may contribute to a decreased rate of acceptance of that sub-group of the population. There is, therefore, a need to provide insights into the role of culture in HCI. Users from various cultures with different preferences may require app designers to process distinctive acceptance criteria when considering cultural differences in design (Aljaroodi et al., 2017; Kyriakoullis & Zaphiris, 2016). mHealth applications should be designed in such a way that they evolve with people's cultures.

Colour should be a reflection of the application pallet and should have suitable contrast ratios. I further draw app designers' attention to the limitations of the size of the screen on mobile phones against the font size. The decision about the font size should be based on the distance of survivors' eyes from the screens. I suggest any important information should be written in bold letters. Considering all these points, I recommend the following guidelines:

- Study idiosyncrasy of design colour preferences of the target population.
- Understand cultural differences and preferences of survivors.
- Ensure no more than two or three colours are used when dealing with the 'accent' colours and do not use neutral background colours (white, black⁷).
- Consider the colour family or HSB⁸ (Hue, Saturation, Brightness).

⁷ <https://uxmovement.com/content/why-you-should-never-use-pure-black-for-text-or-backgrounds/>

⁸ HSB (Hue, Saturation, Brightness) are three characteristics are commonly used to distinguish one colour from another. "Hue is determined by the dominant wavelength of the visible spectrum. It is the attribute that permits colours to be classified as red, yellow, green, blue, or an intermediate colour". "Saturation pertains the amount of white light mixed with a hue. High-saturation colours, such as the circle on the left, contain little or no white light". "Brightness refers to intensity, distinguished by the amount of shading mixed with the hue. Any desired hue of light can be produced when various amounts of two of

- Be cautious about using dark colours.
- Use colour instead of text where needed to increase usability of interfaces.
- Make sure of the proximity⁹ and frequency¹⁰ of the colour in the design.
- Make sure that content is read easily by ensuring the contrast between the text and background. Using light-coloured texts may look aesthetically pleasing but reading it can be difficult especially if it is on a lighter background.
- Consider the distance of survivors' eyes from the screen.
- Use font size 16¹¹ to increase UX.

7.3.4.2 Guideline #9: Relevant mHealth applications should be customised for survivors

My findings highlight the importance of customisation of applications for survivors who may have different preferences when it comes to accepting an application. This is consistent with Aljaroodi et al. (2017); Chin, Li, Lau, and Wong (2021); Mallet et al. (2016), which all agreed that customisation allows survivors to use mHealth applications in a way that meets their preference with the intent of providing survivors more control over the user experience. In addition, considering there are different types of post-stroke complications, survivors need an application that allows them to use it in the way they desire. For example, a survivor may want to be reminded about upcoming actions or a survivor with vision complications may need an appropriate font size for readability. This reflects the importance of integrating customisation features into the design to increase survivors' ability to use them in a way they would like to (Martin, 2012).

the primary colours of light—the primary colours being red, green, and blue—are combined mechanically, either by addition or by subtraction". <https://www.britannica.com/video/151068/Colours-wavelengths-electromagnetic-radiation-range-eye-characteristics>

⁹ Proximity defines when an accent colour is beside another colour.

¹⁰ Frequency here describes how often the colour is used within the viewport. In decluttering a viewport, proximity and frequency need to be considered.

¹¹ <https://learnui.design/blog/mobile-desktop-website-font-size-guidelines.html>

Having the ability to customise applications to meet each survivor's unique needs can contribute to more attractive interfaces for users and thus enhance the UX of applications (Y. Wang, Tan, & Clemmensen, 2016). In addition, customisation offers each user a dominant role in the process of personalisation by allowing a user to take control over the content leading to a feeling of sovereignty or autonomy (H. Kang & Sundar, 2016; Sundar, Bellur, & Jia, 2012). For example, a study by K. Kim et al. (2015) on customisation features in games showed that users have a greater sense of control over their online experiences. Through feelings of control, customisation can develop autonomy; as suggested by the theories of self-determination, individuals can be expected to feel independent or autonomous when they choose, sense and comprehend the relevance of personal tasks they are involved with (Katz & Assor, 2007). Therefore, based on the findings, I suggest that mHealth applications should offer survivors the authority and access to or means for their HCP to modify the interface, providing information and features that are bespoke to the individual survivor.

Moreover, the relationship between customisation and motivation was explained by Peng, Lin, Pfeiffer, and Winn (2012), who emphasised that this relationship can even be rationalised by the concept of perceived control. In other words, customisation is presumed to offer a condition that fulfils an individual needs for autonomy by creating a sense of choice over technologies, which in turn develops greater motivation. Such motivation can result in decision to accept mHealth applications. Thus, I propose the following guidance:

- Ensure that the customisation feature is integrated into the design. Survivors experience different post-stroke complications which limit them in using mHealth applications. Therefore, mHealth applications should be tailored to survivors' needs and abilities. Applications must have options that survivors can customise and then adjust as per their needs which can provide them with a feeling of control that can motivate survivors in repeating interactions.
- Integrate adaptive functionalities into applications such as the font colour, font sizes, layout, and background to suit survivors' preferences, to increase the

acceptance rate. This improves the overall usability and ensures personalised experiences for each survivor.

While customisation features in mobile applications can offer flexibility and personalised experiences, there are some points to consider:

- The customisation could be challenging for survivors, particularly for those who struggling with executive functioning or cognitive issues (LaPiana et al., 2020). It can be difficult for them to browse and customise the application according to their needs if there are too many options or complicated settings. This may prevent them from using the customisation features to their full potential.
- To use customisation options, users typically need to comprehend and alter numerous settings and preferences (Pallant, Sands, & Karpen, 2020). Survivors may find it challenging to effectively do this, particularly those with minimal computer literacy or cognitive impairment. Users could be deterred from using the service due to the steep learning curve associated with customising features.
- Survivors might inadvertently alter settings that restrict the application's usefulness or accessibility for their unique requirements. The overall purpose of the customisation options may be undermined by confusion, difficulty navigating, or unexpected outcomes brought on by configuration mistakes (Pallant et al., 2020).
- When employing personalisation features, users should make decisions and often reevaluate their preferences. However, this may add to the cognitive load on survivors. Their ability to interact with the application efficiently may be hindered by the requirement to constantly change settings and make decisions.
- Implementation and maintenance of customisation options can provide technical challenges. It can be difficult to guarantee that the application will stay responsive and reliable across multiple modification choices. There may be compatibility problems or conflicts between various customisations, which could result in technical hiccups or performance problems that affect the user experience (Pallant et al., 2020).

App designers should carefully weigh the trade-off between customisation choices and simplicity to reduce these risks. They ought to make an effort to offer user-friendly interfaces, understandable directions, and simple modification options. Providing presets or predetermined profiles that address typical stroke-related requirements might help lessen the cognitive load brought on by customisation. To better meet the demands of survivors, the design and implementation of customisation features can be improved with the use of user testing and feedback.

7.3.4.3 Guideline #10: Ensure simplicity is applied in the design

One insight I gained from my design experience which is consistent with the finding of this inquiry is that making applications as simple as possible contribute to good UX. Simplicity needs to be applied in the design, which is consistent with the findings of prior literature (Osborne, Juengst, & Smith, 2021; H. Zhang et al., 2020). However, simplicity is not limited to the usability of an application but must be applied to its content as well (Epalte, Tomson, Vētra, & Bērziņa, 2020). The information the applications provide should be easy to understand when the development is intended for survivors with post-stroke complications. For example, survivors with a post-stroke cognition issue, which is associated with reduced capacity for attention and understanding, can only process a few distinct pieces of information in a given time.

With respect to the usability of applications, the navigation component is an important aspect that helps users move around the application. If app designers develop applications that suit target users such as survivors, the navigation component will then ensure a consistent and good UX by adhering to an established set of principles. Further, some survivors are not capable of performing several tasks simultaneously due to post-stroke complications and a single task can take them a long time to perform. Breaking tasks down will assist survivors to see those tasks as more doable and approachable. Hence, mHealth applications should be designed in a simple way that means survivors are able to learn how to use them. Certainly, the need to mentally transform spatial information negatively influences mobile task performance.

Decluttering is an important aspect that contributes to simplicity of applications. Visual and content cluttering is considered to be one of the worst antagonists of design (Bauerly & Liu, 2006; McMains & Kastner, 2011; S. E. Palmer, Gardner, & Wickens, 2008). With a cluttered interface, survivors are overloaded with a lot of information, images, buttons, and icons that make the interface more complicated, in particular considering the small screen of mobile devices. Cluttered applications may make survivors feel lost especially survivors who experience cognitive impairment because they are not able to understand the content and so they will not use that particular application. Therefore, decluttering can reduce cognitive load¹² (Reed, Jofre, Reader, & Yucel, 2020). My findings suggest that some survivors can sometimes have a limited amount of processing power due to their stroke, and when applications provide too much information simultaneously, it might overwhelm survivors and reduce their intention to use. Decluttering contributes to improving the comprehension, usability, eye-focus, readability and UX of mHealth applications (Skelly, 2016).

Applying visual weights can also help in simplicity of applications. Visual weights are forces that attract the user's eye. The more weight an element in an interface has, the more the eye is attracted to it (Babich, 2020). For example, one of the characteristics that determine the visual weight of an element is its size. A larger element in the interface attracts the eye more than a smaller one, making the interface simple to navigate. Therefore, the format must determine the extent to which survivors who live with visual or cognitive impairment are able to figure out all the features and functions of applications. The effective use of visual weights will help survivors better understand the information provided. Therefore, for example, using an appropriate type of icon is important for conveying the appropriate type of information. The icons must, however, be meaningful and simple, enhancing survivors' perceptions of their meanings. Symbols may work well. Symbols are generally more recognisable than text. Simply touching the

¹² Cognitive load is the quantity of brainpower needed for using mHealth applications (Patel, 2016).

symbol on the screen would be helpful for survivors, as identifying keys can be cognitively difficult for them.

My findings show that some survivors experience post-stroke fatigue which is associated with low or lack of focus. Inconsistency in mHealth applications can be confusing and impact focus when operating such applications. Moreover, inconsistency in design is one of the factors that contribute to poor UX design. Therefore, consistency in design becomes one of the important aspects of any good UX design (Nikolov, 2017). Consistency can be categorised in terms of visual consistency, functional consistency, internal consistency, and external consistency (Lidwell, Holden, & Butler, 2010). Visual consistency is also called 'aesthetic consistency' and refers to 'style and appearance' (Schlatter & Levinson, 2013). Aesthetic consistency also must be considered in pictures that are used in applications. This means that similar elements in any application must be consistent with respect to size, colour, shape, and font.

Being functionally consistent implies improving usability and learnability with the aim of permitting humans to leverage present knowledge on how the layout features work (Lidwell et al., 2010). The call (i.e., phone call) in mobile devices is one of the examples of an identical layout that is the same for all mobile devices. The green colour is commonly associated with answering the call. Red indicates that the user can reject the call. Call functionality is sometimes designed horizontally, sometimes vertically. In the horizontal design, the red colour is mostly placed on the right and green on the left. Such practical consistency in design contributes to its simplicity and improves UX.

Internal or inner consistency is the relationship among different elements inside a layout. External or outside consistency is consistency with different additives in unique settings (Schlatter & Levinson, 2013). One example of external consistency for mHealth applications is a web service linked with a mobile application: both must share similar characteristics and a similar interface. This enables users to make a frictionless transition between the applications and websites. Inconsistency in an application and website is bound to cause confusion. I propose the following guidance:

- Apply the 'simplicity' concept, which refers to developing mHealth applications to be as simple as possible to operate and easy to understand, including in providing information, i.e., using simple words to present information.
- Focus on the learnability aspect. This means that applications should be easily used by beginners and should not take much time to learn how to use, regardless of the digital literacy level of survivors.
- Ensure the navigation of the application and its pattern is simple and intuitive. Good features and compelling content are not going to help survivors who for example live with fatigue or have poor digital literacy if they are unable to find them or if it takes a lot of effort and time to navigate around the applications.
- Utilise standard components of navigation. If a survivor is already using some applications and they are familiar with the patterns of navigation in those applications then, intuitively, they know how to move around this new application as well.
- Prioritise the options of navigation. There are various options for user interactions with any application. Hence, it is recommended that a designer should assign various levels of priority to the tasks of users, that is, high, medium, or low priority. mHealth applications must give prominence to the destinations and paths with high priority and frequent usage in the user interface. To use these paths, the navigation must be defined. The structure of information should also be organised in a manner, which requires the least number of swipes, taps, and screens.
- Avoid mixing navigation patterns. When primary navigation patterns have been selected for the applications, then they must be utilised throughout. There should not be a circumstance where one part of the application has a tab bar, and another part has a side drawer. This may confuse survivors with cognitive issues.

- Make the navigation highly visible and show the current location of usage. Survivors with memory issues often forget the simplest things or have difficulty remembering them, and/or where they are currently in applications. Hence, navigation must be made visible, and the location must be clear enough so that users can easily find it without remembering it all the time.
- Utilise functional animations for clarifying navigational transitions. Providing animations describing the state of transitions is an effective method of putting survivors at ease. Since it has been evident that some survivors have trouble understanding several common things, animation can be very helpful in assisting these users.
- Divide instructions, tasks, or routine activities into several subtasks that help survivors to follow the instructions.
- Provide a step-by-step guide with a confirmation button for each step, to make it easier for survivors to follow.
- Consider the techniques of functional minimalism which may assist in dealing with the issue of a cluttered user interface.
- Make sure the content is minimal: survivors are presented with the data that is needed, and no extra information is provided unless it is important.
- Make use of 'whitespace' in the design. Horizontal and vertical whitespace between sections and elements on the interface is important. This makes the interface more visible and readable.
- Consider a fixed-width page container for content, which allows horizontal whitespace on the right or left. This makes the main content more readable. However, this may not be a good option due to the screen size of mobile devices. Using vertical whitespace in content also increases readability.

- Consider size and scale to declutter the interface. For example, managing the size and scale for the plethora of devices to have responsive design; Using EM¹³ sizing to scale elements; being mindful that if text sizes are the same for different sizes of screen, then scaling is needed; considering two or three font sizes at each responsive breakpoint which is a good medium and apply those sizes for headers, normal text, and subheadings; considering text boldness where needed; limiting the length of text to 25 to 30 characters for each line, to increase the readability; avoiding squeezing lines; having some space within the text and less important text content should have less contrast.
- Use the hidden toolbar on applications to show additional options and extra functions. This contributes to decluttering the interface and good UX.
- Use a small number of interface elements to improve the usability of mHealth applications.
- Ensure the maximum visual weights are applied in the design such as large items which are more likely to catch the eyes of survivors. Small touch controls enhance the chance of false selections.
- Accumulation of further weights to any component is conceivable with the font size, weight, and colours.
- Ensure consistency is applied in the design of mHealth applications i.e., in the visual interface – buttons, icons, logos, and labels must be constant throughout the applications. In functionality – interactive elements must function identically in all sections of mHealth applications. In internal and external consistency, for example, consistency among different additives in unique settings or among different elements inside a layout. This optimises simplicity in terms of easy navigability.

¹³ “An EM is a unit in the field of typography, equal to the currently specified point size” (Bringhurst, 2004). For example, “one EM in a 16-point typeface is 16 points”.

- Maintain consistency by following the guidelines of the platform. Every mobile operating system, for example, the Android operation system, has standard guidelines for the design of the interface. Consistency with such guidelines means survivors may already be familiar with the interactive patterns of the operating system.

7.4 Cycle two - Practical knowing and associated guidelines

Findings from this cycle supported the initial guidelines proposed in the previous cycle. However, my findings from cycle two further contributed to guideline development. I consider the identified features as components of a good design and present them below.

7.4.1 Guideline #11: Eye-tracking feature should be integrated into the design

Findings from this cycle suggest that eye-tracking can improve UX. My findings from cycle one report that survivors experience a range of complications such as physical complications that Charlotte (see section 6.2.2.2.1) experiences. Therefore, different features are needed in the development of mHealth applications to respond to different needs of survivors. Thus, applications should be designed in such a way that survivors need to put less effort into using them and an eye-tracking feature can be one of the solutions.

Integrating an eye-tracking feature into the design opens possibilities that can assist survivors like Charlotte who physically have difficulties in using such technologies and improve the navigability and interactivity of mHealth applications. Eye-tracking systems have been integrated with 'virtual reality' to support survivors in rehabilitation (Cameirao, Faria, Paulino, Alves, & Bermúdez i Badia, 2016), reducing the accumulated impact of developing further post-stroke impairments to improve health outcomes.

The most significant advantage of the eye-tracking system in mobile technologies is hands-free interaction. Mobile users have found gaze-based interactions to be easier and more intuitive (Khamis, Alt, & Bulling, 2018). This feature overcomes

the challenges of common HCI, for example, pressing a key, when a user's finger dexterity has deteriorated (Kizony, Zeilig, Dudkiewicz, Schejter-Margalit, & Rand, 2016), performing gestures such as using buttons and sliding bars when survivors having upper limb and hand mobility issues or navigating an application when survivors have an arm disability. Considering such advantages, integrating the eye-tracking feature into the design could help to decrease resistance of survivors to interact with mHealth applications. This newly identified feature may assist app designers to realise and explore its benefits, contributing to accessibility, and the enhancement of survivors' acceptance of mHealth applications, as such, I am proposing the following guidance:

- Integrate an eye-tracking feature that measures where the user's eye is focused and tracks the user's eye position or movement for the visual stimulus presented on the mobile interface. Using this technology, survivors could be able to use mHealth applications hands-free by just focusing on interface elements.

While eye-tracking features in mobile applications can offer certain benefits for survivors, they are also some considerations. Some of these considerations include:

- Eye-tracking options may not always be very accurate or dependable (Klaib, Alsrehin, Melhem, & Bashtawi, 2019), particularly when it is used by people who may have atypical eye movements as a result of diseases like Parkinson, Huntington, dementia, stroke, multiple sclerosis, and traumatic brain injury (Das et al., 2022). Applications that use inaccurate or inconsistent eye-tracking data risk being less effective and yielding unreliable results.
- Maintaining sustained attention and eye-movement control is frequently required when using eye-tracking functions (J. Li et al., 2020). It may be challenging for survivors with vision abnormalities, weak eye muscles, or cognitive problems to maintain the required eye motions or focus for long periods of time. This may prevent them from taking full advantage of the eye-tracking functionality.
- The proper use of eye-tracking technology may require considerable practise and learning. The eye-tracking feature may be challenging for survivors with

cognitive impairment to comprehend and adjust to, which can contribute to frustration and lower willingness to use the application.

- The quality and capabilities of the device's built-in camera, sensor or limitation of touchscreen may be a restriction on the eye-tracking feature in applications (Gunawardena, Ginige, & Javadi, 2022). The eye-tracking feature's performance or accuracy will be limited by insufficient hardware or software.
- Using eye-tracking features for long period of time might wear on the eyes and induce fatigue (Yan Wang et al., 2019), especially for survivors who already have visual impairments or sensitivity. The amount of time survivors can interact with the application may be limited by prolonged use.

When including eye-tracking elements in mobile applications for survivors, app developers must take these factors into mind. These issues can be mitigated and the advantages of eye-tracking technology for stroke rehabilitation can be maximised with careful usability testing, individualised support, and consideration for each person's requirements and talents.

7.4.2 Guideline #12: Game-based applications should be considered in the design

My findings report that game-based applications may help survivors in doing rehabilitation activities. Gamification offers the potential to better facilitate self-management in patients with chronic diseases like stroke (Miller, Cafazzo, & Seto, 2016). For example, survivors may experience cognitive impairment, therefore, a brain-training application can help survivors to have fun as well as a game to provide them with effective cognitive training. Such applications can provide survivors with daily challenges to improve various cognitive aspects such as attention, memory, mental agility, and problem-solving. Game-based applications may also contribute to the development of autonomous motivation in users (Bitrián, Buil, & Catalán, 2020). While it was discussed in Chapter 2 that older adult survivors may not be interested in using game-based

applications, it has been reported in a very recent study carried out by Luo et al. (2021), that game-based rehabilitation tools are acceptable for elderly survivors, and that they motivate survivors to engage with such tools. This indicates such game-based applications are now more acceptable (Tuah, Ahmedy, Gani, & Yong, 2021).

It is recommended gamification in mHealth applications should focus on patients' goals (Peng, Kanthawala, Yuan, & Hussain, 2016). For example, game-based applications may contain stages such that, upon completing a stage of rehabilitation, survivors would then move to the next level; this approach may motivate survivors in using the applications to achieve their goals. According to Brewer, Horgan, Hickey, and Williams (2013), mHealth interventions that cover a wide range of activities, and provide functions for and compatibility with the goals of survivors, may be adopted by more users. Therefore, users such as survivors using mHealth applications will see the applications as a necessity (Garett & Young, 2019). My findings suggest that integrating gamification design principles is likely to increase the level of survivors' engagement in mHealth applications. However, the customisation of game mechanics to the purpose of mHealth applications aiming at certain target patients is important and, in this case, the users will mainly be survivors. I, thus, propose the following guidance:

- Consider integrating gaming concepts in the design to increase survivors' engagement.
- Explore survivors' perspectives on game-based applications to ensure those applications meet survivors' expectations.
- Study the effect of game-based applications on survivors' motivation and engagement.
- Determine the purpose of game-based applications.
- Include neuroscientists and educators' input when it comes to design. They are the best persons who know what makes game-based learning effective neurologically. mHealth applications that have gaming characteristics will have the potential for promoting learning (Thompson, 2017).

- Ensure the game design parameters integrated into games-based applications remain simple and are not only used to provide exercises but also more visually and graphically engaging content.
- Build a game to stimulate survivors' minds while they have fun.

It is important to consider that game-based applications for survivors may have some potential disadvantages:

- These applications might call for particular physical and mental skills (Mohtar, Jomhari, Mustafa, & Yusoff, 2023) such as memory, hand-eye coordination, or fine motor control. As such this may prevent some stroke survivors from enjoying and benefiting from the games.
- Survivors with cognitive issues or slower processing speeds may find some game-based applications to be frustrating due to the intricacy or speed of the gameplay. This might reduce the benefit of the activities.
- Game-based applications might not cater to the specific requirements of survivors. Every survivor faces different difficulties and rehabilitation demands (Pugliese et al., 2019), as such a generalised strategy might not be able to fully meet their particular requirements. The game's customisation options might be limited, which would reduce its usefulness for individualised rehabilitation.
- Less participation in therapeutic activities or sessions may result from excessive usage of game-based applications (Tabak, de Vette, van Dijk, & Vollenbroek-Hutten, 2020), thus detracting from more beneficial rehabilitation exercises.
- Applications that are based on games might not be created with consideration for survivors who have hearing loss, vision impairments, or other limitations, making them less inclusive and accessible for all survivors.

HCPs and app designers need to be aware of these potential concerns and carefully consider the individual survivors' needs when incorporating game-based applications into their rehabilitation programs.

7.5 Cycle three - Practical knowing and associated guidelines

The result of this cycle revealed that the proposed guidelines are useful, suggesting app designers should apply them to the design of mHealth applications. In addition to the guidelines developed through cycles one and two, security vulnerabilities were pointed out as needing consideration by the app designer in this final cycle. This aspect focuses on ensuring the privacy of users is protected in the design of mHealth.

7.5.1 Guideline #13: Secure users' confidentiality and privacy

Maintaining privacy and confidentiality for any technology user is a necessity (Zhou, Rau, & Salvendy, 2014). My findings show that security concerns are important aspects in the context of mHealth acceptance (Bajwa, 2014; Islam et al., 2020; Messner, Probst, O'Rourke, Stoyanov, & Baumeister, 2019), specifically underlining the issue of security of personal health information (PHI). Papageorgiou et al. (2018) stated that, for health-related applications, confidentiality is the main issue of concern where the breach of personal data such as private clinical reports, medication lists, and test results are exposed. With respect to the sensitivity of survivors' personal data, including rights that Māori have regarding the ownership and application of Māori data, research on the current legal situation in New Zealand requires securely protecting survivors' data and medical records. This security aspect requires reflecting Tiriti obligations, and compliance with the Health Information Privacy Code (HIPC) 1994 and the Privacy Act 1993 if gathering, preserving, or communicating PHI.

The HIPC is a code of practice under section 46 of the Privacy Act that provides further protections to PHI because of its sensitivity. New Zealand's Privacy Act 1993 provides a general framework for promoting and protecting individuals' privacy. Applications that collect survivors' health records not only need to be HIPC-compliant but, after the data has been conveyed to a health care provider, data becomes PHI and requires protection. App designers need to consider survivors' privacy by establishing certain principles concerning accessing, collecting, using, and exposing data relating to survivors if required. The Health Information Governance Guidelines (HISO 10064:2017)

also provide HCPs with guidance on how to collect and share PHI securely, legally, effectively, and efficiently. This aspect of due diligence is necessary for providing survivors with the confidence that data security and privacy are maintained.

In New Zealand, the Health Practitioners Competency Assurance (HPCA) Act 2003, which controls the licencing and competency of HCPs, is a key piece of legislation (Shaw & Tudor, 2022). By ensuring that HCPs are qualified and fit to practise their various professions, it aims to protect the public's health and safety. Through regulated oversight and uniform standards, the Act seeks to increase public confidence in the knowledge and skills of HCPs. For HCPs, the Act establishes moral and professional norms. By ensuring that HCPs adhere to the appropriate norms of competence and professionalism, this Act plays a critical part in protecting the public. It encourages responsibility, ongoing professional growth, and the highest levels of care within New Zealand's healthcare system. I, as such, recommend the following guidance:

- Consider a system that ensures survivors' details, and their data confidentiality is maintained. Ensure that the system meets national legal standards.
- Combine HIPC, PHI and HPCA rules to develop guidelines to ensure data security and privacy.
- Consider privacy and data protection. The gathering and storage of personal data necessary to record virtual consultations with HCPs should be governed by privacy and data protection legislation. The Privacy Act 2020, which regulates the acquisition, use, storage, and disclosure of personal information, is one such law that must be complied with. The relevant HCPs and patients must give their consent, data needs to be managed securely, and it must comply with privacy laws.
- Consider security measures to prevent unauthorised access to or disclosure of the recorded data. It is important to make sure that confidentiality guidelines are followed during recording and when handling recordings afterwards. Therefore,

ensure any sessions that are recorded, and any associated data are securely stored and only available to approved people.

- Integrate facial recognition features into the design to ensure that the user is the only person who can access the application. This helps ensure survivors' data security and privacy are maintained.
- Have survivors' data stored in a secured server room with access limited to an authorised person.
- Ensure the system administrator's number is carefully managed and provided only to the authorised person.
- Ensure log activities are regularly monitored by the system administrator.
- Protect survivors' data by using an appropriate strategy, such as the use of virtual private networks.
- Ensure Tiriti obligations are considered when it comes to data management in the context of mHealth applications.

7.6 Extra consideration

7.6.1 Guideline #14: Ensure financial assessment

mHealth applications should be cost-effective so that they are affordable for users (Hung, Huang, Chen, & Chu, 2016). The literature reported that mHealth applications can offer a cost-effective and convenient way of achieving self-determined health-related goals (Brandenburg et al., 2013; Rinne et al., 2016; Steinert, Haesner, Tetley, & Steinhagen-Thiessen, 2016). However, these studies did not refer to the cost of mobile devices; rather, they were discussing the cost-effectiveness of self-management applications. The 'cost' factor identified in the present study aligns with Fletcher and Jensen (2015) who stressed that cost remains a potential barrier to the use of mobile devices and contributes to the lack of perceived usability, probably due to less exposure.

My findings suggest that the availability of affordable mobile devices would increase the acceptability of mHealth applications. The cost of new technologies continues to be a significant concern for the reason that many older survivors are on a fixed income. HCPs need to be aware of suitable funding sources to support survivors' procurement of mobile devices for the use of health applications. Yet, it has been argued that when users realise the benefits of exploiting new technologies, these advantages outweigh concerns related to cost (Melenhorst, Rogers, & Bouwhuis, 2006).

Highlighting the cost of mobile devices as a consideration may make app designers pay attention to the cost of developing mHealth applications. App designers must determine if it is feasible to develop the application in terms of cost. This means that app designers must see if the benefit of developing applications is greater than the cost of implementation. From a technical perspective, mHealth solutions are comparatively more beneficial than the traditional methods, for instance, the paper-based systems of record-keeping. From a health outcomes perspective, mHealth applications have the potential to offer a better quality of life. However, from the health care point of view, Lu and Zhang (2013) stated that the cost may outweigh the benefits of implementation. The cost of development can be high and financial support will be needed. Accordingly, I suggest the following guidance:

- Assess the cost of the development to ensure it does not outweigh the benefit of the applications.
- Look for financial support if the cost of development does outweigh the benefits.

7.7 Summary

My key findings included the factors that act as hindrances in the acceptance and use of mHealth applications by survivors. If these factors are addressed, survivors will be arguably more likely to engage in and accept mHealth applications which may contribute to the improvement of survivors' health outcomes. Based on my findings, practical knowing was constructed. Practical knowing and incorporating my design experiences led to actionable knowledge that includes 14 proposed guidelines

developed to respond to the second research question: “How can app designers be guided to develop intuitive UX stroke-related applications to meet survivors' needs and expectations?” I suggest that if app designers consider these guidelines in the design of mHealth applications, survivors’ intention to accept such applications is more likely.

Chapter 8: Discussion and Conclusion

8.1 Introduction

This chapter starts with a discussion on the key findings of this doctoral research into the acceptance of mHealth by survivors. This work has identified several factors that affect mHealth acceptance. I have grouped them into three key findings due to their significant roles in survivors' decisions. First, *social connectivity* through mHealth applications has the potential to have a positive impact on survivors' health outcomes, which positively influences survivors' behaviour towards and acceptance of such applications. Second, the *post-stroke capabilities* of survivors have significant influences on the acceptance of mHealth applications. As such, applications designed with the unique and particular needs of survivors and their post-stroke capabilities in mind are likely to be more acceptable. Third, an emphasis on good *UX design* can enhance survivors' acceptance if cultural differences such as values, language and beliefs are taken into consideration. The incorporation of cultural aspects in the design is important, not only to enable users to experience a good interaction but also to improve users' acceptance behaviour, encouraging continued usage. These three key findings shaped and informed the contributions of this work and are discussed further below. Following that, the key contributions of this doctoral work to the field of mHealth technologies for survivors are discussed, along with an overview of how I intend to take this work forward. This closing chapter concludes by acknowledging the strengths and limitations of this doctoral work, providing insights into the personal and professional development achieved in undertaking this inquiry, and a message to app designers.

8.2 Key findings of this doctoral work

With a social constructionist view and using the interpretivist approach that shaped this inquiry, I interacted with participants using action research methodology. I worked cyclically with three groups of participants, namely, survivors, app designers and HCPs to construct actionable knowledge, a set of guidelines for app designers to support

the development of applications for survivors. This work was carried out in three cycles that were aligned with the action research cycle model of Coghlan and Brannick (2014) and included phases of constructing, planning, taking and evaluating action. The model also has a pre-step phase in which I endeavoured to make sense of the context and purpose of the research before I initiated the actual work.

The potential mHealth applications have to offer, has been well established for people with chronic diseases such as stroke (L. Paul et al., 2018; Piran et al., 2019; Singer & Levine, 2016) (see Chapter 2). Despite this, as H. Zhang et al. (2020) and H. Zhang et al. (2018) have pointed out, the acceptance of such applications among survivors is low. In addition to factors identified by examination of the literature on low acceptance (see Chapter 2), other possible explanations for the low acceptance are 1) the limited studies undertaken to explore the factors that influence survivors, in particular older adults' interactions with such applications. 2) lack of guiding principles on how to design mHealth applications with good UX (Kuerbis, Mulliken, Muench, Moore, & Gardner, 2017).

This doctoral work, therefore, sought to investigate participants' perceptions of the use of mHealth applications by survivors and extend the understanding of mHealth acceptance by further identifying factors, such as post-stroke complications, language barrier, and the design of interface in the study's first cycle. While the first cycle outcomes highlighted the importance of understanding survivors' needs and created an opportunity for the development of the draft guidelines (presented in Chapter 7), it lacked detail on how these guidelines would be perceived by participants. Cycle two, an exploration process, addressed this concern and provided rich understanding of how guidelines could work for users. However, the way in which the proposed guidelines would work in practice to influence mHealth acceptance was a gap that this cycle identified. The development of the prototype in cycle three responded to this gap and provided an in-depth understanding of how the guidelines work practically to increase acceptability. The guidelines were found to be useful.

I consider the outcomes of this doctoral work as a ‘first cut’ for the ongoing development of the proposed guidelines because I believe further research will augment our understanding and inform further improvement of the proposed guidelines. An overview of the key actions associated with the three cycles is illustrated in Figure 8.1 as a way of revisiting the process of this inquiry.

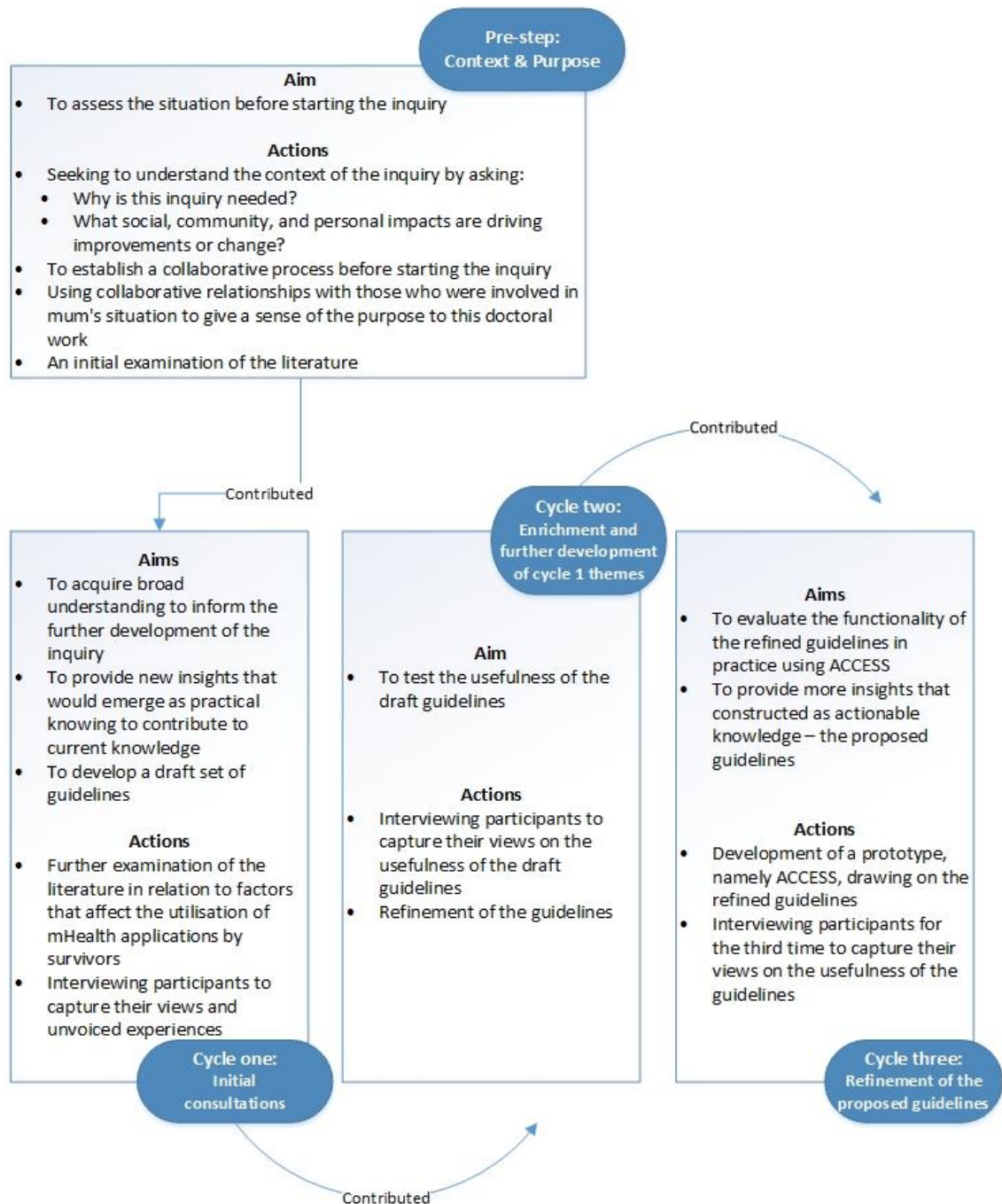


Figure 8.1: Overview of the cycles and associated activities

Through the findings, I saw that many discussions regularly centred on three recurring aspects, namely, *connectivity*, *capability* and *accessibility*, which lead to enhancement of mHealth acceptance. Therefore, I suggest that acceptability is determined by first, *connectivity*. This inquiry has reported the acceptance of connecting through a *social application*. This reveals that survivors would benefit from social engagement which has the potential to have a positive influence on the mental health, physical health, social isolation and quality of life of survivors (Misawa & Kondo, 2019). This in turn indicates that creating an online platform to facilitate this engagement among survivors would be a highly appropriate way to support survivors and may lead to greater UX and acceptability.

Second, the findings of this doctoral work suggest the *post-stroke capabilities* of survivors, which refers to the capability of survivors for using mHealth applications, are determined by the level and type of post-stroke complications they live with. For example, post-stroke depression was found to be one of the significant post-stroke complications that reduce survivors' capability in daily activities, including the use of mHealth applications. One explanation is that post-stroke depression can contribute to the development of survivors' unwillingness to get involved in any activities (Robinson & Jorge, 2016), including attempts to use mHealth services to achieve their goals – better health outcomes and quality of life. The second explanation is that post-stroke depression is associated with self-efficacy (Chau et al., 2021), which leads to survivors lacking motivation to involve themselves in many activities such as participation in rehabilitation or considering using mHealth applications to improve health outcomes. It is therefore evident that post-stroke complications contribute at a basic level to capacity of survivors for using mHealth applications, affecting their acceptability.

Third, it follows having an appropriate *design* is essential for *accessibility* to mHealth applications, in particular by the elderly, as C. Li et al. (2021) have identified in their outcomes. The results of the present inquiry indicate various design aspects that still require close attention and investigation to provide evolving solutions to UX and enhanced acceptability.

8.3 Discussion of key contributions of this doctoral work

This doctoral work contributed to mHealth technology acceptance knowledge in two ways:

1. Augmented understanding of *mHealth technology acceptance* in the context of stroke-related applications through providing in-depth insights into how these technologies can be inclusively improved to enhance survivors' intentions to accept such technologies.
2. Proposing guidelines (presented and discussed in Chapter 7) to improve UX which, if they are integrated into development of mHealth applications, can likely increase the applications' acceptability.

8.3.1 mHealth technology acceptance

With respect to technology acceptance, several definitions and terms can be found in the literature. Terms such as adoption, acceptability, or acceptance are often used. These terms are sometimes likened to HCI concepts, for instance, users' satisfaction (Fischer et al., 2016). Adell (2010) defined 'acceptance' as the degree to which users intend to use technology. In the *Cambridge Dictionary*, the term "Acceptance" (2021) is defined as an agreement on something that is satisfactory. Both these definitions highlight an action that takes place as two objects have effects upon one another, suggesting interaction. The notion of two-way effects is central to the concept of interaction. To translate the concept in the context of HCI, it refers to the interaction between users and a system.

In regard to interaction between users and a system, many researchers have attempted to examine users' interactions with information technologies, users' behaviour and their intention to use technology and to identify factors affecting their acceptance behaviour. Several models have been proposed such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), the Technology

Acceptance Model (TAM) (F. D. Davis, 1989), and the Theory of Planned Behaviour (TPB) (Ajzen, 1991), all of which have been employed extensively in several contexts by researchers with a quantitative focus to study users' acceptance behaviour, including in the context of mHealth technologies (Hoque, 2016; Hoque & Sorwar, 2017; Sezgin, Özkan-Yildirim, & Yildirim, 2018; L. Wu, Li, & Fu, 2011; Yu, Wu, Liu, & Chi, 2021). These quantitative studies show that, for example, the constructs of UTAUT are affected by various external variables, suggesting the original constructs of models like TAM or UTAUT are not sufficient in fully identifying the factors influencing the acceptance of new technologies such as mHealth (Bixter, Blocker, Mitzner, Prakash, & Rogers, 2019). Extension of the models is often necessary to accommodate both the profile of the targeted population and the technological domain (Hoque & Sorwar, 2017). In this case, this inquiry demonstrated that for the acceptance of mHealth technologies by survivors, additional factors such as survivors' willingness to connect to society, post-stroke capability of survivors and survivors' cultural preferences contribute to attitudes toward such technologies.

Researchers have also attempted to explore users' acceptance of mHealth applications with a qualitative focus, for example, Gharaibeh, Gharaibeh, and De Villiers (2020). However, Burns et al. (2021) reasoned that the literature chiefly focuses on the development and usability of mHealth applications rather than the acceptability aspect. Accordingly, Hoque and Sorwar (2017) recommended an extension that could adopt a qualitative approach to unveil users' perceptions of the adoption of mHealth in the context of developing countries. The literature on mHealth acceptance studies in the context of some developed countries like New Zealand is also scarce (Cao, Lim, Sengoku, Guo, & Kodama, 2021). Hence, there remains an important call for qualitative studies to understand mHealth acceptance in the context of developed countries. From a methodological perspective, therefore, this doctoral work has attempted to contribute to mHealth acceptance knowledge by undertaking research with a qualitative focus to explore survivors' intentions. This approach expands understanding of mHealth acceptance by identifying various factors that affect survivors' intentions and behaviour in the New Zealand context.

From a theoretical perspective, this doctoral work contributes to extending research by categorising salient factors into three main aspects of application design. First, this inquiry has indicated that *virtual connectivity* may have a significant role in survivors' acceptance behaviour and may also be a key aspect of UX when attempting to motivate survivors to have repeated interactions with an application. This inquiry found that survivors may appreciate and interact with applications that facilitate social connectivity. This is consistent with Schwarz, Claros-Salinas, and Streibelt (2018) who stress social participation contributes to improvement of recovery. Second, the limited *post-stroke capabilities* of survivors were found to be an important aspect of mHealth acceptance, which H. Zhang et al. (2018) identified as a barrier to use. The complications that survivors experience create impediments often leading to negative behaviour towards mHealth devices. Third, congruent with the literature (Hamm et al., 2017; X. Wang et al., 2021; Wildenbos et al., 2019), this research has shown that while good design may tackle post-stroke issues to improve UX and increase survivors' acceptance, a *culturally-based design* has a key role in attracting survivors' acceptance (Alsswey, Umar, & Bervell, 2018).

In view of these findings, Figure 8.2 visualises the relationship of three main aspects of application design, namely virtual connectivity, post-stroke capabilities and culturally based design, which together are argued to have an impact on survivors' acceptance behaviour. These aspects are discussed in more detail below.

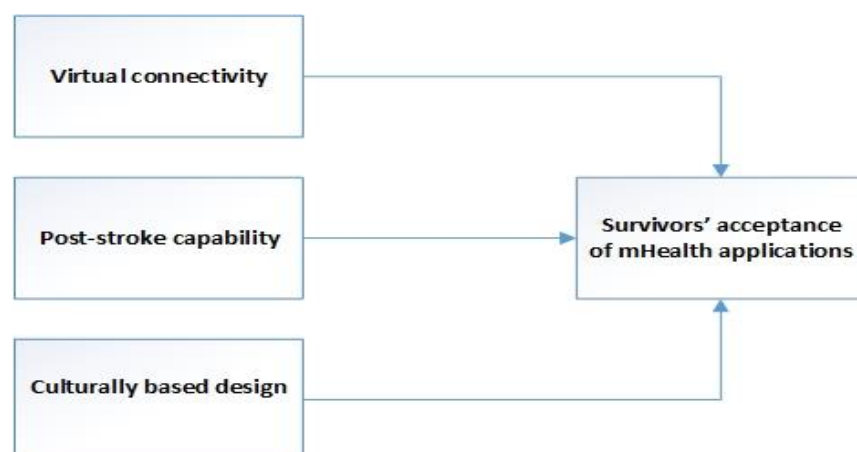


Figure 8.2: Three main aspects of applications design

8.3.1.1 The role of virtual connectivity in mHealth acceptance

The input from survivors has clearly highlighted that survivors can get considerable benefit from mechanisms that enable them to regain their connections in the social world (Brookfield & Mead, 2016). Analysis of findings also underlined the potential for mobile technology to have a role in facilitating post-stroke social participation. Therefore, survivors will potentially find interest and engagement in an application that can provide an online platform connecting them with peer groups. Using these platforms survivors can find others who share common circumstances and experiences, as well as learn from and be motivated by other survivors' stories of recovery and adaptation, contributing to improving self-efficacy. Survivors' positive self-efficacy built through having positive experiences in the performance of tasks or relating to and learning from other survivors' experiences and achievements, are encouraged to believe in themselves and their ability to achieve desired goals. As a result, self-efficacy can increase survivors' motivation (Kurniawati et al., 2020), which in turn may promote positive affects in survivors' behaviour towards repeating their interactions and ultimately accepting a particular technology. This highlights the importance of social participation among survivors to improve learning experiences and emphasises the potential role of mobile technologies in this regard.

Moreover, with the implementation of social applications, survivors would not only be able to advise one another and share their experiences but would also be able to access specific forms of support from HCPs to improve their health outcomes. The availability of applications can encourage survivors to connect with their HCPs and continuously take advice from HCPs directly from home, where no appointment or waiting room is required providing another motivation to accept mHealth for virtual connectivity. Further, positive professional feedback may contribute to survivors' confidence and beliefs in their capability (Hole, Stubbs, Roskell, & Soundy, 2014). Unfortunately, at the time of writing, most of the available applications do not offer such a platform to facilitate online interaction with HCPs, which H. Zhang et al. (2020) have identified as a factor contributing to low acceptance.

The evolution of mobile technologies has enhanced the use of social applications in smartphones, raising the potential to connect people and improve communication. Social applications may develop a safe virtual society that can contribute to lessening post-stroke complications such as post-stroke depression. However, the challenge is in knowing how much these applications actually improve the health of patients (Ringer, 2014). A very recent study aimed to compare social applications to other traditional interventions such as telephone or usual care for self-management, to observe the effects on patients' health outcomes. Their findings demonstrated that social applications do have a positive impact on users' health outcomes (Chiu et al., 2020), which in turn motivates users to interact. The literature includes other evidence-based studies all emphasising the need to maintain social connectivity in survivors (Sorensen et al., 2019), and attesting to the positive impacts of social participation on physical health (C. Li, Jiang, Li, & Zhang, 2018). These conclusions indicate that creating virtual connectivity that facilitates social participation for survivors might equally contribute to solutions that address post-stroke complications. So supporting developments towards this end by including social features in application designs has the potential to positively impact mental health, physical health, social isolation, and the quality of life in survivors (Misawa & Kondo, 2019).

Compared to other types of applications (reminding, monitoring, and being informed) that were identified in this inquiry, the social application appears to be one of the most significant elements in designing an application and its subsequent acceptability. Chiu et al. (2020) have also highlighted this benefit. A possible explanation is that survivors may feel less isolated and depressed by feeling constantly virtually connected. Enabling communication with peers and HCPs offers additional social interactions to provide constant support throughout the recovery process, which assists to improve survivors' quality of life. This is supported by the literature indicating survivors usually perceive their degree of social connectivity as key to improving recovery (Schwarz et al., 2018), and increasing quality of life (C. Li et al., 2018). Importantly, this online space can facilitate such applications as tools that promote the long-term self-management of other health concerns.

H. L. Tong and Laranjo (2018) have systematically reviewed the literature with respect to the integration of social features in mHealth applications and they found users' preferences for social connectivity vary. Some sensed more motivation by using social connectivity, while others were concerned about being judged and offended. As yet, based on my findings and other studies in this field, there remains a contradictory conclusion that reflects the existence of insufficient evidence in the context of survivors' desires for and acceptance of such applications. To fill this gap, there is a need for further exploration of survivors' perspectives on social connectivity. Development of an actual mobile social application targeting the needs of survivors to explore their acceptance behaviour towards it would offer insights into how to optimise the use of mobile applications for social connectivity.

8.3.1.2 Post-stroke capability of survivors in the context of mHealth acceptance

As remarked earlier, various models such as TAM and UTAUT have been proposed and used to investigate technology acceptance, including mHealth acceptance. However, these existing models are limited. While there is existing quantitative-oriented research available on mHealth acceptance, the majority of them have only explored factors such as: perceived ease of use and trust, using TAM (Hoque, 2016); perceived service availability, mobile anxiety, and technical training and support, using M-TAM (Sezgin et al., 2018); and resistance to change, technology anxiety, effort expectancy, social influence, and performance expectancy, using UTAUT (Hoque & Sorwar, 2017). These studies investigated users' behaviour, which is certainly assessed through subjective means, for instance, interpersonal influences.

These existing models focus on behaviour as it relates to technology use, highlighting so quite a constrained view of behaviour. Whereas, behaviour can also be viewed as health-related behaviour, meaning behaviour can be affected by health-related issues. For example, depression can contribute to users' unwillingness to interact, leading to negative behaviour towards technology. Therefore, while these models examine users' behaviours towards the use, models were to extend to also include how that interacts with health-related behaviour, which might result in more

nuanced understanding of technology acceptance in the context of mHealth applications. In this respect, not only the factors from models such as ATUAT but also the factors of health-related behaviour should be considered to extend understanding. In the health domain, the Health Information Technology Acceptance Model (HITAM) was proposed by J. Kim and Park (2012). The HITAM integrates the TAM model with health-related constructs such as health beliefs. Health beliefs describe users' personal beliefs in the effectiveness of a particular behaviour towards improving their health status (M. Zhang, Luo, Nie, & Zhang, 2017). However, limiting the model to health beliefs is not sufficient and a more expanded model which incorporates post-stroke complications would be more likely to address the complexities I have found in my inquiry.

The literature shows that qualitative user experience research has investigated factors that affect information technology usage, in particular, mHealth technologies, with the majority of studies exploring factors like functionality, software limitations, privacy and security issues (Aljaroodi et al., 2017; Allen et al., 2008; Mallet et al., 2016). By comparison, only a few studies have explored factors such as physical impairments (H. Zhang et al., 2018), and cognitive decline (Rinne et al., 2016; Tang et al., 2016), in the context of acceptance.

To extend research in this area, this doctoral work has found that health-related factors such as post-stroke depression and physical impairments, and/or survivors having or developing low self-efficacy may negatively contribute to acceptance of mHealth applications. For example, post-stroke depression has been found to be associated with physical complications and contributes to common emotional complications among survivors (Giaquinto, Spiridigliozzi, & Caracciolo, 2007). Most literature indicates that post-stroke depression contributes to poor functional results (Kutlubaev & Hackett, 2014); low quality of life (Oni, Olagunju, Olisah, Aina, & Ojini, 2018); and high health care dependency (Dossa, Glickman, & Berlowitz, 2011). These studies suggest that depressed survivors may be less likely to participate in rehabilitation sessions, show lower adherence to medications, have poorer post-stroke recovery and

experience a low quality of life, all of which lead to high health care use. As such, survivors experiencing such complications are unlikely to be motivated to engage with mHealth applications for better health outcomes.

Physical complications such as physical and visual impairments have been found to be potential barriers to the acceptance and use of mHealth applications. Literature expresses that survivors with physical complications are at a higher risk of developing depression (De Ryck et al., 2014; Hackett, Yapa, Parag, & Anderson, 2005). This extends to the notion that survivors who suffer from post-stroke physical complications have less capability to perform day-to-day activities, amplifying their dependency and contributing to depression and less confidence, which impacts their belief in an ability to respond to simple tasks, including intention towards accepting mHealth for self-managing their conditions.

Survivors can experience low levels of self-efficacy, potentially inhibiting the acceptance of mHealth applications. In this inquiry, self-efficacy is perceived as survivors' belief in their ability to perform daily activities, including capability for managing their own condition to deliver a greater quality of life. Accordingly, they may lack sufficient confidence to deal with their situation, even to the point of seeking help or advice for their well-being or considering positively the benefits found in embracing new technologies. Studies show that self-efficacy is positively associated with daily activities, mobility and perceived quality of life (Kurniawati et al., 2020). This inquiry pointed out that survivors with low self-efficacy did not believe in getting better or in trying alternative ways to get the support that they needed for this. This, in turn, appeared to have implications for their acceptance of mHealth applications. On the other hand, X. Zhang et al. (2017) have identified self-efficacy as an influential factor in mHealth acceptability.

Despite the findings of this work extending the current research base, with respect to the role of health-related factors in acceptance of mHealth, there is still a need to carry out further studies aiming to investigate health-related factors that are involved in survivors' acceptance behaviour and to extend and broaden the evidence

base due to the limited number of studies presently available. In addition, Burns et al. (2021) have remarked that the focus of the available literature was often related to something other than acceptability. These points indicate that while little attention had been given to the acceptability of mHealth applications in the context of survivors, there was also little focus on the impact of health-related behaviours on acceptance of mHealth applications. As such, there is a need to study post-stroke complications to identify survivors' needs and expectations to design mHealth applications accordingly.

8.3.1.3 The role of culturally based design in mHealth acceptance

While the study results report various factors such as customisation or gamification associated with design that may affect the acceptance of mHealth applications, the characteristics of the study participants (in particular, survivors) also show variations in ethnicity and age, which suggests survivors' preferences for and expectations of acceptable mHealth applications may vary according to their cultural beliefs, values and perceptions. In fact, it may be an important contributor to low acceptability of such technologies.

Many survivors hold diverse cultural values, beliefs, and languages. In addition, as remarked earlier, the incentive for considering older survivors in this inquiry was due to the growth in the increasing number of survivors as the worldwide population ages (Thrift et al., 2017). Age has been identified as one of the main factors associated with stroke (Barber et al., 2016). Generally, older adults suffer from health-related complications, which affect their interactions with mobile technologies. Their preferences regarding mobile technologies are linked to lessening physical abilities and cognitive flexibility, which affect their efficient use of technologies (Mehrotra et al., 2016). Therefore, it makes sense to say that survivors' interactions with mHealth applications can highly depend on their preferences and differences. Thus, designing such applications to be more user friendly with good UX is important for their success. However, good UX design requires consideration of users' cultural preferences and differences for mHealth applications to be welcoming to a wide range of cultures (Alsswey, Umar, & Bervell, 2018; Van Biljon & Kotzé, 2008).

UX design should be cognisant of key cultural aspects, which may affect a user's decision to accept a particular technology (Fisk et al., 2020). Even though general users are interacting with technologies in the context of cultural differences (Alsswey, Umar, & Al-Samarraie, 2018), an understanding of users' perceptions of cultural-based design by app designers has not received much attention in the context of acceptance (Petrie, Weber, Jadhav, & Darzentas, 2017). Therefore, in-depth insight into cultural differences and preferences is important for the triumph of any technology. My findings augment the understanding of cultural differences in the context of acceptance by suggesting that incorporating certain cultural values (such as language) of a particular group of users into a design can enhance the acceptance of that particular technology. Understanding the role of culture in survivors' acceptance behaviour would support the design of a new application and its development for survivors.

The cultural aspect of good UX design found in this inquiry was limited to the use of colour, which is supported by recent research by Alsswey et al. (2020). However, the approach can be expanded to language, customisation, or even to images and layout. Colour was found to be one of the important components in the design of mHealth applications that can improve UX, suggesting that, as a cultural aspect, colour can infer cultural meanings and communicate cultural messages. Meaningful colours can increase users' interactions with technology. To explain this, colour can be employed to communicate a specific feeling or meaning. For example, black often represents negative feelings and communicates an unpleasant message. Accordingly, it is known that diverse colours communicate diverse cultural meanings and impacts, which may affect survivors' acceptance of mHealth applications in different ways (Dhou, 2019). This extends to a perception that using culturally relevant colours may make design elements such as images or icons more eye-catching for users. In this way, users may interact with mHealth more readily which may lead to more interest in using them.

Using the language of specific groups was found to be a crucial design feature, suggesting that it has culturally significant impacts on some survivors' acceptance of mHealth. The possible justification is that using survivors' preferred language in the

design may perform a significant role in mitigating misperception, misunderstanding and anxiety among survivors, where they are forced to engage with a language that is less familiar to them. Khanum, Fatima, and Chaurasia (2012) have reported it as a factor in reducing confusion among users, while Medhi et al. (2011) have identified it as a factor in improving engagement with and usability of mHealth applications. I have proposed that integrating a multi-language feature into the design of mHealth technologies will increase usability, leading to potential acceptance by survivors from different cultures. While the suggestion made emphasises language and culture have a significant impact on survivors' UX, they should be investigated together as they are intertwined and associated with the usability of a technology (Devlin, 2007; Llanos & Muñoz, 2007). My finding also contributes to the scarcity of literature regarding the association between the language background of UX design and its usability (Nantel & Glaser, 2008).

The cultural aspects such as language highlight another finding of this work in supporting a previous study (Mora, González, Arnedo-Moreno, & Álvarez, 2016), stating that customisation can improve UX and highlighting mHealth applications can be customisable tools. Mora et al. suggest offering users direct control over how they interact with applications and how this customisation enhances acceptability. For example, providing users of different cultures with an opportunity to use an application in their native language does increase its acceptability. These findings indicate while customisation may lead to a higher acceptance, it also reflects users have a greater need for cultural specificity. The literature discusses the relationship between customisation and culture, and the notion that customisation can create a condition that fulfils users' culturally different needs which are referred to as '*cultural customisation*' (Singh & Pereira, 2005). Cultural differences influence users' needs, making cultural customisation relevant to fulfilling those different needs; potentially influencing the use (Free et al., 2013). Sia et al. (2009) reported the limitations of research on cultural customisation to meet the needs of users of interactive technologies, suggesting my findings add to the existing literature by proposing that culturally based customisation can enhance mHealth applications acceptance.

Other design elements that can be pointed out as cultural aspects are first, using images that, while contributing to the visual appearance of a design and improving the UX of users, may offend some cultures (Ross & Gao, 2016). As I remarked in the previous chapter, while some images may be acceptable, for example, in western culture they can be inappropriate in other cultures. An image can be referred to as a cultural artefact that comprises ideology and value (Salinas, 2000). In this respect, this inquiry suggests that app designers should integrate culturally appropriate images, meaning they should consider the affects of cultural meanings with images in mHealth applications. In this way, images will contribute to cultural artefacts that have positive messages and social values, which Benaida (2014) specifies as a reflection of the users' culture, indicating a contribution to the good UX of specific groups of users.

Second, a design layout that has been considered and discussed in terms of 'visual weights' in the proposed guidelines highlights the importance of its role in the design of mHealth applications. Alsswey, Umar, and Bervell (2018) have found that a suitable design layout allows users to feel a sense of 'comfortability' and perform their tasks quickly. This reflects a recognition of the fact that for survivors whose native language is, for example, Farsi, the orientation of writing is from right to left. Therefore, if the layout of applications is arranged from right to left, survivors who speak Farsi are provided with a feeling of comfortability, which Ross and Gao (2016) have explained as the sense of familiarity for these users. These authors argue that the layout should follow the practices of the specific culture that users are familiar with, to give users a feeling of ease since it precisely reflects their own culture (Almakky, Sahandi, & Taylor, 2015). As a result, applying cultural elements in the design positively influences survivors' interactions with mHealth applications.

The cultural considerations that have been discussed here strongly emphasise the importance of understanding users' cultural differences to design good UX interfaces to improve users' acceptance behaviour. This extends to the issue of the methods that app designers employ to understand users who are from different cultures. App designers and HCI researchers use a methodology, for example, user-

centred design (Norman & Draper, 1986), which involves working closely with users with certain methods such as focus groups, interviews, or questionnaires (Cairns & Cox, 2008). However, these methods have been developed in Europe and North America and users from different cultures may interpret them differently. For instance, in evaluating a prototype interactive system, users from some cultures may consider it is not appropriate to honestly criticise the design when it has been created by a specialist, which can lead to unreliable and inconsistent conclusions. Such contradictory conclusions not only confuse researchers but also hinders mHealth development. App designers and researchers should be mindful of the likelihood that cultural preferences and differences exist and use caution in expanding methods to different cultures.

As remarked earlier, a small number of researchers, such as Alsswey et al. (2020), have explored the effect of cultural features on users' acceptance and reported that integrating cultural aspects such as a specific language in the design can improve UX and meet users' expectations. Built on the results of the association between users' acceptance of mHealth and culturally based design features, this doctoral work contributes to the existing mHealth acceptance literature (Alsswey, Umar, & Bervell, 2018) by examining and informing survivors' preferences in regard to mHealth and reporting these preferences can be related to their beliefs, values, and perceptions.

8.4 The contribution in context

The current guidelines add to the body of existing guidelines such as Nielsen's principles (Nielsen, 1995), Xcertia (Xcertia mHealth App Guidelines, 2019), HE4EH (Khowaja & Al-Thani, 2020), and UGmHA (Nasr, Alsaggaf, & Sinnari, 2023) by providing more in-depth recommendations and considerations with a focus on stroke survivors. While there may be already some laws governing the matter, the current guidelines provide a more in-depth and focused approach to responding to the bespoke needs of stroke survivors. They draw on and are informed by the lived experience of survivors and the most recent research. A primary objective of this research was to add to existing guidelines and provide app designers with more current and useful guidance to develop

applications for survivors. By taking into account these additional principles, app designers can gain from a more thorough and informed set of suggestions/recommendations to guide their design to support stroke survivors.

Due to their level of specificity and emphasis on the development of mHealth applications for survivors, the developed guidelines play a distinctive role. Despite the fact that there may be broad requirements for the design and development of applications associated with the health care system, these tailored standards are made to address the needs and concerns of survivors and the unique challenges they experience. By concentrating on stroke-related applications, current guidelines provide a set of focused recommendations and suggestions that take into account the specific needs of this particular user group. For example, they take into account user needs in relation to communication difficulties, movement limitations, cognitive restrictions, and the whole rehabilitation process for survivors. The current guidelines also take into account the advancements in development of applications and the continuously changing technical environment. The most recent usability principles, functionality and behavioural criteria are sought to be incorporated into stroke-related applications to ensure their effectiveness and increase their acceptability rate. As such, the aim was to fill a void by providing advice for the creation of mHealth applications, taking into account the particular requirements and needs of survivors, and being in step with the most recent developments in the area of medical technology.

The suggestions and recommendations should be put into action as a practical instrument to guide app designers. However, it is vital to use them with care and recognise the inherent complexity at work when doing so. Instead of considering them as a checklist that must be followed, they should be considered as a framework to guide decision-making. It is crucial to keep in mind that not all of the suggestions and recommendations may be right for all survivors because every survivor has unique demands and preferences. Thus, a tailored approach is required. As a beginning point, app developers should carefully assess and modify the proposed guidelines to match the purpose of the design. The possibility for some features to optimise access for some

survivors while unintentionally excluding other survivors must also be taken into account. App developers should be aware of any constraints that particular design decisions might create. Balancing the demands or preferences of various individuals in the target population should be top priorities. The current guidelines offer a useful structure, but it is important to take into account that continued involvement of relevant parties (such as HCPs) during the development process is essential. Understanding survivors' needs and preferences also requires active user participation and input. To make sure the mHealth applications really satisfy the requirements of the market, continued usability testing and iterative design methods should be integrated into the design cycle.

As such, while the suggestions and recommendations should serve as a starting point for the development of mHealth applications, it is crucial to understand that personalisation, taking into account unique needs, and user involvement are essential elements. The principles act as a checklist and guide, but their implementation necessitates a considerate approach that considers complex demands of survivors as well as the iterative process of the design and development.

8.5 Latest developments – future work

In the research reported in this thesis, I aimed to socially engage with participants to explore their experiences with using mHealth applications for the improvement of survivors' health outcomes. Overall, the exploration of their views identified influential factors that affect mHealth application acceptance, contributing to the development of a series of design guidelines. When followed by app designers, it is intended these guidelines will promote the design of successful mHealth applications that increase UX and, in turn, mHealth application acceptability.

The prototype described in this inquiry was designed to illustrate the proposed guidelines in practice in cycle three. I sought to examine user interface design features to ensure the usefulness of the guidelines. Despite the prototype used to evaluate the proposed guidelines not being fully functional, and lacking elements such as a functional

eye-tracking feature, the outcomes were positive. Following this, due to the existence of insufficient evidence reported in this doctoral work (see section 8.3.1.1), I have since developed a mobile-based social application, integrating the main aspects of the proposed guidelines. In future work, I aim to use the social application as a means of further exploring survivors' views on that as a mechanism of social connectivity.

The idea of developing an actual mobile-based social application arose for several reasons. First, current findings suggest that enabling social participation may be an appropriate way to address post-stroke challenges. Social participation provides an opportunity for people to share experiences and learn from and encourage each other, potentially contributing to self-efficacy and ultimately to motivation. The integration of social features into the application reflects guideline #1. Using a social platform, survivors can also explore useful resources that may help encourage them to improve their digital literacy. Second, survivors would be able to connect directly with their HCPs to maintain a flow of professional advice; in turn, HCPs would be able to monitor their patients' health conditions. In this way, survivors would be connected to the support they need – social support. Third, a social application would address the need, highlighted by Burns et al. (2021) and Patomella et al. (2021), for the development of mHealth applications targeting survivors. Fourth, developing such a social application would lead to iterations that permit an examination of the application toward meeting the needs of all survivors. Lastly, the aim is to improve survivors' behaviour towards and acceptance of the application.

Steps have been taken to initiate the development of the application, namely StrokeLink, where JavaScript¹⁴ was used to write the front-end codes. JavaScript can be read, interpreted, and then run by browsers. It creates a powerful client-side experience as the JavaScript running in the browser is 100% decoupled from how the HTML web page is generated, which means that users will continuously have the same good

¹⁴ JavaScript is a scripting language that allows developers to create content, images, control multimedia or animate https://developer.mozilla.org/en-US/docs/Learn/JavaScript/First_steps/What_is_JavaScript

experience as JavaScript works regardless of the server-side language used (MDN, 2019). In the early stage of the development, Expo¹⁵ was used to simulate StrokeLink. Then it was found that some third-party libraries could not be used, and Android Studio¹⁶ was used instead.

For the back-end language, Golang was used. Golang is an open-source programming language that allows developers to develop simple and reliable software efficiently. The programmer can normalise the framework and include API in a unified norm quickly, with little coding. The Ali Cloud server which is a cloud service provider was used to build the back-end project. Ali Cloud facilitates scripting back-end. Virtualisation technology was used to facilitate the rapid deployment of the development. Based on the Golang and Apache 2.0 protocol, 'Docker' was chosen as an open-source application container engine (Docker, 2019), and images were written to package the server programs as well as the database independently, accomplishing the effective deployment of the online project. Figure 8.3 illustrates screenshots of the login page.

¹⁵ Expo is a common open-source platform for developing applications for iOS and Android <https://expo.dev/>

¹⁶ "Android Studio offers a unified environment where developers can develop applications for Android phones, tablets etc. Structured code modules permit developers to divide their project into units of functionality that they can independently develop and test" <https://developer.android.com/studio/features>

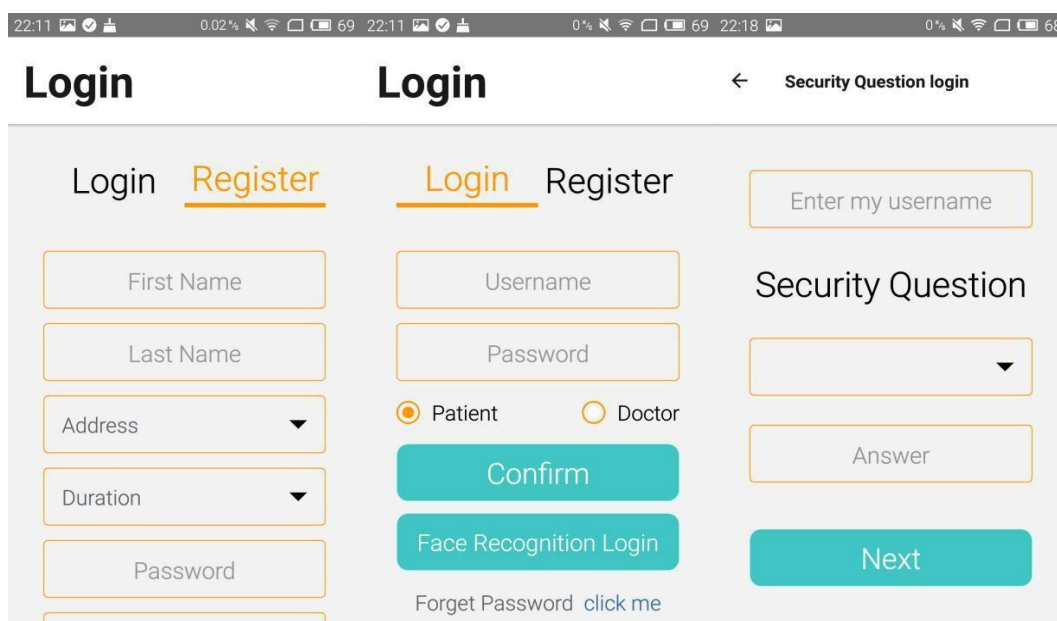


Figure 8.3: The login page of StrokeLink

To reflect guideline #3, the integration of VoiceOver (for iOS) and TalkBack (for Android) will enable survivors to activate the program to read aloud all the visible words. The VoiceOver screen reader expresses exactly what is taking place on the screen. TalkBack is specifically designed to support visually impaired survivors with language aids. Visually impaired survivors can interact effectively with the application. When using Android applications, Talkback provides real-time language feedback (Android Central, 2019). Reflecting the same guideline, Hover Text is also integrated into the design which allows survivors to immediately enlarge a selection of text.

Considering guideline #6, the application will allow survivors to save their data during offline use and upload them once they go online. In addition, I am considering integrating a system where survivors who experience connectivity issues will be able to use the application.

Other features, such as a multi-language option and customisation feature, will be integrated into the design to address guidelines #7 and #9. My short-term goal is to make the application accessible in two to three different languages to explore survivors' perspectives. If the application would meet survivors' expectations, then '*localisation*' is the long-term goal to enable survivors to use the application in their native language.

With respect to font size and colours, I used 16 in text, large icons and images to ensure visibility. I endeavoured to use light colours to enhance readability. However, customisation will allow survivors to customise the font size and colours. As a result, guidelines #8 and #9 are applied and the application may have a chance to be welcoming to a wide range of cultural attributes.

Guideline #10 is my focus in designing the application. I endeavour to apply simplicity concept in the process of the design to ensure its acceptability by survivors. Applying simplicity concept means integrations of all associated propositions are essential. I also aim to create a short video to guide survivors in navigating the application. In this respect, guideline #4 will be applied.

To integrate guideline #11, eye-tracking, an application programming interface (API) named Face++¹⁷ will be used to address post-stroke complications. The screen reader feature will also be incorporated into the program. React Native¹⁸ also can provide API for mobile applications to implement the screen reader function (Laplante, 2017).

Face recognition login is integrated into the design to address post-stroke complications such as physical complications. This feature also ensures users' privacy and data security (see guideline #13). Figure 8.4 illustrates a screenshot of the face recognition login in StrokeLink.

¹⁷ "Face++ is a platform that allows developers to add leading, deep learning-based image analysis recognition technology into applications, with simple and powerful APIs and SDKs" <https://www.faceplusplus.com/about-us/>

¹⁸ "React Native is an open-source user interface software framework which is used to develop applications for Android, Android TV etc by allowing developers to use the React framework along with native platform capabilities" <https://reactnative.dev/>

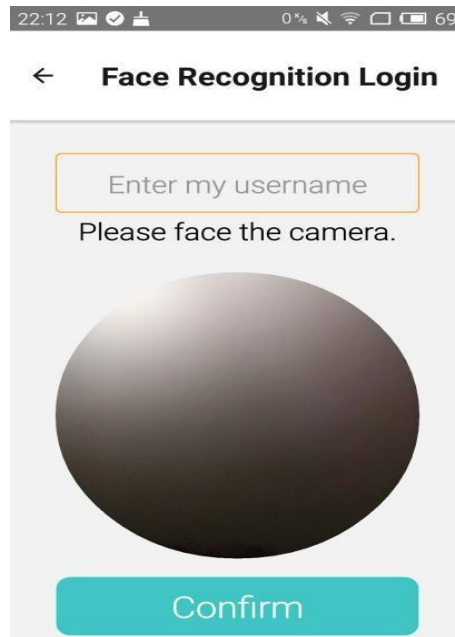


Figure 8.4: Screenshot of face recognition login in StrokeLink

With respect to usability testing, I would like to acknowledge two of the participants with stroke have expressed their readiness to be involved in the process of designing, developing, testing, refining, and testing again until the application is ready to be made widely available. While there is a lot of work to do, there is ample room for development. I am only at the beginning of this road to supporting survivors and the wider community, and I am also acknowledging that, as designers of stroke-related applications, we need to consistently be involved in augmenting our understanding of stroke and survivors' needs to design an intuitive UX interface.

8.6 Strengths and limitations of this doctoral work

There are a number of outcomes that add certainty and significance to the contributions and conclusions of this thesis. These include the following:

First, the development of a set of guidelines to help app designers was the foremost outcome of this PhD inquiry and the most significant contribution of this work. The proposed guidelines were specifically developed by considering the main themes identified from participants' input. This was made possible by the extensive collaborative interaction with participants. The guidelines were ultimately co-created

with participants who were given opportunities, through interviews, for input over three cycles of the development. This proved invaluable in constantly testing the guidelines and improving their usefulness.

Second, although the aim of this PhD inquiry was to develop guidelines, further consideration of how these guidelines might be applied in practice was also in view from the outset and receiving a proposal from participants further supported this approach. Being a research officer in the design team at altLAB also added a significant dimension to designing the prototype with good UX. I was directly able to consider how such a prototype might work in real-life settings. This inspired me to choose to include the development of an actual mobile application on my agenda for considering future work. As a result, steps were taken to initiate the development of the application as described in section 8.4 above.

Third, the literature review formed another significant contribution to this inquiry. This ultimately increased the quality of this work by examining existing studies, pinpointing knowledge gaps and constructing a robust foundation for conclusions. These outcomes further directed the development of the work and helped me in designing the inquiry at an early stage as well as supporting my own findings throughout.

Forth, the qualitative findings of this inquiry contribute to the mHealth technology acceptance literature. The qualitative focus of this inquiry produced an in-depth understanding of potential factors that influence survivors' decisions to accept mHealth applications. Certainly, this qualitative inquiry produced a range of key findings in relation to mHealth technologies acceptance that previous qualitative research has not identified. These key findings are considered in section 8.3 and are categorised as contributions made by this doctoral work.

Lastly, using the 'information power' approach to define the end-point proved to be an effective strategy for this research. My research experience informed the choice I made to apply this technique rather than a predetermined sample size. The concept of the information power approach is based on five aspects that are fully described in

section 4.3.2.3. One of the aspects is the quality of interview dialogues. Over the three cycles in this inquiry, I found the quality of the interviews' dialogues was good and the data was valuable. Therefore, the outcomes of this doctoral work are based on the richness of the information that participants provided.

This PhD inquiry must also be considered within the context of its limitations.

First, my dual role within this inquiry, as both a carer and an insider researcher, may have impacted the interpretation of the findings. While I believe that my own experience made a significant contribution to this work, it may also raise a point of concern that there is a possibility of bias towards certain findings. Being a carer informed the choice I made to position myself within the survivors' community to research the community. Therefore, it is possible that my experience may impact the way I perceived the findings; yet, I acknowledge that transparency was maintained from the beginning to the end. To facilitate this transparency, many direct quotes from participants were provided in Chapter 6 to allow readers to look into the strength of the interpretation.

Second, a limitation with respect to cycles two and three was their relatively small sample sizes. However, the small sample size is consistent with qualitative methodology where a key focus is on gaining an in-depth understanding of a given phenomenon. Aiming for diversity within the sample size from the outset allows a researcher to understand issues from different perspectives. This made me realise that including survivors' families or carers might have allowed the situation to be studied even more broadly. Therefore, further study may be necessary to expand the understanding of the phenomenon of mHealth application acceptance from further perspectives.

Third, to some extent, the outcomes are limited by the fact that the participants (survivors) were passive users of mHealth applications and from fairly a non-technology-orientated group. This group would theoretically have less knowledge of technologies than average users and, hence, further qualitatively oriented research is needed to

include active users of mHealth applications to extend the knowledge of acceptance based on their perspectives.

Forth, another limitation was the focus of this inquiry on older adult survivors, which may limit the transferability of the outcome. There is a growing population of young survivors whose needs and expectations are not well addressed in current literature. This highlights the importance of carrying out further research in the context of young survivors.

Lastly, this inquiry also reports variation in ethnicity of participants which suggests survivors' preferences and expectations may vary according to their cultural beliefs, values, and perceptions. This variation in ethnicity highlights a perception that if participants had been purposely selected from a specific culture or community, the outcomes could have been different. Further, since little attention has been given to understanding users' perceptions of culturally based design in the context of mHealth acceptance (Petrie et al., 2017), it is reasonable to suggest that further in-depth investigations should be carried out to explore survivors' perceptions of their acceptance of mHealth from different cultures/communities. I carried out this inquiry in New Zealand, in a context where there are significant disparities in outcomes following stroke for the Māori population. While Māori were not specifically targeted in this research, the sample did include some Māori perspectives. Regardless, the interview questions did not explicitly seek to explore the perspectives of Māori and the analysis did not yield findings of particular note from a Māori worldview. This is a limitation that needs to be addressed in future research exploring the use and acceptance of mHealth post-stroke. In this way, research can further augment our understanding of mHealth acceptance in the context of Māori culture.

8.7 Personal reflections

Reflecting on my experiences of this doctoral work, I regard it as a memorable journey – a research journey into the world of new technologies in the context of stroke that has changed me forever. The whole process was intriguing. In particular, I liked

listening to my participants' stories and learning about survivors' needs. I now find stroke and post-stroke requirements hold an ongoing challenge and concern.

I initiated this doctoral work through the integration of my personal experiences which led to my personal as well as professional development. First, the level of my self-confidence has considerably improved as a consequence of undertaking this inquiry. This was chiefly attained through overcoming the challenges I experienced. As a result of great efforts, which included managing my time, and thanks to the inspiration given by supervisors, family, and friends, I became more competent, overcoming my sense of timidity to undertake this work confidently. I do not hesitate to say that I will considerably benefit from this augmented level of self-confidence in the future as a researcher. Each piece of research is considered as a project and no project can be completed without strong and effective leadership. A project manager has to have a high level of self-confidence to communicate their vision to other people involved. In this way, I can express that being so engaged in this research has indirectly furthered my leadership skills as well.

Second, the contribution of this work attests to the growing level of my ability to contribute as a scholar and researcher bringing a critical mindset to theory, evidence and data. I need to acknowledge that, preceding my engagement in this work, I was prone to believe and recognise most of the perspectives expressed in books or articles as realities, reasoning that if scholars have published books, they must have profound knowledge of the topic examined within those books. However, this PhD experience has caused this perspective to change. This was a result of realising my own experience showed I could identify a range of limitations associated with some of the work I examined in the literature.

Lastly, one of the challenging and laborious requirements of this research was that of transcribing audio recordings. Here the biggest challenge was in deciding which data I would use and how to put it together in a way that was both interesting and engaging, to construct unique contributions to 'practical knowing'. By way of doing this, I undertook interviews, established my theoretical structure, and reflected on what I

had examined. This process gave me more confidence in my interpretations of the findings, to such an extent that I comprehended them in more critical ways.

The first-hand experience of this work provided me with insights and the acquisition of skills that have enabled me to fulfil my potential in my current and future roles, assisting and motivating me to work towards my career goals.

8.8 A message from the Author

Today's designers are tomorrow's best hope (Don Norman)

From climate change to cultural inequalities, today's problems might seem too big, too complex for any individual to make an impact single-handedly. However, if you are a designer – or a design-minded person – you can be a part of the solution more than you know.

I believe a designer's mindset and skillset will help to find practical and sustainable solutions to the most complex problems of our times. According to Norman and Draper (1986), the more we apply user-centred design towards modern solutions, the more successful we will be at solving and preventing such problems. Designers who are already familiar with user-centred design will naturally be in a position to lead this effort.

However, to lead positive change through user-centred design, designers need to be better trained and have more influence in their organisations. I believe that to achieve both these outcomes, we need to start with better design education – the kind that uplifts, empowers, and prepares designers to become problem-solving pioneers in their careers and communities alike.

What do you need to become a 21st-century designer? 21st-century design sounds futuristic, but it is based on user-centred design, which has existed for 80-100 years. Each and every future-minded designer can make a palpable difference towards a better world. Now it is time to stop thinking of individuals as powerless and think

instead of how they may use their designer's toolkit to design a better world. Stay tuned for the 21st century.

Designers (often unwittingly) contribute to the problems they could instead be fixing. We need to understand what we are doing wrong as designers and – more importantly – how to do better. One way to learn is through mistakes. Every successful design is the direct result of hundreds of prior attempts. When it comes to big challenges, I recommend that designers break them into smaller ones to quickly and repeatedly learn from and build on them.

For tomorrow's designers, we need to gain knowledge of:

- How as designers we can improve worldwide
- How we can employ user-centred design to resolve convoluted worldwide challenges
- What skills will be needed to make differences worldwide

Each experience will build on another to augment our understanding of user-centred design to offer the practical skills needed to make differences worldwide.

"It always seems impossible until it's done." Nelson Mandela
<https://www.goodreads.com/quotes/36606-it-always-seems-impossible-until-it-s-done>

"The challenge is to use the principles of human-centred design to produce positive results, products that enhance lives and add to our pleasure and enjoyment. The goal is to produce a great product, one that is successful, and that customers love. It can be done." Don Norman
<https://www.interaction-design.org/literature/topics/human-centered-design>

8.9 Closing statements

mHealth applications are speedily evolving as a way to deliver stroke-related interventions that can be customised for survivors. mHealth intervention elements need to be grounded in HCI designs and interactive practices that provide good UX interfaces. The literature has reported the low acceptance of mHealth applications among survivors. To find out why this is so, this doctoral work explored the use of mHealth applications among survivors over three cycles. By exploring and documenting each participant's view, I provided an in-depth understanding of the survivors' needs and expectations of mHealth applications. My findings imply that mHealth applications are of assistance if they can meet survivors' needs and expectations. In addition, my findings reveal factors that may contribute to major roles in the design and, thus, the acceptability of mHealth applications.

To return to what this doctoral work has brought to light, findings revealed that there is a significant need for mHealth solutions for survivors. Post-stroke complications reflect that survivors need support and mHealth applications have the potential to offer such support. Despite their potential, low acceptance of these technologies by survivors remains. I sought to carry out an inquiry into this problem by interacting with participants to explore their perceptions of the use of mHealth applications by survivors, seeking insight into factors that affect this low acceptance to collaboratively construct actionable knowledge – namely, a set of guidelines for mHealth application design. An analysis of interview transcripts revealed what participants believe should be integrated into the design of mHealth applications. Findings identified a range of factors that must be considered when app designers are conceptualising mHealth applications with good UX. These findings now serve as a basis for future research and the building of mHealth applications.

The research resulted in three key themes: qualities promoting acceptance of mHealth - desired applications (connectivity); post-stroke capability of survivors (capability); qualities influencing survivors' possibilities for access to mHealth

applications (accessibility) and 17 supporting categories presented in Chapter 6. These findings were fed into the development of the proposed guidelines (presented in Chapter 7) to guide app designers in designing mHealth applications with improved UX that meet survivors' needs and expectations. The underlying purpose is to encourage survivors to continuously engage with stroke-related mHealth applications and also increase their acceptance. I used the guidelines to design a prototype to test their usability in practice, which proved the proposed guidelines to be useful. Further developing the guidelines as well as monitoring feedback from their implementation can assist individuals, including myself, who seek to develop applications that support survivors.

In this chapter, I endeavoured to draw on what I found over three research cycles to make sense of the data in seeking to achieve the aims of this doctoral work. In doing this I also sought to draw readers' attention to the value of mobile-based social applications. Through integrating the main aspects of the proposed guidelines, I created the agenda for future work. The initial steps for the development of a new application have already been taken, with two of my survivor participants stating their willingness to be involved in the design process.

I hope this doctoral work, which was an exceptional experience for me, will contribute to the mHealth technology research and inform the mHealth acceptance literature through the examination of the factors for improving UX. I explored the boundary conditions of participants' insights into mHealth services from different perspectives and identified, in this context, the key factors in human decision-making. As a result, I have been led to the proposition that users' desires and preferences are a key element in designing good UX, emphasising the concept of cultural differences to increase acceptability. However, in leading to this conclusion, perhaps the main contributions of this doctoral work were: first, the documentation of all stakeholders' experiences, in particular, the survivors' experiences, to unfold the realities which exist in their worlds and hearing their unvoiced needs; and second, proposing a set of guidelines to help app designers to address survivors' needs. To the best of my

knowledge, this inquiry is among the first to explore survivors' experiences of the use of mHealth applications, mHealth acceptability among survivors and certainly the first to propose guidelines for the development of good UX stroke-related mHealth applications for survivors.

References

- Abaza, H., & Marschollek, M. (2017). mHealth application areas and technology combinations. *Methods of Information in Medicine*, 56(S1), e105-e122. <https://doi.org/10.3414/ME17-05-0003>
- Abdolrahmani, A., Storer, K. M., Roy, A. R. M., Kuber, R., & Branham, S. M. (2020). Blind leading the sighted: Drawing design insights from blind users towards more productivity-oriented voice interfaces. *ACM Transactions on Accessible Computing (TACCESS)*, 12(4), 1-35. <https://doi.org/10.1145/3368426>
- Acceptance. (2021). In *Cambridge dictionary*. Retrieved from <https://dictionary.cambridge.org/dictionary/english/acceptance>
- Adell, E. (2010, April). *Acceptance of driver support systems*. Paper presented at the European Conference on Human Centred Design for Intelligent Transport Systems, Berlin, Germany. Retrieved from https://www.researchgate.net/profile/Emeli-Adell/publication/229049067_Acceptance_of_driver_support_systems/links/547ec0310cf2de80e7cc5d9a/Acceptance-of-driver-support-systems.pdf
- Adelman, C. (1993). Kurt Lewin and the origins of action research. *Educational Action Research*, 1(1), 7-24. <https://doi.org/10.1080/0965079930010102>
- Aho, K., Harmsen, P., Hatano, S., Marquardsen, J., Smirnov, V. E., & Strasser, T. (1980). Cerebrovascular disease in the community: Results of a WHO collaborative study. *Bulletin of the World Health Organization*, 58(1), 113-130. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2395897/>
- Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, 50(2), 179-211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Al Ayubi, S. U., Parmanto, B., Branch, R., & Ding, D. (2014). A persuasive and social mHealth application for physical activity: A usability and feasibility study. *mHealth and uHealth*, 2(2), 1-27. <https://doi.org/10.2196/mhealth.2902>
- Alam, M. Z., Hu, W., Kaium, M. A., Hoque, M. R., & Alam, M. M. D. (2020). Understanding the determinants of mHealth apps adoption in Bangladesh: A SEM-Neural network approach. *Technology in Society*, 61, 1-18. <https://doi.org/10.1016/j.techsoc.2020.101255>
- Aldekhyyel, R. N., Almulhem, J. A., & Binkheder, S. (2021). Usability of telemedicine mobile applications during COVID-19 in Saudi Arabia: A heuristic evaluation of

patient user interfaces *MDPI*. Symposium conducted at the meeting of the Healthcare <https://doi.org/10.3390/healthcare9111574>

- Aljaroodi, H. M., Adam, M. T., Chiong, R., Cornforth, D. J., & Minichiello, M. (2017). Empathic avatars in stroke rehabilitation: A co-designed mHealth artifact for stroke survivors. In A. Maedche, J. vom Brocke, & A. Hevner (Eds.), *Designing the digital transformation: 12th International Conference, DESRIST 2017 Karlsruhe, Germany, May 30 – June 1, 2017 proceedings* (pp. 73-89). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-59144-5_5
- Allen, M., McGrenere, J., & Purves, B. (2008). The field evaluation of a mobile digital image communication application designed for people with aphasia. *ACM Transactions on Accessible Computing (TACCESS)*, 1(1), 5. <https://doi.org/10.1145/1361203.1361208>
- Almakky, H., Sahandi, R., & Taylor, J. (2015). The effect of culture on user interface design of social media - A case study on preferences of Saudi Arabians on the Arabic user interface of Facebook. *World Academy of Science, Engineering and Technology International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 9(1), 107-111. Retrieved from <http://eprints.bournemouth.ac.uk/23776/>
- Alsswey, A., & Al-Samarraie, H. (2020). Elderly users' acceptance of mHealth user interface (UI) design-based culture: The moderator role of age. *Journal on Multimodal User Interfaces*, 14(1), 49-59. <https://doi.org/10.1007/s12193-019-00307-w>
- Alsswey, A., Al-Samarraie, H., El-Qirem, F. A., Alzahrani, A. I., & Alfarraj, O. (2020). Culture in the design of mHealth UI. *The Electronic Library*. <https://doi.org/10.1108/EL-04-2019-0097>
- Alsswey, A., Umar, I., & Al-Samarraie, H. (2018). Towards mobile design guidelines-based cultural values for elderly Arabic users. *Journal of Fundamental and Applied Sciences*, 10(2S), 964-977.
- Alsswey, A., Umar, I., & Bervell, B. (2018). Investigating the acceptance of mobile health application user interface cultural-based design to assist Arab elderly users. *International Journal of Advanced Computer Science and Applications*, 9(8), 144-152.
- American Heritage. (1993). *American heritage college dictionary*. Retrieved from <https://www.amazon.com/American-Heritage-College-Dictionary/dp/0395671612>
- Andrade, F., Nascimento, L., Wood, G., & Calil, S. (2015). Applying heuristic evaluation on medical devices user manuals *Springer*. Symposium conducted at the meeting

of the World Congress on Medical Physics and Biomedical Engineering, June 7-12, 2015, Toronto, Canada

- Android Central. (2019). *What is Google TalkBack?* Retrieved from <https://www.androidcentral.com/what-google-talk-back>
- Argyris, C. (1993). *Knowledge for action*. San Francisco, CA: Jossey-Bass.
- Attride-Stirling, J. (2001). Thematic networks: An analytic tool for qualitative research. *Qualitative Research*, 1(3), 385-405. <https://doi.org/10.1177/146879410100100307>
- Babich, N. (2020). *11 ways to add more visual weight to UI object*. Retrieved from <https://uxplanet.org/11-ways-to-add-more-visual-weight-to-ui-object-6aca19c7bc97>
- Bajwa, M. (2014). mHealth security. *Pakistan Journal of Medical Sciences*, 30(4), 904-907. <https://doi.org/10.12669/pjms.304.5210>
- Ballard, K. J., Etter, N. M., Shen, S., Monroe, P., & Tien Tan, C. (2019). Feasibility of Automatic Speech Recognition for Providing Feedback During Tablet-Based Treatment for Apraxia of Speech Plus Aphasia. *American Journal of Speech-Language Pathology*, 28(2S), 818-834.
- Ballester, R. B., Maier, M., Duff, A., Cameirao, M., Bermudez, S., Duarte, E., . . . Verschure, P. F. (2019). A critical time window for recovery extends beyond one-year post-stroke. *Journal of Neurophysiology*, 122, 350-357. <https://doi.org/10.1152/jn.00762.2018>
- Ballinger, C. (2004). Writing up rigour: Representing and evaluating good scholarship in qualitative research. *British Journal of Occupational Therapy*, 67(12), 540-546. <https://doi.org/10.1177/030802260406701204>
- Bamford, J., Sandercock, P., Dennis, M., Warlow, C., & Burn, J. (1991). Classification and natural history of clinically identifiable subtypes of cerebral infarction. *The Lancet*, 337(8756), 1521-1526. [https://doi.org/10.1016/0140-6736\(91\)93206-O](https://doi.org/10.1016/0140-6736(91)93206-O)
- Barber, P. A., Krishnamurthi, R., Parag, V., Anderson, N. E., Ranta, A., Kilfoyle, D., . . . Bennett, D. A. (2016). Incidence of transient ischemic attack in Auckland, New Zealand, in 2011 to 2012. *Stroke*, 47(9), 2183-2188. <https://doi.org/10.1161/STROKEAHA.116.014010>
- Barlow, J., Wright, C., Sheasby, J., Turner, A., & Hainsworth, J. (2002). Self-management approaches for people with chronic conditions: A review. *Patient Education and Counseling*, 48(2), 177-187. [https://doi.org/10.1016/s0738-3991\(02\)00032-0](https://doi.org/10.1016/s0738-3991(02)00032-0)

- Barnard, Y., Bradley, M. D., Hodgson, F., & Lloyd, A. D. (2013). Learning to use new technologies by older adults: Perceived difficulties, experimentation behaviour and usability. *Computers in Human Behavior*, 29(4), 1715-1724. <https://doi.org/10.1016/j.chb.2013.02.006>
- Basak, S., Agrawal, H., Jena, S., Gite, S., Bachute, M., Pradhan, B., & Assiri, M. (2023). Challenges and Limitations in Speech Recognition Technology: A Critical Review of Speech Signal Processing Algorithms, Tools and Systems. *CMES-Computer Modeling in Engineering & Sciences*, 135(2). <https://doi.org/10.32604/cmcs.2022.021755>
- Bauerly, M., & Liu, Y. (2006). Computational modeling and experimental investigation of effects of compositional elements on interface and design aesthetics. *International Journal of Human-Computer Studies*, 64(8), 670-682. <https://doi.org/10.1016/j.ijhcs.2006.01.002>
- Baum, F., MacDougall, C., & Smith, D. (2006). Participatory action research. *Journal of Epidemiology & Community Health*, 60(10), 854-857. <https://doi.org/10.1136/jech.2004.028662>
- Benaida, M. (2014). *Developing Arabic usability guidelines for e-learning websites in higher education* (Doctoral thesis, University of Salford, Manchester, UK). Retrieved from <http://usir.salford.ac.uk/id/eprint/31988/>
- Benyon, D. (2019). *Designing user experience: A guide to HCI, UX and interaction design* (4th ed.). Harlow, UK: Pearson Education.
- Berg, S. (2004). Snowball sampling. In S. Kotz & N. L. Johnson (Eds.), *Encyclopedia of statistical sciences* (Vol. 8). <https://doi.org/10.1002/0471667196.ess2478.pub2>
- Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. New York, NY: Doubleday.
- Bernhardt, J., Hayward, K. S., Kwakkel, G., Ward, N. S., Wolf, S. L., Borschmann, K., . . . Corbett, D. (2017). Agreed definitions and a shared vision for new standards in stroke recovery research: The stroke recovery and rehabilitation roundtable taskforce. *International Journal of Stroke*, 12(5), 444-450. <https://doi.org/10.1177/1747493017711816>
- Bhattacharjee, M., Vairale, J., Gawali, K., & Dalal, P. M. (2012). Factors affecting burden on caregivers of stroke survivors: Population-based study in Mumbai (India). *Annals of Indian Academy of Neurology*, 15(2), 113-119. <https://doi.org/10.4103/0972-2327.94994>
- Bhattacharjya, S., Stafford, M. C., Cavuoto, L. A., Yang, Z., Song, C., Subryan, H., . . . Langan, J. (2019). Harnessing smartphone technology and three dimensional printing to create a mobile rehabilitation system, mRehab: assessment of

- usability and consistency in measurement. *Journal of Neuroengineering and Rehabilitation*, 16(1), 1-13. <https://doi.org/10.1186/s12984-019-0592-y>
- Biduski, D., Bellei, E. A., Rodriguez, J. P. M., Zaina, L. A. M., & De Marchi, A. C. B. (2020). Assessing long-term user experience on a mobile health application through an in-app embedded conversation-based questionnaire. *Computers in Human Behavior*, 104, 106169. <https://doi.org/10.1016/j.chb.2019.106169>
- Bitrián, P., Buil, I., & Catalán, S. (2020). Gamification in sport apps: the determinants of users' motivation. *European Journal of Management and Business Economics*, 29(3), 365-381. <https://doi.org/10.1108/EJMBE-09-2019-0163>
- Bixter, M. T., Blocker, K. A., Mitzner, T. L., Prakash, A., & Rogers, W. A. (2019). Understanding the use and non-use of social communication technologies by older adults: A qualitative test and extension of the UTAUT model. *Gerontechnology*, 18(2), 70-88. <https://doi.org/10.4017/gt.2019.18.2.002.00>
- Bjorkman, H., & Sundgren, M. (2005). Political entrepreneurship in action research: Learning from two cases. *Journal of Organizational Change Management*, 18(5), 399-415. <https://doi.org/10.1108/09534810510614913>
- Blackley, S. V., Schubert, V. D., Goss, F. R., Al Assad, W., Garabedian, P. M., & Zhou, L. (2020). Physician use of speech recognition versus typing in clinical documentation: a controlled observational study. *International Journal of Medical Informatics*, 141, 104178. <https://doi.org/10.1016/j.ijmedinf.2020.104178>
- Blaikie, N. (1993). *Approaches to social enquiry*. Cambridge, UK: Polity.
- Blume, A., & Board, O. (2013). Language barriers. *Econometrica*, 81(2), 781-812. <https://doi.org/10.3982/ECTA9183>
- Blumer, H. (1986). *Symbolic interactionism: Perspective and method*. Berkeley, CA: University of California Press.
- Bogardus, E. S. (1926). The group interview. *Journal of Applied Sociology*, 10(4), 372-382. Retrieved from <https://www.sid.ir/en/Journal/ViewPaper.aspx?ID=249914>
- Boger, E. J., Demain, S., & Latter, S. (2013). Self-management: A systematic review of outcome measures adopted in self-management interventions for stroke. *Disability and Rehabilitation*, 35(17), 1415-1428. <https://doi.org/10.3109/09638288.2012.737080>
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. London, UK: Sage Publications.

- Brandenburg, C., Worrall, L., Copland, D., & Rodriguez, A. (2017). Barriers and facilitators to using the CommFit™ smartphone app to measure talk time for people with aphasia. *Aphasiology*, 31(8), 901-927. <https://doi.org/10.1080/02687038.2016.1219016>
- Brandenburg, C., Worrall, L., Rodriguez, A., & Copland, D. (2013). Mobile computing technology and aphasia: An integrated review of accessibility and potential uses. *Aphasiology*, 27(4), 444-461. <https://doi.org/10.1080/02687038.2013.772293>
- Bratzke, L. C., Muehrer, R. J., Kehl, K. A., Lee, K. S., Ward, E. C., & Kwekkeboom, K. L. (2015). Self-management priority setting and decision-making in adults with multimorbidity: A narrative review of literature. *International Journal of Nursing Studies*, 52(3), 744-755. <https://doi.org/10.1016/j.ijnurstu.2014.10.010>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Braun, V., & Clarke, V. (2012). Thematic analysis. In H. E. Cooper, P. M. Camic, D. L. Long, A. Panter, D. E. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, research designs* (Vol. 2, pp. 57-71). Washington: American Psychological Association.
- Braun, V., & Clarke, V. (2019a). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589-597. <https://doi.org/10.1080/2159676X.2019.1628806>
- Braun, V., & Clarke, V. (2019b). Thematic analysis. In P. Liamputtong (Ed.), *Handbook of research methods in health social sciences* (pp. 843-860). <https://doi.org/10.1007/978-981-10-5251-4>
- Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328-352. <https://doi.org/10.1080/14780887.2020.1769238>
- Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health*, 13(2), 201-216. <https://doi.org/10.1080/2159676X.2019.1704846>
- Braun, V., Clarke, V., & Weate, P. (2016). Using thematic analysis in sport and exercise research. In B. Smith & A. C. Sparkes (Eds.), *Routledge handbook of qualitative research in sport and exercise* (pp. 191-205). London, UK: Routledge. <https://doi.org/10.4324/9781315762012>
- Brew-Sam, N., & Chib, A. (2020). Theoretical advances in mobile health communication research: An empowerment approach to self-management. In J. Kim & H. Song

(Eds.), *Technology and health* (pp. 151-177). <https://doi.org/10.1016/B978-0-12-816958-2.00008-3>

- Brewer, L., Horgan, F., Hickey, A., & Williams, D. (2013). Stroke rehabilitation: Recent advances and future therapies. *QJM: An International Journal of Medicine*, 106(1), 11-25. <https://doi.org/10.1093/qjmed/hcs174>
- Bringhurst, R. (2004). *The elements of typographic style*. Vancouver, Canada: Hartley & Marks Vancouver.
- Brookfield, K., & Mead, G. (2016). Physical environments and community reintegration post stroke: Qualitative insights from stroke clubs. *Disability & Society*, 31(8), 1013-1029. <https://doi.org/10.1080/09687599.2016.1223606>
- Brydon-Miller, M., Rector Aranda, A., & Stevens, D. M. (2015). *Widening the circle: Ethical reflection in action research and the practice of structured ethical reflection*. London, UK: Sage Publications.
- Bryman, A. (2015). *Social research methods*. Oxford, UK: Oxford University Press.
- Burnes, B., & Cooke, B. (2013). Kurt Lewin's field theory: A review and re-evaluation. *International Journal of Management Reviews*, 15(4), 408-425. <https://doi.org/10.1111/j.1468-2370.2012.00348.x>
- Burns, S., Terblanche, M., Perea, J., Lillard, H., DeLaPena, C., Grinage, N., . . . Cox, E. (2021). mHealth intervention applications for adults living with the effects of stroke: A scoping review. *Archives of Rehabilitation Research and Clinical Translation*, 3(1), 1-22. <https://doi.org/10.1016/j.arrct.2020.100095>
- Cairns, P. E., & Cox, A. L. (2008). *Research methods for human-computer interaction*. Cambridge, UK: Cambridge University Press.
- Caldeira, C., Costa Figueiredo, M., Dodakian, L., de Souza, C. R., Cramer, S. C., & Chen, Y. (2021). Towards supporting data-driven practices in stroke telerehabilitation technology. *Proceedings of the ACM on Human-Computer Interaction*, 5(CSCW1), 1-33. <https://doi.org/10.1145/3449099>
- Cameirao, M. S., Faria, A. L., Paulino, T., Alves, J., & Bermúdez i Badia, S. (2016). The impact of positive, negative and neutral stimuli in a virtual reality cognitive-motor rehabilitation task: A pilot study with stroke patients. *Journal of Neuroengineering and Rehabilitation*, 13(70), 1-15. <https://doi.org/10.1186/s12984-016-0175-0>
- Cao, J., Lim, Y., Sengoku, S., Guo, X., & Kodama, K. (2021). Exploring the shift in international trends in mobile health research from 2000 to 2020: Bibliometric analysis. *JMIR mHealth and uHealth*, 9(9), e31097. <https://doi.org/10.2196/31097>

- Carr, W., & Kemmis, S. (1983). *Becoming critical: Knowing through action research*. Geelong, Australia: Deakin University Press.
- Cayne, J., & Loewenthal, D. (2018). Exploring the unknown in psychotherapy through phenomenological research. In D. Loewenthal & D. Winter (Eds.), *What is psychotherapeutic research?* (pp. 117-132). London, UK: Routledge.
- Cechetti, N. P., Bellei, E. A., Biduski, D., Rodriguez, J. P. M., Roman, M. K., & De Marchi, A. C. B. (2019). Developing and implementing a gamification method to improve user engagement: A case study with an m-Health application for hypertension monitoring. *Telematics and Informatics*, 41, 126-138. <https://doi.org/10.1016/j.tele.2019.04.007>
- Chang, H., Zhao, J., Qiao, Y., Yao, H., Wang, X., Li, J., & Liu, J. (2018). Mobile phone application for self-assessment of acute stroke patients: A tool for extended care and follow-up. *Medicine*, 97(26). <https://doi.org/10.1097/MD.00000000000011263>
- Changizi, M., & Kaveh, M. (2017). Effectiveness of the mHealth technology in improvement of healthy behaviors in an elderly population: A systematic review. *Mhealth*, 3(11), 1-9. <https://doi.org/10.21037/mhealth.2017.08.06>
- Charlier, N., Ott, M., Remmele, B., & Whitton, N. (2012, October). *Not just for children: Game-based learning for older adults*. Paper presented at the 6th European Conference on Games Based Learning, Cork, Ireland.
- Chatzoudis, G., Plitsis, M., Stamouli, S., Dimou, A.-L., Katsamanis, A., & Katsouros, V. (2022). Zero-Shot Cross-lingual Aphasia Detection using Automatic Speech Recognition. *arXiv preprint arXiv:2204.00448*.
- Chau, J. P., Lo, S. H., Zhao, J., Choi, K. C., Lam, S. K., Butt, L., & Thompson, D. R. (2021). Factors associated with post-stroke depression in Chinese stroke survivors. *Journal of Stroke and Cerebrovascular Diseases*, 30(11), 106076. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.106076>
- Chib, A., van Velthoven, M. H., & Car, J. (2015). mHealth adoption in low-resource environments: A review of the use of mobile healthcare in developing countries. *Journal of Health Communication*, 20(1), 4-34. <https://doi.org/10.1080/10810730.2013.864735>
- Chimatiro, G. L., & Rhoda, A. J. (2019). Scoping review of acute stroke care management and rehabilitation in low and middle-income countries. *BMC Health Services Research*, 19(789). <https://doi.org/10.1186/s12913-019-4654-4>
- Chin, J. N., Li, S., Lau, S. C., & Wong, A. (2021). Self-monitoring for stroke survivors using mobile health technology: Qualitative study of user experiences. *The American*

- Chinn, P., & Jacobs, M. (1987). *Theory and nursing: A systematic approach* (2nd ed.). St. Louis, MO: Mosby.
- Chiu, C.-J., Yu, Y.-C., Du, Y.-F., Yang, Y.-C., Chen, J.-Y., Wong, L.-P., & Tanasugarn, C. (2020). Comparing a social and communication app, telephone intervention, and usual care for diabetes self-management: 3-Arm quasiexperimental evaluation study. *mHealth and uHealth*, 8(6), e14024. <https://doi.org/10.2196/14024>
- Cho, W., Heilinger, A., Xu, R., Zehetner, M., Schobesberger, S., Murovec, N., . . . Guger, C. (2017). Hemiparetic stroke rehabilitation using avatar and electrical stimulation based on non-invasive brain computer interface. *International Journal of Physical Medicine Rehabilitation*, 5(411), 2-5. <https://doi.org/10.4172/2329-9096.1000411>
- Chun, H.-Y. Y., Carson, A. J., Tsanas, A., Dennis, M. S., Mead, G. E., Calabria, C., & Whiteley, W. N. (2020). Telemedicine cognitive behavioral therapy for anxiety after stroke: proof-of-concept randomized controlled trial. *Stroke*, 51(8), 2297-2306. <https://doi.org/10.1161/STROKEAHA.120.029042>
- Chung, A. E., Skinner, A. C., Hasty, S. E., & Perrin, E. M. (2017). Tweeting to health: A novel mHealth intervention using Fitbits and Twitter to foster healthy lifestyles. *Clinical Pediatrics*, 56(1), 26-32. <https://doi.org/10.1177/0009922816653385>
- Clark, J. S., Porath, S., Thiele, J., & Jobe, M. (2020). *Action research*. Manhattan, KS: New Prairie Press, Kansas State University Libraries.
- Clark, N. M., Becker, M. H., Janz, N. K., Lorig, K., Rakowski, W., & Anderson, L. (1991). Self-management of chronic disease by older adults: A review and questions for research. *Journal of Aging and Health*, 3(1), 3-27. <https://doi.org/10.1177/089826439100300101>
- Coghlan, D. (2007a). Insider action research doctorates: Generating actionable knowledge. *Higher Education*, 54(2), 293-306. <https://doi.org/10.1007/s10734-005-5450-0>
- Coghlan, D. (2007b). Insider action research: Opportunities and challenges. *Management Research News*, 30(5), 335-343. <https://doi.org/10.1108/01409170710746337>
- Coghlan, D. (2016). Retrieving a philosophy of practical knowing for action research. *International Journal of Action Research*, 12(1), 84-107. <https://doi.org/10.1688/IJAR-2016-01-Coghlan>

- Coghlan, D., & Brannick, T. (2014). *Doing action research in your own organization* (4th ed.). London, UK: Sage Publications.
- Coghlan, D., & Shani, A. B. (2005). Roles, politics, and ethics in action research design. *Systemic Practice and Action Research*, 18(6), 533-546. <https://doi.org/10.1007/s11213-005-9465-3>
- Coghlan, D., & Shani, A. B. (2014). Creating action research quality in organization development: Rigorous, reflective and relevant. *Systemic Practice and Action Research*, 27(6), 523-536. <https://doi.org/10.1007/s11213-013-9311-y>
- Cohen, A., & Alroi, N. (1981). Diagnostic action research as an instrument in teacher education. *British Journal of Teacher Education*, 7(2), 176-186. <https://doi.org/10.1080/0260747810070206>
- Coleman, G. (2015). Core issues in modern epistemology for action researchers: Dancing between knower and known. In H. Bradbury (Ed.), *The SAGE handbook of action research* (pp. 392-400). London, UK: Sage Publications.
- Connelly, L. M. (2016). Trustworthiness in qualitative research. *Medsurg Nursing*, 25(6), 435-437. Retrieved from <https://www.proquest.com/openview/44ffecf38cc6b67451f32f6f96a40c78/1/advanced>
- Cook, V. E., Ellis, A. K., & Hildebrand, K. J. (2016). Mobile health applications in clinical practice: pearls, pitfalls, and key considerations. *Annals of Allergy, Asthma & Immunology*, 117(2), 143-149. <https://doi.org/10.1016/j.anai.2016.01.012>
- Cooray, C., Matusевичius, M., Wahlgren, N., & Ahmed, N. (2015). Mobile phone-based questionnaire for assessing 3 months modified ranking score after acute stroke: A pilot study. *Circulation: Cardiovascular Quality and Outcomes*, 8(6_suppl_3), S125-S130. <https://doi.org/10.1161/CIRCOUTCOMES.115.002055>
- Cornet, V. P., Toscos, T., Bolchini, D., Ghahari, R. R., Ahmed, R., Daley, C., . . . Holden, R. J. (2020). Untold stories in user-centered design of mobile health: Practical challenges and strategies learned from the design and evaluation of an app for older adults with heart failure. *mHealth and uHealth*, 8(7), e17703. <https://doi.org/10.2196/17703>
- Coster, S., & Norman, I. (2009). Cochrane reviews of educational and self-management interventions to guide nursing practice: A review. *International Journal of Nursing Studies*, 46(4), 508-528. <https://doi.org/10.1016/j.ijnurstu.2008.09.009>
- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage Publications.

- Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.
- Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London, UK: Sage Publications.
- Das, J., Graham, L., Morris, R., Barry, G., Godfrey, A., Walker, R., & Stuart, S. (2022). Eye Movement in Neurological Disorders. *Eye Tracking: Background, Methods, and Applications*, 185-205.
- Davis, C. (2008). Critical action research. In L. M. Given (Ed.), *The SAGE encyclopedia of qualitative research methods* (pp. 139-142). Thousand Oaks, CA: Sage Publications.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340. <https://doi.org/10.2307/249008>
- De Ryck, A., Brouns, R., Geurden, M., Elseviers, M., De Deyn, P. P., & Engelborghs, S. (2014). Risk factors for poststroke depression: Identification of inconsistencies based on a systematic review. *Journal of Geriatric Psychiatry and Neurology*, 27(3), 147-158. <https://doi.org/10.1177/0891988714527514>
- De Wit, L., Theuns, P., Dejaeger, E., Devos, S., Gantenbein, A. R., Kerckhofs, E., . . . Putman, K. (2017). Long-term impact of stroke on patients' health-related quality of life. *Disability and Rehabilitation*, 39(14), 1435-1440. <https://doi.org/10.1080/09638288.2016.1200676>
- DeBronkart, D., & Sands, D. (2013). *Let patients help*. New Hampshire: Smash Words.
- Demain, S., Burridge, J., Ellis-Hill, C., Hughes, A.-M., Yardley, L., Tedesco-Triccas, L., & Swain, I. (2013). Assistive technologies after stroke: Self-management or fending for yourself? A focus group study. *BMC Health Services Research*, 13(334). <https://doi.org/10.1186/1472-6963/13/334>
- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning future media environments* (pp. 9-15). <https://doi.org/10.1145/2181037.2181040>
- Devlin, S. L. (2007). Investigating the effect of language and culture on student interaction with and in WebCT. *Innovation in Teaching and Learning in Information and Computer Sciences*, 6(2), 22-30. <https://doi.org/10.11120/ital.2007.06020022>
- Dewey, J. (1910). *How we think*. Lexington, MA: D C Health Press.

- Dewey, J. (1922). *Human nature and conduct*. New York, NY: Henry Holt and Company Press.
- Dhou, K. (2019). An innovative design of a hybrid chain coding algorithm for bi-level image compression using an agent-based modeling approach. *Applied Soft Computing*, 79, 94-110. <https://doi.org/10.1016/j.asoc.2019.03.024>
- Dixit, A., Sethi, P., Garg, P., & Pruthi, J. (2022). Speech Difficulties and Clarification: A Systematic Review/IEEE. Symposium conducted at the meeting of the 2022 11th International Conference on System Modeling & Advancement in Research Trends (SMART) <https://doi.org/10.1109/SMART55829.2022.10047048>
- Docker. (2019). *Home page*. Retrieved from <https://www.docker.com/>
- Dossa, A., Glickman, M. E., & Berlowitz, D. (2011). Association between mental health conditions and rehospitalization, mortality, and functional outcomes in patients with stroke following inpatient rehabilitation. *BMC Health Services Research*, 11(1), 311. <https://doi.org/http://www.biomedcentral.com/1472-6963/11/311>
- Dworzynski, K., Ritchie, G., & Playford, E. D. (2015). Stroke rehabilitation: Long-term rehabilitation after stroke. *Clinical Medicine*, 15(5), 461-464. <https://doi.org/10.7861/clinmedicine.15-5-461>
- Eekels, J., & Roozenburg, N. F. (1991). A methodological comparison of the structures of scientific research and engineering design: Their similarities and differences. *Design Studies*, 12(4), 197-203. [https://doi.org/10.1016/0142-694X\(91\)90031-Q](https://doi.org/10.1016/0142-694X(91)90031-Q)
- Eliot, T. S. (1942). *Little Gidding*. London, UK: Faber and Faber.
- Ellis, C., Phillips, R., Hill, T., & Briley, P. M. (2019). Social network structure in young stroke survivors with aphasia: A case series report *Thieme Medical Publishers*. Symposium conducted at the meeting of the Seminars in speech and language <https://doi.org/10.1055/s-0039-1688695>
- Epalte, K., Tomsone, S., Vētra, A., & Bērziņa, G. (2020). Patient experience using digital therapy “Vigo” for stroke patient recovery: A qualitative descriptive study. *Disability and Rehabilitation: Assistive Technology*. Advance online publication. <https://doi.org/10.1080/17483107.2020.1839794>
- Eslami Jahromi, M., Farokhzadian, J., & Ahmadian, L. (2021). Two-sided perspective on tele-speech therapy: Experiences of stuttering patients, and their parents. *Assistive Technology*. Advance online publication. <https://doi.org/10.1080/10400435.2021.1937378>
- Farage, M. A., Miller, K. W., Ajayi, F., & Hutchins, D. (2012). Design principles to accommodate older adults. *Global Journal of Health Science*, 4(2), 2-25. <https://doi.org/10.5539/gjhs.v4n2p2>

- Feigin, V. L., Abajobir, A., Abate, K. H., Abd-Allah, F., Abdulle, A. M., Abera, S. F., . . . Aichour, I. (2017). Global, regional, and national burden of neurological disorders during 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015. *The Lancet Neurology*, *16*(11), 877-897. [https://doi.org/10.1016/S1474-4422\(17\)30299-5](https://doi.org/10.1016/S1474-4422(17)30299-5)
- Feigin, V. L., Barker-Collo, S., Parag, V., Senior, H., Lawes, C. M. M., Ratnasabapathy, Y., . . . For the ASTRO Study Group. (2010). Auckland stroke outcomes study: Part 1: Gender, stroke types, ethnicity, and functional outcomes 5 years poststroke. *Neurology*, *75*(18), 1597-1607. <https://doi.org/10.1212/WNL.0b013e3181fb44b3>
- Feigin, V. L., Krishnamurthi, R., Parmar, P., Norrving, B., Mensah, G., Bennett, D., . . . Truelsen, T. (2015). Update on the global burden of ischemic and hemorrhagic stroke in 1990-2013: The GBD 2013 study. *Neuroepidemiology*, *45*(3), 161-176. <https://doi.org/10.1159/000441085>
- Feigin, V. L., & Vos, T. (2019). Global burden of neurological disorders: From global burden of disease estimates to actions. *Neuroepidemiology*, *52*(1-2), 1-2. <https://doi.org/10.1159/000495197>
- Ferreira, C., Guimaraes, V., Santos, A., & Sousa, I. (2014). Gamification of stroke rehabilitation exercises using a smartphone. In *Proceedings of the 8th International Conference on Pervasive Computing Technologies for Healthcare* (pp. 282-285). <https://doi.org/10.4108/icst.pervasivehealth.2014.255326>
- Fischer, A. J., Dart, E. H., Leblanc, H., Hartman, K. L., Steeves, R. O., & Gresham, F. M. (2016). An investigation of the acceptability of videoconferencing within a school-based behavioral consultation framework. *Psychology in the Schools*, *53*(3), 240-252. <https://doi.org/10.1002/pits.21900>
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Fisk, A. D., Czaja, S. J., Rogers, W. A., Charness, N., & Sharit, J. (2020). *Designing for older adults: Principles and creative human factors approaches* (2nd ed.). Boca Raton, FL: CRC Press.
- Fletcher, J., & Jensen, R. (2015). Overcoming barriers to mobile health technology use in the aging population. *On-Line Journal of Nursing Informatics*, *19*(3), 1-8. Retrieved from <https://www.proquest.com/docview/1770029775?accountid=8440>
- Forsgren, N., Durcikova, A., Clay, P. F., & Wang, X. (2016). The integrated user satisfaction model: Assessing information quality and system quality as second-order constructs in system administration. *Communications of the Association*

for *Information Systems*, 38, 803-839. Retrieved from <http://researchrepository.murdoch.edu.au/id/eprint/31195>

- Fosslien, L., Duffy, M. W., & COVID, A. (2020). 10 Digital Miscommunications—and How to Avoid Them.
- Fraser, M., & Fraser, A. (2001). Are people with learning disabilities able to contribute to focus groups on health promotion? *Journal of Advanced Nursing*, 33(2), 225-233. <https://doi.org/10.1111/j.1365-2648.2001.01657.x>
- Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., . . . Haines, A. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. *PLoS Medicine*, 10(1), 1-45. <https://doi.org/10.1371/journal.pmed.1001362>
- Frith, H., & Gleeson, K. (2004). Clothing and embodiment: Men managing body image and appearance. *Psychology of Men & Masculinity*, 5(1), 40-48. <https://doi.org/10.1037/1524-9220.5.1.40>
- Fryer, C. E., Luker, J. A., McDonnell, M. N., & Hillier, S. L. (2016). Self management programmes for quality of life in people with stroke. *The Cochrane Library*, 2016(8), CD010442. <https://doi.org/10.1002/14651858.CD010442.pub2>
- Garcia, M. B. (2019). A speech therapy game application for aphasia patient neurorehabilitation—a pilot study of an mHealth app. *International Journal of Simulation: Systems, Science & Technology*. <https://doi.org/10.5013/IJSSST.a.20.S2.05>
- Garett, R., & Young, S. D. (2019). Health care gamification: A study of game mechanics and elements. *Technology, Knowledge and Learning*, 24(3), 341-353. <https://doi.org/10.1007/s10758-018-9353-4>
- Gharaibeh, M. K., Gharaibeh, N. K., & De Villiers, M. V. (2020). A qualitative method to explain acceptance of mobile health application: Using innovation diffusion theory. *International Journal of Advanced Science and Technology*, 29(4), 3426-3432. Retrieved from <http://sersc.org/journals/index.php/IJAST/article/view/24430>
- Giaquinto, S., Spiridigliozzi, C., & Caracciolo, B. (2007). Can faith protect from emotional distress after stroke? *Stroke*, 38(3), 993-997. <https://doi.org/10.1161/01.STR.0000257996.26950.59>
- Grau-Pellicer, M., Lalanza, J., Jovell-Fernández, E., & Capdevila, L. (2020). Impact of mHealth technology on adherence to healthy PA after stroke: A randomized study. *Topics in Stroke Rehabilitation*, 27(5), 354-368. <https://doi.org/10.1080/10749357.2019.1691816>

- Greenwood, N., Mackenzie, A., Cloud, G. C., & Wilson, N. (2009). Informal primary carers of stroke survivors living at home—challenges, satisfactions and coping: A systematic review of qualitative studies. *Disability and Rehabilitation*, 31(5), 337-351. <https://doi.org/10.1080/09638280802051721>
- Gunawardena, N., Ginige, J. A., & Javadi, B. (2022). Eye-tracking technologies in mobile devices Using edge computing: a systematic review. *ACM Computing Surveys*, 55(8), 1-33. <https://doi.org/10.1145/3546938>
- Habermas, J., & McCarthy, T. (1984). *The theory of communicative action - Reason and the rationalization of society* (Vol. 1). Boston, MA: Beacon Press.
- Hackett, M. L., Yapa, C., Parag, V., & Anderson, C. S. (2005). Frequency of depression after stroke: A systematic review of observational studies. *Stroke*, 36(6), 1330-1340. <https://doi.org/10.1161/01.STR.0000165928.19135.35>
- Hale, L., Jones, F., Mulligan, H., Levack, W., Smith, C., Claydon, L., . . . MacKenzie, N. (2014). Developing the Bridges self-management programme for New Zealand stroke survivors: A case study. *International Journal of Therapy and Rehabilitation*, 21(8), 381-388. <https://doi.org/10.12968/ijtr.2014.21.8.381>
- Haley, W. E., Roth, D. L., Hovater, M., & Clay, O. J. (2015). Long-term impact of stroke on family caregiver well-being: A population-based case-control study. *Neurology*, 84(13), 1323-1329. <https://doi.org/10.1212/WNL.000000001418>
- Hamine, S., Gerth-Guyette, E., Faulx, D., Green, B. B., & Ginsburg, A. S. (2015). Impact of mHealth chronic disease management on treatment adherence and patient outcomes: A systematic review. *Journal of Medical Internet Research*, 17(2), 1-15. <https://doi.org/10.2196/jmir.3951>
- Hamm, J., Money, A., & Atwal, A. (2017). Fall prevention self-assessments via mobile 3D visualization technologies: Community dwelling older adults' perceptions of opportunities and challenges. *Human Factors*, 4(2), 1-22. <https://doi.org/10.2196/humanfactors.7161>
- Hassenzahl, M. (2003). The thing and I: Understanding the relationship between user and product. In M. A. Blythe, K. Overbeeke, A. F. Monk, & P. C. Wright (Eds.), *Funology. From usability to enjoyment* (pp. 31-42). Dordrecht, The Netherlands: Springer. https://doi.org/10.1007/1-4020-2967-5_4
- Health Information Privacy Code.
- Herr, K., & Anderson, G. L. (2015). *The action research dissertation: A guide for students and faculty* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- Hesse-Biber, S. (2015). Mixed methods research: The “thing-ness” problem. *Qualitative Health Research*, 25(6), 775-788. <https://doi.org/10.1177/1049732315580558>

- Hirakawa, Y., Takeda, K., Tanabe, S., Koyama, S., Motoya, I., Sakurai, H., . . . Nagata, J. (2018). Effect of intensive motor training with repetitive transcranial magnetic stimulation on upper limb motor function in chronic post-stroke patients with severe upper limb motor impairment. *Topics in Stroke Rehabilitation*, 25(5), 321-325. <https://doi.org/10.1080/10749357.2018.1466971>
- Hjelm, T. (2014). *Social constructionisms: Approaches to the study of the human world*. London, UK: Macmillan International Higher Education.
- Hofstede, G. (1998). Attitudes, values and organizational culture: Disentangling the concepts. *Organization Studies*, 19(3), 477-493. <https://doi.org/10.1177/017084069801900305>
- Hogan, S., & Siddharth, P. (2018). *The social and economic costs of stroke in New Zealand*. Retrieved from https://nzier.org.nz/static/media/filer_public/50/e1/50e137dc-bb2a-4246-83a2-bb097a838f06/social_and_economic_costs_of_stroke_report.pdf
- Hole, E., Stubbs, B., Roskell, C., & Soundy, A. (2014). The patient's experience of the psychosocial process that influences identity following stroke rehabilitation: A metaethnography. *The Scientific World Journal*, 2014, 1-13. <https://doi.org/10.1155/2014/349151>
- Holian, R., & Coghlan, D. (2013). Ethical issues and role duality in insider action research: Challenges for action research degree programmes. *Systemic Practice and Action Research*, 26, 399-415. <https://doi.org/10.1007/s11213-012-9256-6>
- Hong, K.-S. (2011). Disability-adjusted life years analysis: Implications for stroke research. *Journal of Clinical Neurology*, 7(3), 109-114. <https://doi.org/10.3988/jcn.2011.7.3.109>
- Hoque, R. (2016). An empirical study of mHealth adoption in a developing country: The moderating effect of gender concern. *BMC Medical Informatics and Decision Making*, 16(1), 1-10. <https://doi.org/10.1186/s12911-016-0289-0>
- Hoque, R., & Sorwar, G. (2017). Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. *International Journal of Medical Informatics*, 101, 75-84. <https://doi.org/10.1016/j.ijmedinf.2017.02.002>
- Horne, J., Lincoln, N. B., Preston, J., & Logan, P. (2014). What does confidence mean to people who have had a stroke? – A qualitative interview study. *Clinical Rehabilitation*, 28(11), 1125-1135. <https://doi.org/10.1177/0269215514534086>
- Hotter, B., Padberg, I., Liebenau, A., Knispel, P., Heel, S., Steube, D., . . . Meisel, A. (2018). Identifying unmet needs in long-term stroke care using in-depth assessment and the post-stroke checklist – The Managing Aftercare for Stroke (MAS-I) study.

- Hughes, C., Mariscal, T., Baye, M., Belay, G. J., Hintze, A., Padilla, A., . . . Gordon-Murer, C. (2019). Development of an Upper Extremity {Stroke Rehabilitation mHealth Application for sub-Saharan Africa: A Usability Study/*IEEE*. Symposium conducted at the meeting of the 2019 IST-Africa Week Conference (IST-Africa)
<https://doi.org/10.23919/ISTAFRICA.2019.8764867>
- Hung, Y.-X., Huang, P.-C., Chen, K.-T., & Chu, W.-C. (2016). What do stroke patients look for in game-based rehabilitation: A survey study. *Medicine*, 95(11), 1-10.
<https://doi.org/10.1097/MD.0000000000003032>
- Hwang, N.-K., Park, J.-S., & Chang, M.-Y. (2021). Telehealth interventions to support self-management in stroke survivors: A systematic review. *Healthcare*, 9(472), 1-19.
<https://doi.org/10.3390/healthcare9040472>
- Islam, M. N., Islam, I., Munim, K. M., & Islam, A. N. (2020). A review on the mobile applications developed for COVID-19: An exploratory analysis. *IEEE Access*, 8, 145601-145610. <https://doi.org/10.1109/ACCESS.2020.3015102>
- Joffe, H. (2012). Thematic analysis. In D. Harper & A. R. Thompson (Eds.), *Qualitative research methods in mental health and psychotherapy: A guide for students and practitioners* (pp. 210-223). Chichester, UK: John Wiley & Sons.
- Johnson, C. O., Nguyen, M., Roth, G. A., Nichols, E., Alam, T., Abate, D., . . . Abu-Rmeileh, N. M. (2019). Global, regional, and national burden of stroke, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology*, 18(5), 439-458. [https://doi.org/10.1016/S1474-4422\(19\)30034-1](https://doi.org/10.1016/S1474-4422(19)30034-1)
- Jokinen, H., Melkas, S., Ylikoski, R., Pohjasvaara, T., Kaste, M., Erkinjuntti, T., & Hietanen, M. (2015). Post-stroke cognitive impairment is common even after successful clinical recovery. *European Journal of Neurology*, 22(9), 1288-1294.
<https://doi.org/10.1111/ene.12743>
- Jones, F., & Riazi, A. (2011). Self-efficacy and self-management after stroke: A systematic review. *Disability and Rehabilitation*, 33(10), 797-810.
<https://doi.org/10.3109/09638288.2010.511415>
- Jones, F., Riazi, A., & Norris, M. (2013). Self-management after stroke: Time for some more questions? *Disability and Rehabilitation*, 35(3), 257-264.
<https://doi.org/10.3109/09638288.2012.691938>
- Jones, S. C., Kharlamov, A., Yanovski, B., Kim, D. K., Easley, K. A., Yushmanov, V. E., . . . Boada, F. E. (2006). Stroke onset time using sodium MRI in rat focal cerebral ischemia. *Stroke*, 37(3), 883-888.
<https://doi.org/10.1161/01.STR.0000198845.79254.0f>

- Jonkman, N. H., Schuurmans, M. J., Jaarsma, T., Shortridge-Baggett, L. M., Hoes, A. W., & Trappenburg, J. C. (2016). Self-management interventions: Proposal and validation of a new operational definition. *Journal of Clinical Epidemiology*, *80*, 34-42. <https://doi.org/10.1016/j.jclinepi.2016.08.001>
- Jorgensen, H. S., Nakayama, H., Raaschou, H. O., & Olsen, T. S. (1999). Stroke: Neurologic and functional recovery the Copenhagen stroke study. *Physical Medicine and Rehabilitation Clinics*, *10*(4), 887-906. [https://doi.org/10.1016/S1047-9651\(18\)30169-4](https://doi.org/10.1016/S1047-9651(18)30169-4)
- Kaiser, K. M., & Bostrom, R. P. (1982). Personality characteristics of MIS project teams: An empirical study and action-research design. *MIS Quarterly*, *6*(4), 43-60. <https://doi.org/10.2307/249066>
- Kamal, A., Khoja, A., Usmani, B., Magsi, S., Malani, A., Peera, Z., . . . Zulfiqar, M. (2020). Effect of 5-minute movies shown via a mobile phone app on risk factors and mortality after stroke in a low-to middle-income country: randomized controlled trial for the stroke caregiver dyad education intervention (Movies4Stroke). *JMIR mHealth and uHealth*, *8*(1), e12113. <https://doi.org/10.2196/12113>
- Kamwesiga, J. T., Tham, K., & Guidetti, S. (2017). Experiences of using mobile phones in everyday life among persons with stroke and their families in Uganda – a qualitative study. *Disability and Rehabilitation*, *39*(5), 438-449. <https://doi.org/10.3109/09638288.2016.1146354>
- Kang, H., & Sundar, S. S. (2016). When self is the source: Effects of media customization on message processing. *Media Psychology*, *19*(4), 561-588. <https://doi.org/10.1080/15213269.2015.1121829>
- Kang, Y.-N., Shen, H.-N., Lin, C.-Y., Elwyn, G., Huang, S.-C., Wu, T.-F., & Hou, W.-H. (2019). Does a Mobile app improve patients' knowledge of stroke risk factors and health-related quality of life in patients with stroke? A randomized controlled trial. *BMC Medical Informatics and Decision Making*, *19*(1), 1-9. <https://doi.org/10.1186/s12911-019-1000-z>
- Katan, M., & Luft, A. (2018). Global burden of stroke. *Seminars in Neurology*, *38*(02), 208-211. <https://doi.org/10.1055/s-0038-1649503>
- Katz, I., & Assor, A. (2007). When choice motivates and when it does not. *Educational Psychology Review*, *19*(4), 429. <https://doi.org/10.1007/s10648-006-9027-y>
- Kaufman, J. (2016). *Principles of mobile app design*. Retrieved from <https://www.apteligent.com/wp-content/uploads/2016/07/00-Whitepaper-Principles-of-App-Design-V1-1.pdf>

- Kaur, K., Gurnani, B., Nayak, S., Deori, N., Kaur, S., Jethani, J., . . . Sukhija, J. (2022). Digital eye strain-a comprehensive review. *Ophthalmology and therapy*, 11(5), 1655-1680. <https://doi.org/10.1007/s40123-022-0054>
- Kemmis, S. (2006). Exploring the relevance of critical theory for action research: Emancipatory action research in the footsteps of Jurgen Habermas. In P. Reason & H. Bradbury (Eds.), *Handbook of action research* (Vol. 4, pp. 94-105). Los Angeles, CA: Sage Publications.
- Kemmis, S., McTaggart, R., & Nixon, R. (2013). *The action research planner: Doing critical participatory action research*. London, UK: Springer Science & Business Media Press.
- Kemmis, S., McTaggart, R., & Nixon, R. (2015). *Critical theory and critical participatory action research*. Los Angeles, CA: Sage Publications.
- Kemp, S. (2019). *Digital 2019: New Zealand*. Retrieved from <https://datareportal.com/reports/digital-2019-new-zealand>
- Khamis, M., Alt, F., & Bulling, A. (2018). The past, present, and future of gaze-enabled handheld mobile devices: Survey and lessons learned. In *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services* (pp. 1-17). <https://doi.org/10.1145/3229434.3229452>
- Khan, K., & Donthula, S. (2019). Investigating motivational and usability issues of mHealth wellness apps for improved user experience. In X.-S. Yang, S. Sherratt, N. Dey, & A. Joshi (Eds.), *Third International Congress on Information and Communication Technology* (pp. 573-587). Retrieved from https://link.springer.com/chapter/10.1007/978-981-13-1165-9_53
- Khanum, M. A., Fatima, S., & Chaurasia, M. A. (2012). Arabic interface analysis based on cultural markers. *International Journal of Computer Science Issues*, 9(1), 255-262. Retrieved from <https://arxiv.org/abs/1203.3660>
- Khasawneh, O. Y. (2018). Technophobia without borders: The influence of technophobia and emotional intelligence on technology acceptance and the moderating influence of organizational climate. *Computers in Human Behavior*, 88, 210-218. <https://doi.org/10.1016/j.chb.2018.07.007>
- Khowaja, K., & Al-Thani, D. (2020). New checklist for the heuristic evaluation of mHealth apps (HE4EH): Development and usability study. *JMIR mHealth and uHealth*, 8(10), e20353. <https://doi.org/10.2196/20353>
- Kim, J., & Park, H.-A. (2012). Development of a health information technology acceptance model using consumers' health behavior intention. *Journal of Medical Internet Research*, 14(5), e133. <https://doi.org/10.2196/jmir.2143>

- Kim, K., Schmierbach, M. G., Chung, M.-Y., Fraustino, J. D., Dardis, F., & Ahern, L. (2015). Is it a sense of autonomy, control, or attachment? Exploring the effects of in-game customization on game enjoyment. *Computers in Human Behavior, 48*, 695-705. <https://doi.org/10.1016/j.chb.2015.02.011>
- Kim, Y., Jung, H.-T., Park, J., Kim, Y., Ramasarma, N., Bonato, P., . . . Lee, S. I. (2019). Towards the design of a ring sensor-based mHealth system to achieve optimal motor function in stroke survivors. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 3*(4), 1-26. <https://doi.org/10.1145/3369817>
- King, N., Cassell, C., & Symon, G. (2004). Using templates in the thematic analysis of text. In *Essential guide to qualitative methods in organizational research* (Vol. 2, pp. 256-270). Thousand Oaks, CA: Sage Publications.
- Kinney, J. M., & Kahana, E. (1989). Reviewed work: Unending work and care: Managing chronic illness at home. In *Contemporary sociology* (Vol. 18, pp. 945-947). <https://doi.org/10.2307/2074227>
- Kinzler, K. D., & Spelke, E. S. (2011). Do infants show social preferences for people differing in race? *Cognition, 119*(1), 1-9. <https://doi.org/10.1016/j.cognition.2010.10.019>
- Kirkup, M., & Carrigan, M. (2000). Video surveillance research in retailing: Ethical issues. *International Journal of Retail & Distribution Management, 28*(11), 470-480. <https://doi.org/10.1108/09590550010356831>
- Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education, 6*(5), 26-41. <https://doi.org/10.5430/ijhe.v6n5p26>
- Kizony, R., Zeilig, G., Dudkiewicz, I., Schejter-Margalit, T., & Rand, D. (2016). Tablet apps and dexterity: Comparison between 3 age groups and proof of concept for stroke rehabilitation. *Journal of Neurologic Physical Therapy, 40*(1), 31-39. <https://doi.org/10.1097/NPT.000000000000110>
- Klaib, A. F., Alrehin, N. O., Melhem, W. Y., & Bashtawi, H. O. (2019). IoT Smart Home Using Eye Tracking and Voice Interfaces for Elderly and Special Needs People. *J. Commun., 14*(7), 614-621. <https://doi.org/10.12720/jcm.14.7.614-621>
- Kleineberg, N. N., Richter, M. K., Becker, I., Weiss, P. H., & Fink, G. R. (2020). Verum versus sham tDCS in the treatment of stroke-induced apraxia: Study protocol of the randomized controlled trial RAdiCS-“Rehabilitating (stroke-induced) Apraxia with direct Current Stimulation”. *Neurological Research and Practice, 2*(7), 1-7. <https://doi.org/10.1186/s42466-020-0052-y>

- Kneebone, I. I., & Lincoln, N. B. (2012). Psychological problems after stroke and their management: State of knowledge. *Neuroscience and Medicine*, 3(01), 83. <https://doi.org/10.4236/nm.2012.31013>
- Koenig-Bruhin, M., Kolonko, B., At, A., Annoni, J.-M., & Hunziker, E. (2013). Aphasia following a stroke: Recovery and recommendations for rehabilitation. *Swiss Archives of Neurology and Psychiatry*, 164(8), 292-298.
- Kossi, O., Batcho, C. S., Adoukonou, T., & Thonnard, J.-L. (2016). Functional recovery after stroke in Benin: A six-month follow-up study. *Journal of Rehabilitation Medicine*, 48(8), 671-675. <https://doi.org/10.2340/16501977-2128>
- Kottilingam, D. (2020). Emotional wellbeing assessment for elderly using multi-language robot interface. *Journal of Information Technology and Digital World*, 2(1), 1-10. <https://doi.org/10.36548/jitdw.2020.1.001>
- Kringle, E. A., Setiawan, I. M. A., Golias, K., Parmanto, B., & Skidmore, E. R. (2020). Feasibility of an iterative rehabilitation intervention for stroke delivered remotely using mobile health technology. *Disability and Rehabilitation: Assistive Technology*, 15(8), 908-916. <https://doi.org/10.1080/17483107.2019.1629113>
- Krohn, R., & Metcalf, D. (2012). *mHealth: From smartphones to smart systems*. Chicago, IL: HIMSS Publishing.
- Krueger, R. A., & Casey, M. A. (2014). *Focus groups: A practical guide for applied research*. London, UK: Sage Publications.
- Kuerbis, A., Mulliken, A., Muench, F., Moore, A. A., & Gardner, D. (2017). Older adults and mobile technology: Factors that enhance and inhibit utilization in the context of behavioral health. *Mental Health and Addiction Research*, 2(2), 1-11. <https://doi.org/10.15761/MHAR.1000136>
- Kulnik, S. T., Poestges, H., Brimicombe, L., Hammond, J., & Jones, F. (2017). Implementing an interprofessional model of self-management support across a community workforce: A mixed-methods evaluation study. *Journal of Interprofessional Care*, 31(1), 75-84. <https://doi.org/10.1080/13561820.2016.1246432>
- Kurniawati, N. D., Rihi, P. D., & Wahyuni, E. D. (2020). Relationship of family and self efficacy support to the rehabilitation motivation of stroke patients. *EurAsian Journal of BioSciences*, 14(1), 2427-2430.
- Kutlubaev, M. A., & Hackett, M. L. (2014). Part II: Predictors of depression after stroke and impact of depression on stroke outcome: An updated systematic review of observational studies. *International Journal of Stroke*, 9(8), 1026-1036. <https://doi.org/10.1111/ij.s.12356>

- Kvale, S. (1996). *InterViews: An introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage Publications.
- Kyriakoullis, L., & Zaphiris, P. (2016). Culture and HCI: A review of recent cultural studies in HCI and social networks. *Universal Access in the Information Society*, 15(4), 629-642. <https://doi.org/10.1007/s10209-015-0445-9>
- Kytö, M., Maye, L., & McGookin, D. (2019). Using both hands: Tangibles for stroke rehabilitation in the home. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. <https://doi.org/10.1145/3290605.3300612>
- Lainay, C., Benzenine, E., Durier, J., Daubail, B., Giroud, M., Quantin, C., & Bejot, Y. (2015). Hospitalization within the first year after stroke: The Dijon stroke registry. *Stroke*, 46(1), 190-196. <https://doi.org/10.1161/STROKEAHA.114.007429>
- Langan, J., Bhattacharjya, S., Subryan, H., Xu, W., Chen, B., Li, Z., & Cavuoto, L. (2020). In-home rehabilitation using a smartphone app coupled with 3D printed functional objects: Single-subject design study. *JMIR mHealth and uHealth*, 8(7), e19582. <https://doi.org/10.2196/19582>
- LaPiana, N., Duong, A., Lee, A., Alschitz, L., Silva, R. M., Early, J., . . . Mourad, P. (2020). Acceptability of a mobile phone-based augmented reality game for rehabilitation of patients with upper limb deficits from stroke: Case study. *JMIR Rehabilitation and Assistive Technologies*, 7(2), e17822. <https://doi.org/10.2196/17822>
- Laplante, P. A. (2017). *Encyclopedia of computer science and technology* (Vol. 2). Boca Raton, FL: CRC Press Taylor & Francis Group.
- Larson, R. S. (2018). A path to better-quality mHealth apps. *JMIR mHealth and uHealth*, 6(7), e10414. <https://doi.org/10.2196/10414>
- Lattanzi, S., Cagnetti, C., Provinciali, L., & Silvestrini, M. (2017). Neutrophil-to-lymphocyte ratio and neurological deterioration following acute cerebral hemorrhage. *Oncotarget*, 8(34), 57489-57494. <https://doi.org/10.18632/oncotarget.15423>
- Lautenschlager, N. T., Cox, K. L., & Ellis, K. A. (2022). Physical activity for cognitive health: what advice can we give to older adults with subjective cognitive decline and mild cognitive impairment? *Dialogues in clinical neuroscience*. <https://doi.org/10.31887/DCNS.2019.21.1/nlautenschlager>
- Lee, Lim, S. H., Kim, K. H., Kim, K. J., Kim, Y. R., Chang, W. N., . . . Hwang, B. Y. (2015). Six-month functional recovery of stroke patients: A multi-time-point study. *International Journal of Rehabilitation Research*, 38(2), 173. <https://doi.org/10.1097/MRR.000000000000108>

- Lee, H. E., & Cho, J. (2019). Social media use and well-being in people with physical disabilities: Influence of SNS and online community uses on social support, depression, and psychological disposition. *Health communication, 34*(9), 1043-1052. <https://doi.org/10.1080/10410236.2018.1455138>
- Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues, 2*(4), 34-46. <https://doi.org/10.1111/j.1540-4560.1946.tb02295.x>
- Lewis, T. L. (2013). A systematic self-certification model for mobile medical apps. *Journal of Medical Internet Research, 15*(4), 1-3. <https://doi.org/10.2196/jmir.2446>
- Li, C., Jiang, S., Li, N., & Zhang, Q. (2018). Influence of social participation on life satisfaction and depression among Chinese elderly: Social support as a mediator. *Journal of Community Psychology, 46*(3), 345-355. <https://doi.org/10.1002/jcop.21944>
- Li, C., Neugroschl, J., Zhu, C. W., Aloysi, A., Schimming, C. A., Cai, D., . . . Loizos, M. (2021). Design considerations for mobile health applications targeting older adults. *Journal of Alzheimer's Disease, 79*(1), 1-8. <https://doi.org/10.3233/JAD-200485>
- Li, J., Li, H., Umer, W., Wang, H., Xing, X., Zhao, S., & Hou, J. (2020). Identification and classification of construction equipment operators' mental fatigue using wearable eye-tracking technology. *Automation in Construction, 109*, 103000. <https://doi.org/10.1016/j.autcon.2019.103000>
- Lidwell, W., Holden, K., & Butler, J. (2010). *Universal principles of design, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design*. Beverly, MA: Rockport Publishers.
- Lin, Y.-T., & Hertzum, M. (2020). How do designers make user-experience design decisions? In A. Marcus & E. Rosenzweig (Eds.), *HCI 2020. Design, user experience, and usability. Interaction design*. https://doi.org/10.1007/978-3-030-49713-2_13
- Lipson, D. M., Sangha, H., Foley, N. C., Bhogal, S., Pohani, G., & Teasell, R. W. (2005). Recovery from stroke: Differences between subtypes. *International Journal of Rehabilitation Research, 28*(4), 303-308. <https://doi.org/10.1097/00004356-200512000-00002>
- Llanos, C. I., & Muñoz, M. N. (2007). Design guidelines for web applications based on local patterns. In *Proceedings of the Euro American Conference on Telematics and Information Systems: Association for Computing Machinery*. <https://doi.org/10.1145/1352694.1352740>
- Loneragan, B. (1992). *Insight: An essay in human understanding*. Toronto, Canada: Toronto University Press.

- Lorig, K., & Holman, H. (2003). Self-management education: History, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine*, 26(1), 1-7. https://doi.org/10.1207/S15324796ABM2601_01
- Lorig, K., Holman, H., Sobel, D., Laurent, D., Minor, M., & Gonzalez, V. (2012). *Living a healthy life with chronic conditions: Self-management of heart disease, arthritis, diabetes, asthma, bronchitis, emphysema & other physical & mental health condition*. Boulder, CO: Bull Publishing Company.
- Lorig, K., Ritter, P., Stewart, A., Sobel, D., Brown Jr, B., Bandura, A., . . . Holman, H. (2001). Chronic disease self-management program: 2-year health status and health care utilization outcomes. *Medical Care*, 39(11), 1217-1223. <https://doi.org/10.1097/00005650-200111000-00008>
- Lu, J., & Zhang, S. (2013). *E-health web application framework and platform based on the cloud technology*. Kristianstad University. Retrieved from <https://www.diva-portal.org/smash/get/diva2:647835/FULLTEXT01.pdf>
- Luo, Z., Durairaj, P., Lau, C. M., Katsumoto, Y., Do, E. Y.-L., Zainuddin, A. S. B., & Kawauchi, K. (2021). Gamification of upper limb virtual rehabilitation in post stroke elderly using SilverTune-a multi-sensory tactile musical assistive system. In *Proceedings of the 2021 IEEE 7th International Conference on Virtual Reality (ICVR)* (pp. 149-155). <https://doi.org/10.1109/ICVR51878.2021.9483850>
- Lynch, E. A., Jones, T. M., Simpson, D. B., Fini, N. A., Kuys, S. S., Borschmann, K., . . . Mahendran, N. (2018). Activity monitors for increasing physical activity in adult stroke survivors. *Cochrane Database of Systematic Reviews*, 2018(7), CD012543. <https://doi.org/10.1002/14651858.CD012543.pub2>
- Lyons, E., & Coyle, A. (2016). *Analysing qualitative data in psychology*. London, UK: Sage Publications.
- Magnusson, C., Rasmus-Gröhn, K., Rydeman, B., & Caltenco, H. (2018). Walk after stroke: Initial development of a step counting game for stroke survivors. *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct. Association for Computing Machinery*, 237-244. <https://doi.org/10.1145/3236112.3236145>
- Mahmood, A., Blaizy, V., Verma, A., Stephen Sequeira, J., Saha, D., Ramachandran, S., . . . Solomon, J. M. (2019). Acceptability and attitude towards a mobile-based home exercise program among stroke survivors and caregivers: A cross-sectional study. *International Journal of Telemedicine and Applications*, 2019, 1-6. <https://doi.org/10.1155/2019/5903106>
- Mallet, K., Shamloul, R., Corbett, D., Finestone, H., Hatcher, S., Lumsden, J., . . . Swartz, R. (2016). Recovernow: Feasibility of a mobile tablet-based rehabilitation

- intervention to treat post-stroke communication deficits in the acute care setting. *PLoS One*, 11(12), 1-12. <https://doi.org/10.1371/journal.pone.0167950>
- Mallet, K., Shamloul, R., Pugliese, M., Power, E., Corbett, D., Hatcher, S., . . . Dukelow, S. (2019). RecoverNow: A patient perspective on the delivery of mobile tablet-based stroke rehabilitation in the acute care setting. *International Journal of Stroke*, 14(2), 174-179. <https://doi.org/10.1177/1747493018790031>
- Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: Guided by information power. *Qualitative Health Research*, 26(13), 1753-1760. <https://doi.org/10.1177/1049732315617444>
- Marcheschi, E., Von Koch, L., Pessah-Rasmussen, H., & Elf, M. (2018). Home setting after stroke, facilitators and barriers: A systematic literature review. *Health & Social Care in the Community*, 26(4), e451-e459. <https://doi.org/10.1111/hsc.12518>
- Marrow, A. J. (1977). *The practical theorist: The life and work of Kurt Lewin*. New York, NY: Teachers College Press.
- Martin, T. (2012). Assessing mHealth: Opportunities and barriers to patient engagement. *Journal of Health Care for the Poor and Underserved*, 23(3), 935-941. <https://doi.org/10.1353/hpu.2012.0087>
- Masters, J. (1995). *The history of action research in Hughes action research electronic reader*. Retrieved from <http://www.behs.cchs.usyd.edu.au/arow/Reader/rmasters.htm>
- Maynard, M. (1994). Methods, practice and epistemology: The debate about feminism and research. In M. Maynard & J. Purvis (Eds.), *Researching women's lives from a feminist perspective* (pp. 10-26). London, UK: Taylor & Francis.
- McAllister, S., Derrett, S., Audas, R., Herbison, P., & Paul, C. (2013). Do different types of financial support after illness or injury affect socio-economic outcomes? A natural experiment in New Zealand. *Social Science & Medicine*, 85, 93-102. <https://doi.org/10.1016/j.socscimed.2013.02.041>
- McKenna, S., Jones, F., Glenfield, P., & Lennon, S. (2015). Bridges self-management program for people with stroke in the community: A feasibility randomized controlled trial. *International Journal of Stroke*, 10(5), 697-704. <https://doi.org/10.1111/ijis.12195>
- McKevitt, C., Fudge, N., Redfern, J., Sheldenkar, A., Crichton, S., Rudd, A. R., . . . Silver, L. E. (2011). Self-reported long-term needs after stroke. *Stroke*, 42(5), 1398-1403. <https://doi.org/10.1161/STROKEAHA.110.598839>
- McMahon, S., Vankipuram, M., Hekler, E. B., & Fleury, J. (2014). Design and evaluation of theory-informed technology to augment a wellness motivation intervention.

Translational Behavioral Medicine, 4(1), 95-107.
<https://doi.org/10.1007/s13142-013-0221-4>

McMains, S., & Kastner, S. (2011). Interactions of top-down and bottom-up mechanisms in human visual cortex. *Journal of Neuroscience*, 31(2), 587-597.
<https://doi.org/10.1523/JNEUROSCI.3766-10.2011>

McNiff, J. (2017). *Action research: All you need to know*. Newbury Park, CA: Sage Publications.

MDN. (2019). *Web docs*. Retrieved from <https://developer.mozilla.org/en-US/docs/Web/JavaScript>

Medhi, I., Patnaik, S., Brunskill, E., Gautama, S. N., Thies, W., & Toyama, K. (2011). Designing mobile interfaces for novice and low-literacy users. *ACM Transactions on Computer-Human Interaction*, 18(1), 1-28.
<https://doi.org/10.1145/1959022.1959024>

Mehrotra, S., Motti, V. G., Frijns, H., Akkoc, T., Yengeç, S. B., Calik, O., . . . Neerinx, M. A. (2016). Embodied conversational interfaces for the elderly user. In *Proceedings of the 8th Indian Conference on Human Computer Interaction: IHCI '16* (pp. 90-95). <https://doi.org/10.1145/3014362.3014372>

Melenhorst, A.-S., Rogers, W. A., & Bouwhuis, D. G. (2006). Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity. *Psychology and Aging*, 21(1), 190-195. <https://doi.org/10.1037/0882-7974.21.1.190>

Mendoza, J. A., Baker, K. S., Moreno, M. A., Whitlock, K., Abbey-Lambertz, M., Waite, A., . . . Chow, E. J. (2017). A Fitbit and Facebook mHealth intervention for promoting physical activity among adolescent and young adult childhood cancer survivors: A pilot study. *Pediatric Blood and Cancer*, 64(12), 1-9.
<https://doi.org/10.1002/pbc.26660>

Mesko, B. (2013). *Social media in clinical practice*. Berlin, Germany: Springer.

Mesko, B. (2014). *The guide to the future of medicine: Technology and the human touch*. Budapest, Hungary: Webicina KFT.

Messner, E.-M., Probst, T., O'Rourke, T., Stoyanov, S., & Baumeister, H. (2019). mHealth applications: Potentials, limitations, current quality and future directions. In H. Baumeister & C. Montag (Eds.), *Digital phenotyping and mobile sensing* (pp. 235-248). Berlin, Germany: Springer.

Micallef, N., Baillie, L., & Uzor, S. (2016). Time to exercise!: An aide-memoire stroke app for post-stroke arm rehabilitation. In *Proceedings of the 18th International*

Conference on Human-Computer Interaction with Mobile Devices and Services (pp. 112-123). <https://doi.org/10.1145/2935334.2935338>

- Middlemiss, L., Ambrosio-Albalá, P., Emmel, N., Gillard, R., Gilbertson, J., Hargreaves, T., . . . Tod, A. (2019). Energy poverty and social relations: A capabilities approach. *Energy Research and Social Science*, 55, 227-235. <https://doi.org/10.1016/j.erss.2019.05.002>
- Miller, A. S., Cafazzo, J. A., & Seto, E. (2016). A game plan: Gamification design principles in mHealth applications for chronic disease management. *Health Informatics Journal*, 22(2), 184-193. <https://doi.org/10.1177/1460458214537511>
- Misawa, J., & Kondo, K. (2019). Social factors relating to depression among older people in Japan: Analysis of longitudinal panel data from the AGES project. *Aging & Mental Health*, 23(10), 1423-1432. <https://doi.org/10.1080/13607863.2018.1496225>
- Mohammadyari, S., & Singh, H. (2015). Understanding the effect of e-learning on individual performance: The role of digital literacy. *Computers & Education*, 82, 11-25. <https://doi.org/10.1016/j.compedu.2014.10.025>
- Mohtar, S., Jomhari, N., Mustafa, M. B., & Yusoff, Z. M. (2023). Mobile learning: research context, methodologies and future works towards middle-aged adults—a systematic literature review. *Multimedia Tools and Applications*, 82(7), 11117-11143. <https://doi.org/10.1007/s11042-022-13698-y>
- Mora, A., González, C., Arnedo-Moreno, J., & Álvarez, A. (2016). Gamification of cognitive training: A crowdsourcing-inspired approach for older adults. In *Proceedings of the XVII International Conference on Human Computer Interaction*. <https://doi.org/10.1145/2998626.2998663>
- Morgan, D. (1996). Focus groups. *Annual Review of Sociology*, 22(1), 129-152. <https://doi.org/10.1146/annurev.soc.22.1.129>
- Morgan, H., Entwistle, V. A., Cribb, A., Christmas, S., Owens, J., Skea, Z. C., & Watt, I. S. (2017). We need to talk about purpose: A critical interpretive synthesis of health and social care professionals' approaches to self-management support for people with long-term conditions. *Health Expectations*, 20(2), 243-259.
- Moron, M., Yanez, R., Cascado, D., Suarez-Mejias, C., & Sevillano, J. (2014). A mobile memory game for patients with Acquired Brain Damage: A preliminary usability study. In *Proceedings of the IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI)* (pp. 302-305). <https://doi.org/10.1109/BHI.2014.6864363>

- Mosa, A. S. M., Yoo, I., & Sheets, L. (2012). A systematic review of healthcare applications for smartphones. *BMC Medical Informatics and Decision Making*, 12(67), 1-31. <https://doi.org/10.1186/1472-6947/12/67>
- Mozaffarian, D., Benjamin, E. J., Go, A. S., Arnett, D. K., Blaha, M. J., Cushman, M., . . . Fullerton, H. J. (2016). Executive summary: Heart disease and stroke statistics - 2016 update: A report from the American Heart Association. *Circulation*, 133(4), 447-454. <https://doi.org/10.1161/CIR.0000000000000366>
- Mukundan, G., & Seidenwurm, D. J. (2018). Economic and societal aspects of stroke management. *Neuroimaging Clinics of North America* 28(4), 683-689. <https://doi.org/10.1016/j.nic.2018.06.009>
- Mulhall, A. (2003). In the field: Notes on observation in qualitative research. *Journal of Advanced Nursing*, 41(3), 306-313. <https://doi.org/10.1046/j.1365-2648.2003.02514.x>
- Muntaner-Mas, A., Vidal-Conti, J., Borrás, P. A., Ortega, F. B., & Palou, P. (2017). Effects of a Whatsapp-delivered physical activity intervention to enhance health-related physical fitness components and cardiovascular disease risk factors in older adults. *The Journal of Sports Medicine and Physical Fitness*, 57(1-2), 90-102. <https://doi.org/10.23736/S0022-4707.16.05918-1>
- Naik, S., & Sudarshan, E. (2019). Smart healthcare monitoring system using raspberry Pi on IoT platform. *ARPJ Journal of Engineering and Applied Sciences*, 14(4), 872-876.
- Nam, H., Cha, M., Kim, Y., Kim, E., Park, E., Lee, H., . . . Heo, J. (2012). Use of a handheld, computerized device as a decision support tool for stroke classification. *European Journal of Neurology*, 19(3), 426-430. <https://doi.org/10.1111/j.1468-1331.2011.03530.x>
- Nantel, J., & Glaser, E. (2008). The impact of language and culture on perceived website usability. *Journal of Engineering and Technology Management*, 25(1-2), 112-122. <https://doi.org/10.1016/j.jengtecman.2008.01.005>
- Nasr, E., Alsaggaf, W., & Sinnari, D. (2023). Developing Usability Guidelines for mHealth Applications (UGmHA). *Multimodal Technologies and Interaction*, 7(3), 26. <https://doi.org/10.3390/mti7030026>
- Nelson, L. A., Mulvaney, S. A., Johnson, K. B., & Osborn, C. Y. (2017). mHealth intervention elements and user characteristics determine utility: A mixed-methods analysis. *Diabetes Technology & Therapeutics*, 19(1), 9-17. <https://doi.org/10.1089/dia.2016.0294>

- Newman, S., Steed, L., & Mulligan, K. (2004). Self-management interventions for chronic illness. *The Lancet*, 364(9444), 1523-1537. [https://doi.org/10.1016/S0140-6736\(04\)17277-2](https://doi.org/10.1016/S0140-6736(04)17277-2)
- Ngafeeson, M. (2015). Understanding user resistance to information technology in healthcare: The nature and role of perceived threats. *Transactions of the International Conference on Health Information Technology Advancement*, 3(1). Retrieved from https://scholarworks.wmich.edu/ichita_transactions/56
- Nielsen, J. (1995). *10 Usability Heuristics for User Interface Design*. Retrieved from <https://www.nngroup.com/articles/ten-usability-heuristics/>
- Nikolov, A. (2017). *Design principle: Consistency*. Retrieved from <https://uxdesign.cc/design-principle-consistency-6b0cf7e7339f>
- Nimrod, G. (2018). Technophobia among older Internet users. *Educational Gerontology*, 44(2-3), 148-162. <https://doi.org/10.1080/03601277.2018.1428145>
- Norman, D. (1988). *The psychology of everyday things* (Vol. 5). New York, NK: Basic Books.
- Norman, D. (2013). *The design of everyday things: Revised and expanded edition*: Basic books.
- Norman, D., & Draper, S. W. (1986). *User centered system design; New perspectives on human-computer interaction*. Mahwah, NJ: L. Erlbaum Associates Inc.
- Norman, D., & Nielsen, J. (2019). *The definition of user experience (UX)*. Retrieved from <https://www.nngroup.com/articles/definition-user-experience/>
- North, M., Wilkinson, T., & Bourne, S. (2014). The impact of an electronic self-management system for patients with COPD. *European Respiratory Journal*, 44(Suppl 58), 1413. Retrieved from https://erj.ersjournals.com/content/44/Suppl_58/1413.short
- Nunamaker, J., Chen, M., & Purdin, T. D. (1990). Systems development in information systems research. *Journal of Management Information Systems*, 7(3), 89-106. <https://doi.org/10.1080/07421222.1990.11517898>
- Oh, S. S., Kim, K.-A., Kim, M., Oh, J., Chu, S. H., & Choi, J. (2021). Measurement of digital literacy among older adults: systematic review. *Journal of Medical Internet Research*, 23(2), e26145. <https://doi.org/10.2196/26145>
- Ohno, K., Tomori, K., Takebayashi, T., Sawada, T., Nagayama, H., Levack, W., . . . Higashi, T. (2017). Development of a tool to facilitate real life activity retraining in hand and arm therapy. *British Journal of Occupational Therapy*, 80(5), 310-318. <https://doi.org/10.1177/0308022617692602>

- Olaiya, M. T., Cadilhac, D. A., Kim, J., Nelson, M. R., Srikanth, V. K., Andrew, N. E., . . . Phan, T. (2017). Long-term unmet needs and associated factors in stroke or TIA survivors: An observational study. *Neurology*, 89(1), 68-75. <https://doi.org/10.1212/WNL.0000000000004063>
- Oliver, P., & Jupp, V. (2006). Snowball sampling. In V. Jupp (Ed.), *The SAGE dictionary of social research methods*. <https://doi.org/10.4135/9780857020116.n192>
- Oni, O. D., Olagunju, A. T., Olisah, V. O., Aina, O. F., & Ojini, F. I. (2018). Post-stroke depression: Prevalence, associated factors and impact on quality of life among outpatients in a Nigerian hospital. *South African Journal of Psychiatry*, 24, a1058. <https://doi.org/10.4102/sajpsychiatry.v24i0.1058>
- Onwuegbuzie, A., & Leech, N. (2007). A call for qualitative power analyses. *Quality and Quantity*, 41, 105-121. <https://doi.org/10.1007/s11135-005-1098-1>
- Ormston, R., Spencer, L., Barnard, M., & Snape, D. (2014). The foundations of qualitative research. In J. Ritchie, J. Lewis, C. M. Nicholls, & R. Ormston (Eds.), *Qualitative research practice: A guide for social science students and researchers* (pp. 1-25). London, UK: Sage Publications.
- Ortega-Martín, M. E., Lucena-Antón, D., Luque-Moreno, C., Heredia-Rizo, A. M., & Moral-Munoz, J. A. (2020). Aplicaciones móviles en el abordaje terapéutico del ictus: Revisión en repositorios comerciales y búsqueda de evidencia. *Revista Española de Salud Pública*, 93, e201906035.
- Osborne, C. L., Juengst, S. B., & Smith, E. E. (2021). Identifying user-centered content, design, and features for mobile health apps to support long-term assessment, behavioral intervention, and transitions of care in neurological rehabilitation: An exploratory study. *British Journal of Occupational Therapy*, 84(2), 101-110. <https://doi.org/10.1177/0308022620954115>
- Paez, L. E., & Del Río, C. Z. (2019). Elderly users and their main challenges usability with mobile applications: A systematic review. In *International Conference on Human-Computer Interaction. HCI 2019: Design, user experience, and usability. Design philosophy and theory* (pp. 423-438). https://doi.org/10.1007/978-3-030-23570-3_31
- Pallant, J. L., Sands, S., & Karpen, I. O. (2020). The 4Cs of mass customization in service industries: a customer lens. *Journal of Services Marketing*, 34(4), 499-511. <https://doi.org/10.1108/JSM-04-2019-0176>
- Palmer, R. (1969). *Hermeneutics: Interpretation theory in Schleiermacher, Dilthey, Heidegger, and Gadamer*. Evanston, IL: Northwestern University Press.
- Palmer, S. E., Gardner, J. S., & Wickens, T. D. (2008). Aesthetic issues in spatial composition: Effects of position and direction on framing single objects. *Spatial*

Vision, 21(3), 421-449. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.381.1488&rep=rep1&type=pdf>

- Pang, H., & Ruan, Y. (2023). Determining influences of information irrelevance, information overload and communication overload on WeChat discontinuance intention: The moderating role of exhaustion. *Journal of Retailing and Consumer Services*, 72, 103289. <https://doi.org/10.1016/j.jretconser.2023.103289>
- Pankomera, R., & van Greunen, D. (2018). A model for implementing sustainable mHealth applications in a resource-constrained setting: A case of Malawi. *The Electronic Journal of Information Systems in Developing Countries*, 84(2), 1-12. <https://doi.org/10.1002/isd2.12019>
- Papageorgiou, A., Strigkos, M., Politou, E., Alepis, E., Solanas, A., & Patsakis, C. (2018). Security and privacy analysis of mobile health applications: The alarming state of practice. *IEEE Access*, 6, 9390-9403. <https://doi.org/10.1109/ACCESS.2018.2799522>
- Parke, H. L., Epiphaniou, E., Pearce, G., Taylor, S. J., Sheikh, A., Griffiths, C. J., . . . Pinnock, H. (2015). Self-management support interventions for stroke survivors: A systematic meta-review. *PLoS One*, 10(7), 1-23. <https://doi.org/10.1371/journal.pone.0131448>
- Patel, D. (2016). *Minimize overload while designing mobile user experience*. Retrieved from <https://www.apptentive.com/blog/2016/12/07/cognitive-overload-in-mobile-user-experience/>
- Patomella, A., Farias, L., Eriksson, C., Guidetti, S., & Asaba, E. (2021). Engagement in everyday activities for prevention of stroke: Feasibility of an mHealth-supported program for people with TIA. *Healthcare*, 9(968), 1-15. <https://doi.org/10.3390/healthcare9080968>
- Paul, L., Campbell, E., Gray, C., Brewster, S., Ramsay, A., Gill, J. M., . . . Dybus, A. (2018). Increasing physical activity in stroke survivors using STARFISH, an interactive smartphone application: Protocol for a randomised controlled trial. *Technology and Disability*, 30(1-2), 77-82. <https://doi.org/10.3233/TAD-180196>
- Paul, M., Maglaras, L., Ferrag, M. A., & AlMomani, I. (2023). Digitization of healthcare sector: A study on privacy and security concerns. *ICT Express*. <https://doi.org/10.1016/j.icte.2023.02.007>
- Pearl, C. (2016). *Designing voice user interfaces: Principles of conversational experiences*. Sebastopol, CA: O'Reilly Media, Inc.
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of*

Management Information Systems, 24(3), 45-77.
<https://doi.org/10.2753/MIS0742-1222240302>

Peirce, C. S. (1905). What pragmatism is. *The Monist*, 15(2), 161-181.

Peng, W., Kanthawala, S., Yuan, S., & Hussain, S. A. (2016). A qualitative study of user perceptions of mobile health apps. *BMC Public Health*, 16(1158), 1-11.
<https://doi.org/10.1186/s12889-016-3808-0>

Peng, W., Lin, J.-H., Pfeiffer, K. A., & Winn, B. (2012). Need satisfaction supportive game features as motivational determinants: An experimental study of a self-determination theory guided exergame. *Media Psychology*, 15(2), 175-196.
<https://doi.org/10.1080/15213269.2012.673850>

Pernecky, T. (2016). *Epistemology and metaphysics for qualitative research*. Thousand Oaks, CA: Sage Publications.

Petrie, H., Weber, G., Jadhav, C., & Darzentas, J. S. (2017). Issues of culture in designing for accessibility. In *IFIP Conference on Human-Computer Interaction INTERACT 2017: Global thoughts, local designs* (pp. 55-67). https://doi.org/10.1007/978-3-319-92081-8_6

Piran, P., Thomas, J., Kunnakkat, S., Pandey, A., Gilles, N., Weingast, S., . . . Levine, S. R. (2019). Medical mobile applications for stroke survivors and caregivers. *Journal of Stroke and Cerebrovascular Diseases*, 28(11), 1-8.
<https://doi.org/10.1016/j.jstrokecerebrovasdis.2019.104318>

Pope, C., Ziebland, S., & Mays, N. (2000). Qualitative research in health care: Analysing qualitative data. *BMJ: British Medical Journal*, 320, 114-116.
<https://doi.org/10.1136/bmj.320.7227.114>

Prabhakaran, S., Zarahn, E., Riley, C., Speizer, A., Chong, J. Y., Lazar, R. M., . . . Krakauer, J. W. (2008). Inter-individual variability in the capacity for motor recovery after ischemic stroke. *Neurorehabilitation and Neural Repair*, 22(1), 64-71.
<https://doi.org/10.1177/1545968307305302>

Price, M. M., Crumley-Branyon, J. J., Leidheiser, W. R., & Pak, R. (2016). Effects of information visualization on older adults' decision-making performance in a medicare plan selection task: A comparative usability study. *Human Factors*, 3(1), e16. <https://doi.org/10.2196/humanfactors.5106>

Privacy Act.

Pugliese, M., Ramsay, T., Shamloul, R., Mallet, K., Zakutney, L., Corbett, D., . . . Wilson, K. (2019). RecoverNow: A mobile tablet-based therapy platform for early stroke rehabilitation. *PLoS One*, 14(1), e0210725.
<https://doi.org/10.1371/journal.pone.0210725>

- Pustisek, M., & Peternel, K. (2011). An inclusive mobile texting system. In G. J. Gelderblom, M. Soede, L. Adriaens, & K. Miesenberger (Eds.), *Everyday technology for independence and care [Proceedings of the 11th AAATE Conference]* (pp. 1073-1081). <https://doi.org/10.3233/978-1-60750-814-4-1073>
- Qiu, L., & Abdullah, S. (2021). Voice assistants for speech therapy. In *UbiComp '21: Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers* (pp. 211-214). <https://doi.org/10.1145/3460418.3479336>
- Qudah, B., & Luetsch, K. (2019). The influence of mobile health applications on patient-healthcare provider relationships: A systematic, narrative review. *Patient Education and Counseling*, *102*(6), 1080-1089. <https://doi.org/10.1016/j.pec.2019.01.021>
- Quinlan, C., Babin, B., Carr, J., & Griffin, M. (2019). *Business research methods*. Boston, MA: Cengage Press.
- Ramesh, V., Nguyen, A., Agrawal, K., Meyer, B. C., Cauwenberghs, G., & Weibel, N. (2020). Assessing clinicians' reliance on computational aids for acute stroke diagnosis. *Proceedings of the 14th EAI International Conference on Pervasive Computing Technologies for Healthcare. Association for Computing Machinery*, 146-155. <https://doi.org/10.1145/3421937.3422019>
- Ranta, A. (2018). Projected stroke volumes to provide a 10-year direction for New Zealand stroke services. *The New Zealand Medical Journal*, *131*(1477), 15-28. Retrieved from https://assets-global.website-files.com/5e332a62c703f653182faf47/5e332a62c703f656912fd388_Ranta-FINAL.pdf
- Ranta, A., Barber, P., Harwood, M., Cadilhac, D., McNaughton, H., Thompson, S., . . . Girvan, J. (2019). Abstract WP406: New Zealand hospital stroke service provision: A national survey. *Stroke*, *50*(Suppl_1), AWP406-AWP406. https://doi.org/10.1161/str.50.suppl_1.WP406
- Reason, P. (2006). Choice and quality in action research practice. *Journal of Management Inquiry*, *15*(2), 187-203. <https://doi.org/10.1177/1056492606288074>
- Reason, P., & Bradbury, H. (2008). *The Sage handbook of action research participative inquiry and practice*. London, UK: Sage Publications.
- Reed, A., Jofre, A., Reader, F., & Yucel, I. (2020). *Developing helpdesk mobile app to support classroom technology during COVID-19 pandemic*. Retrieved from <http://hdl.handle.net/20.500.12648/1615>

- Requena, M., Montiel, E., Baladas, M., Muchada, M., Boned, S., López, R., . . . Rodríguez-Luna, D. (2019). FARMALARM: application for mobile devices improves risk factor control after stroke. *Stroke*, *50*(7), 1819-1824. <https://doi.org/10.1161/STROKEAHA.118.024355>
- Research 2 Guidance. (2017). *Mhealth app economics 2017: Current status and future trends in mobile health*. Retrieved from <https://research2guidance.com/product/mhealth-economics-2017-current-status-and-future-trends-in-mobile-health/>
- Richardson, J., Loyola-Sanchez, A., Sinclair, S., Harris, J., Letts, L., MacIntyre, N. J., . . . McBay, C. (2014). Self-management interventions for chronic disease: A systematic scoping review. *Clinical Rehabilitation*, *28*(11), 1067-1077. <https://doi.org/10.1177/0269215514532478>
- Richardson, M. S. (2004). The emergence of new intentions in subjective experience: A social/personal constructionist and relational understanding. *Journal of Vocational Behavior*, *64*(3), 485-498. <https://doi.org/10.1016/j.jvb.2003.12.011>
- Riley, R. W. (1996). Revealing socially constructed knowledge through quasi-structured interviews and grounded theory analysis. *Journal of Travel & Tourism Marketing*, *5*(1-2), 21-40. https://doi.org/10.1300/J073v05n01_03
- Ringer, N. (2014). *The use of mobile applications in preventive care and health-related conditions: A review of the literature* (Honors thesis, University of Central Florida, UCF Daytona Beach, Orlando, FL). Retrieved from <https://stars.library.ucf.edu/honorstheses1990-2015/1647/>
- Rinne, P., Mace, M., Nakornchai, T., Zimmerman, K., Fayer, S., Sharma, P., . . . Bentley, P. (2016). Democratizing neurorehabilitation: How accessible are low-cost mobile-gaming technologies for self-rehabilitation of arm disability in stroke? *PLoS One*, *11*(10). <https://doi.org/10.1371/journal.pone.0163413>
- Robinson, R. G., & Jorge, R. E. (2016). Post-stroke depression: A review. *American Journal of Psychiatry*, *173*(3), 221-231. <https://doi.org/10.1176/appi.ajp.2015.15030363>
- Ross, J., & Gao, J. (2016). Overcoming the language barrier in mobile user interface design: A case study on a mobile health app. *arXiv*, *1605.04693*. Retrieved from <https://arxiv.org/abs/1605.04693>
- Rowan, J. (2006). The humanistic approach to action research. In P. Reason & H. Bradbury (Eds.), *Handbook of action research* (pp. 106-116). London, UK: Sage Publications.
- Sacco, R. L., Kasner, S. E., Broderick, J. P., Caplan, L. R., Connors, J., Culebras, A., . . . Higashida, R. T. (2013). An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American Heart

- Association/American Stroke Association. *Stroke*, 44(7), 2064-2089. <https://doi.org/10.1161/STR.0b013e318296aeca>
- Sadler, E., Wolfe, C. D., Jones, F., & McKeivitt, C. (2017). Exploring stroke survivors' and physiotherapists' views of self-management after stroke: A qualitative study in the UK. *BMJ Open*, 7(3). <https://doi.org/10.1136/bmjopen-2016-011631>
- Saldana, J. (2015). *The coding manual for qualitative researchers*. London, UK: Sage Publications.
- Salinas, C. D. (2000). *Toward a critical rhetoric of images: Design/writing within a corporate website* (PhD thesis, Purdue University, West Lafayette, IN.). Retrieved from <https://www.proquest.com>
- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, 4(1), 5-18. <https://doi.org/10.1080/15710880701875068>
- Sarfo, F. S., Treiber, F., Gebregziabher, M., Adamu, S., Nichols, M., Singh, A., . . . Adu-Darko, N. (2019). Phone-based intervention for blood pressure control among Ghanaian stroke survivors: A pilot randomized controlled trial. *International Journal of Stroke*, 14(6), 630-638. <https://doi.org/10.1177/1747493018816423>
- Schlatter, T., & Levinson, D. (2013). *Visual usability: Principles and practices for designing digital applications*. Waltham, MA: Morgan Kaufman.
- Schmuck, R. A. (2006). *Practical action research for change*. Washington, DC: Corwin Press.
- Schulz, R., Tompkins, C. A., & Rau, M. T. (1988). A longitudinal study of the psychosocial impact of stroke on primary support persons. *Psychology and Aging*, 3(2), 131-141. <https://doi.org/10.1037/0882-7974.3.2.131>
- Schutz, W. C. (1958). *FIRO: A three-dimensional theory of interpersonal behavior*. Pittsburgh, PA: Rinehart Publications.
- Schwandt, T. A. (1998). Constructivist, interpretivist approaches to human inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues* (pp. 221-259). Thousand Oaks, CA: Sage Publications.
- Schwarz, B., Claros-Salinas, D., & Streibelt, M. (2018). Meta-synthesis of qualitative research on facilitators and barriers of return to work after stroke. *Journal of Occupational Rehabilitation*, 28(1), 28-44. <https://doi.org/10.1007/s10926-017-9713-2>
- Sezgin, E., Özkan-Yildirim, S., & Yildirim, S. (2018). Understanding the perception towards using mHealth applications in practice: Physicians' perspective.

- Shao, Y., Zhou, J., & Wang, W. (2023). Smartphone touch gesture for right-handed older adults: touch performance and offset models. *Journal of Ambient Intelligence and Humanized Computing*, 14(3), 2549-2566. <https://doi.org/10.1007/s12652-022-04502-8>
- Shaw, S., & Tudor, K. (2022). The Emperors' new clothes: The socialisation and regulation of health professions. *Journal of Interprofessional Education & Practice*, 28, 100519. <https://doi.org/10.1016/j.xjep.2022.100519>
- Sheridan, N. F., Kenealy, T. W., Connolly, M. J., Mahony, F., Barber, P. A., Boyd, M. A., . . . Doughty, R. (2011). Health equity in the New Zealand health care system: A national survey. *International Journal for Equity in Health*, 10(45), 1-14. <https://doi.org/10.1186/1475-9276-10-45>
- Shiferaw, B., Downey, L., & Crewther, D. (2019). A review of gaze entropy as a measure of visual scanning efficiency. *Neuroscience & Biobehavioral Reviews*, 96, 353-366. <https://doi.org/10.1016/j.neubiorev.2018.12.007>
- Short, N., Harmsen, R., Kjellgren, G., O'Neill, C., Pinney, H., Rivera, A. D., & Warnaar, V. (2017). Use of Dexteria application to improve fine motor coordination in the nondominant hand. *Journal of Hand Therapy*, 30(1), 106-108. <https://doi.org/10.1016/j.jht.2016.03.014>
- Shrestha, G. S., Upadhyaya, S., Sharma, A. K., & Gajurel, B. P. (2012). Ocular-visual defect and visual neglect in stroke patients - A report from Kathmandu, Nepal. *Journal of Optometry*, 5(1), 43-49. <https://doi.org/10.1016/j.optom.2011.11.001>
- Sia, C. L., Lim, K. H., Leung, K., Lee, M. K., Huang, W. W., & Benbasat, I. (2009). Web strategies to promote internet shopping: Is cultural-customization needed? *MIS Quarterly*, 33(3), 491-512. <https://doi.org/10.2307/20650306>
- Siedlecki, S. L. (2020). Understanding descriptive research designs and methods. *Clinical Nurse Specialist*, 34(1), 8-12. <https://doi.org/10.1097/NUR.0000000000000493>
- Siegel, D., Acharya, P., & Sivo, S. (2017). Extending the technology acceptance model to improve usage & decrease resistance toward a new technology by faculty in higher education. *Journal of Technology Studies*, 43(2), 58-69. Retrieved from <https://www.jstor.org/stable/10.2307/90023142>
- Silverman, D. (2013). *Doing qualitative research: A practical handbook*. London, UK: Sage Publications.
- Simpson, D. B., Bird, M.-L., English, C., Gall, S. L., Breslin, M., Smith, S., . . . Callisaya, M. L. (2020). Connecting patients and therapists remotely using technology is

- feasible and facilitates exercise adherence after stroke. *Topics in Stroke Rehabilitation*, 27(2), 93-102. <https://doi.org/10.1080/10749357.2019.1690779>
- Singer, J., & Levine, S. R. (2016). Stroke and technology: Prescribing mHealth apps for healthcare providers, patients and caregivers – a brief, selected review. *Future Neurology*, 11(2), 109-112. <https://doi.org/10.2217/fnl-2016-0005>
- Singh, N., & Pereira, A. (2005). *The culturally customized web site*. London, UK: Routledge. <https://doi.org/10.4324/9780080481333>
- Singhal, A. (2003). Overcoming AIDS stigma: Creating safe communicative spaces. *Journal of Communication Studies*, 2(3), 33-42. Retrieved from http://utminers.utep.edu/asinghal/Articles%20and%20Chapters/Singhal_Safe_Spaces_AIDS_Stigma_J_O_Comm_St_2003.pdf
- Skelly, C. (2016). *How to declutter your design*. Retrieved from <https://medium.com/wdstack/how-to-declutter-your-design-88cbd9e45015>
- Skogestad, I. J., Kirkevold, M., Indredavik, B., Gay, C., & Lerdal, A. V. (2019). Lack of content overlap and essential dimensions – A review of measures used for post-stroke fatigue. *Journal of Psychosomatic Research*, 124(10), 1-7. <https://doi.org/10.1016/j.ipsychores.2019.109759>
- Sorensen, S. L., Pedersen, S. K. S., & Pallesen, H. (2019). Social psychological mechanisms and processes in a novel, health professional-led, self-management intervention for older stroke individuals: A synthesis and phenomenological study. *BMC Health Services Research*, 19(1), 1-15. <https://doi.org/10.1186/s12913-019-4150-x>
- Srivastva, S., Obert, S. L., & Neilsen, E. H. (1977). Organizational analysis through group processes: A theoretical perspective for organization development. In C. L. Cooper (Ed.), *Organizational development in the UK and USA* (pp. 83-111). New York, NY: Springer Press.
- Stefaniak, J. D., Geranmayeh, F., & Lambon Ralph, M. A. (2022). The multidimensional nature of aphasia recovery post-stroke. *Brain*, 145(4), 1354-1367. <https://doi.org/10.1093/brain/awab377>
- Steinert, A., Haesner, M., Tetley, A., & Steinhagen-Thiessen, E. (2016). Self-monitoring of health-related goals in older adults with use of a smartphone application. *Activities, Adaptation & Aging*, 40(2), 81-92. <https://doi.org/10.1080/01924788.2016.1158569>
- Steinhubl, S. R., Muse, E. D., & Topol, E. J. (2013). Can mobile health technologies transform health care? *JAMA*, 310(22), 2395-2396. <https://doi.org/10.1001/jama.2013.281078>

- Stewart, D. W., & Shamdasani, P. N. (1998). *Focus group research: Exploration and discovery*. London, UK: Sage Publications.
- Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M. (2015). Mobile app rating scale: A new tool for assessing the quality of health mobile apps. *mHealth and uHealth*, 3(1), 1-9. <https://doi.org/10.2196/mhealth.3422>
- Strohmann, T., Höper, L., & Robra-Bissantz, S. (2019). Design guidelines for creating a convincing user experience with virtual in-vehicle assistants. In *Proceedings of the 52nd Hawaii International Conference on System Sciences* (pp. 4813-4822). Retrieved from <https://hdl.handle.net/10125/59919>
- Styhre, A., & Sundgren, M. (2005). Action research as experimentation. *Systemic Practice and Action Research*, 18(1), 53-65. <https://doi.org/10.1007/s11213-005-2459-3>
- Sundar, S. S., Bellur, S., & Jia, H. (2012). Motivational technologies: A theoretical framework for designing preventive health applications. In M. Bang & E. L. Ragnemalm (Eds.), *Persuasive technology. Design for health and safety. PERSUASIVE 2012* (pp. 112-122). https://doi.org/doi.org/10.1007/978-3-642-31037-9_10
- Sureshkumar, K., Murthy, G., Kinra, S., Goenka, S., & Kuper, H. (2015). Development and evaluation of a smartphone-enabled, caregiver-supported educational intervention for management of physical disabilities following stroke in India: Protocol for a formative research study. *BMJ Innovations*, 1(3), 117-126. <https://doi.org/10.1136/bmjinnov-2015-000042>
- Sureshkumar, K., Murthy, G., Natarajan, S., Naveen, C., Goenka, S., & Kuper, H. (2016). Evaluation of the feasibility and acceptability of the 'Care for Stroke' intervention in India, a smartphone-enabled, carer-supported, educational intervention for management of disability following stroke. *BMJ Open*, 6(2), 1-10. <https://doi.org/10.1136/bmjopen-2015-009243>
- Tabak, M., de Vette, F., van Dijk, H., & Vollenbroek-Hutten, M. (2020). A game-based, physical activity coaching application for older adults: design approach and user experience in daily life. *Games for Health Journal*, 9(3), 215-226. <https://doi.org/10.1089/g4h.2018.0163>
- Tang, Z., Lawson, S., Messing, D., Guo, J., Smith, T., & Feng, J. (2016). Collaborative rehabilitation support system: A comprehensive solution for everyday rehab. In *2015 IEEE International Symposium on Multimedia (ISM)* (pp. 61-64). <https://doi.org/10.1109/ISM.2015.62>

- Tate, L. (2023). *The difference between speech and voice recognition*. Retrieved from <https://www.kardome.com/blog-posts/difference-speech-and-voice-recognition>
- Taylor, D., & Bury, M. (2007). Chronic illness, expert patients and care transition. *Sociology of Health & Illness*, 29(1), 27-45. <https://doi.org/10.1111/j.1467-9566.2007.00516.x>
- Taylor, S. J., Pinnock, H., Epiphaniou, E., Pearce, G., Parke, H., Schwappach, A., . . . Greenhalgh, T. (2014). A rapid synthesis of the evidence on interventions supporting self-management for people with long-term conditions (PRISMS – Practical Systematic Review of Self-Management Support for long-term conditions). *Health Services and Delivery Research*, 2(53). <https://doi.org/10.3310/hsdr02530>
- Teasell, R., Fernandez, M. M., McIntyre, A., & Mehta, S. (2014). Rethinking the continuum of stroke rehabilitation. *Archives of Physical Medicine and Rehabilitation*, 95(4), 595-596. <https://doi.org/10.1016/j.apmr.2013.11.014>
- Teasell, R., Foley, N., Hussein, N., & Speechley, M. (2007). *The elements of stroke rehabilitation*. Retrieved from https://www.researchgate.net/profile/Robert-Teasell/publication/265539955_6_The_Elements_of_Stroke_Rehabilitation/links/54e2b5550cf2c3e7d2d43e60/6-The-Elements-of-Stroke-Rehabilitation.pdf
- Thompson, K. (2017). *The neuroscience of what makes game-based learning (GBL) effective*. Retrieved from <https://businesssimulations.com/articles/the-neuroscience-of-what-makes-game-based-learning-gbl-effective>
- Thrift, A. G., Thayabaranathan, T., Howard, G., Howard, V. J., Rothwell, P. M., Feigin, V. L., . . . Cadilhac, D. A. (2017). Global stroke statistics. *International Journal of Stroke*, 12(1), 13-32. <https://doi.org/10.1177/1747493016676285>
- Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, 19(6), 349-357. <https://doi.org/10.1093/intqhc/mzm04>
- Tong, H. L., & Laranjo, L. (2018). The use of social features in mobile health interventions to promote physical activity: A systematic review. *NPJ Digital Medicine*, 1(1), 1-10. Retrieved from <https://www.nature.com/articles/s41746-018-0051-3>
- Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research & Applications*, 5, 147-158. Retrieved from <https://ethnobotanyjournal.org/index.php/era/article/view/126>
- Tousignant, M., Macoir, J., Martel-Sauvageau, V., Boissy, P., Corriveau, H., Gosselin, S., . . . Pagé, C. (2018). Satisfaction with in-home speech telerehabilitation in post-

- stroke aphasia: An exploratory analysis. *Journal of the International Society for Telemedicine and eHealth*, 6, e11 (11-18).
<https://doi.org/10.29086/JISfTeH.6.e11>
- Trombetta, M., Henrique, P. P. B., Brum, M. R., Colussi, E. L., De Marchi, A. C. B., & Rieder, R. (2017). Motion Rehab AVE 3D: A VR-based exergame for post-stroke rehabilitation. *Computer Methods and Programs in Biomedicine*, 151, 15-20.
<https://doi.org/10.1016/j.cmpb.2017.08.008>
- Tuah, N. M., Ahmedy, F., Gani, A., & Yong, L. N. (2021). A survey on gamification for health rehabilitation care: Applications, opportunities, and open challenges. *Information*, 12(2), 1-29. <https://doi.org/10.3390/info12020091>
- Van Biljon, J., & Kotzé, P. (2008). Cultural factors in a mobile phone adoption and usage model. *Journal of Universal Computer Science*, 14(16), 2650-2679. Retrieved from
http://jucs.org/jucs_14_16/cultural_factors_in_a/jucs_14_16_2650_2679_biljon.pdf
- Van Enk, A. A. (2009). The shaping effects of the conversational interview: An examination using Bakhtin's theory of genre. *Qualitative Inquiry*, 15(7), 1265-1286. <https://doi.org/10.1177/1077800409338029>
- Van Oers, C. A., van der Worp, H. B., Kappelle, L. J., Raemaekers, M. A., Otte, W. M., & Dijkhuizen, R. M. (2018). Etiology of language network changes during recovery of aphasia after stroke. *Scientific Reports*, 8(1), 1-12.
<https://doi.org/10.1038/s41598-018-19302-4>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478.
<https://doi.org/10.2307/30036540>
- Vermeeren, A. P., Law, E. L.-C., Roto, V., Obrist, M., Hoonhout, J., & Vaananen-Vainio-Mattila, K. (2010). User experience evaluation methods: Current state and development needs. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending boundaries: NordiCHI '10* (pp. 521-530).
<https://doi.org/10.1145/1868914.1868973>
- Wallace, S. E., Graham, C., & Saraceno, A. (2013). Older adults' use of technology. *Perspectives on Gerontology*, 18(2), 50-59. <https://doi.org/10.1044/gero18.2.50>
- Walls, J. G., Widmeyer, G. R., & El Sawy, O. A. (1992). Building an information system design theory for vigilant EIS. *Information Systems Research*, 3(1), 36-59.
<https://doi.org/10.1287/isre.3.1.36>
- Walsh, M. E., Galvin, R., Loughnane, C., Macey, C., & Horgan, N. F. (2015). Community re-integration and long-term need in the first five years after stroke: Results from

- a national survey. *Disability and Rehabilitation*, 37(20), 1834-1838. <https://doi.org/10.3109/09638288.2014.981302>
- Wang, X., Du, K., Zhu, K., Xu, S., & Zhang, S. (2021). Where should mobile health application providers focus their goals? *International Journal of Computational Intelligence Systems*, 14(1), 1119-1131. <https://doi.org/10.2991/ijcis.d.210305.001>
- Wang, Y., Tan, C.-W., & Clemmensen, T. (2016). Do you get better user experiences when you customize your smartphone? An experiment with object and behavior-based beliefs and attitudes. In *ECIS2016 Proceedings*. Retrieved from https://aisel.aisnet.org/ecis2016_rp/113
- Wang, Y., Zhai, G., Chen, S., Min, X., Gao, Z., & Song, X. (2019). Assessment of eye fatigue caused by head-mounted displays using eye-tracking. *Biomedical engineering online*, 18, 1-19. <https://doi.org/10.1186/s12938-019-0731-5>
- Wildenbos, G. A., Jaspers, M. W., Schijven, M. P., & Dusseljee-Peute, L. (2019). Mobile health for older adult patients: Using an aging barriers framework to classify usability problems. *International Journal of Medical Informatics*, 124, 68-77. <https://doi.org/10.1016/j.ijmedinf.2019.01.006>
- Wildenbos, G. A., Peute, L., & Jaspers, M. (2018). Aging barriers influencing mobile health usability for older adults: A literature based framework (MOLD-US). *International Journal of Medical Informatics*, 114, 66-75. <https://doi.org/10.1016/j.ijmedinf.2018.03.012>
- Williamson, G. R., & Prosser, S. (2002). Action research: Politics, ethics and participation. *Journal of Advanced Nursing*, 40(5), 587-593. <https://doi.org/10.1046/j.1365-2648.2002.02416.x>
- Winberg, C., Kylberg, M., Pettersson, C., Harnett, T., Hedvall, P.-O., Mattsson, T., & Månsson, E. L. (2017). The use of apps for health in persons with multiple sclerosis, Parkinson's disease and stroke - barriers and facilitators. *Studies in Health Technology and Informatics*, 242, 638-641. Retrieved from <https://europepmc.org/article/med/28873864>
- Winstein, C. J., Stein, J., Arena, R., Bates, B., Cherney, L. R., Cramer, S. C., . . . Harvey, R. L. (2016). Guidelines for adult stroke rehabilitation and recovery. *Stroke*, 47(6), e98-e169. <https://doi.org/10.1161/STR.0000000000000098>
- Wong, D., Wang, Q., Stolwyk, R., & Ponsford, J. (2017). Do smartphones have the potential to support cognition and independence following stroke? *Brain Impairment*, 18(3), 310-320. <https://doi.org/10.1017/BrImp.2017.10>
- Woodman, P., Riazi, A., Pereira, C., & Jones, F. (2014). Social participation post stroke: A meta-ethnographic review of the experiences and views of community-dwelling

- stroke survivors. *Disability and Rehabilitation*, 36(24), 2031-2043. <https://doi.org/10.3109/09638288.2014.887796>
- World Health Organization. (2018a). *mHealth: New horizons for health through mobile technologies: Second global survey on ehealth* Geneva, Switzerland: WHO Press.
- World Health Organization. (2018b). *Stroke: A global response is needed*. Retrieved from <http://www.who.int/bulletin/volumes/94/9/16-181636/en/>
- World Stroke Organization. (2019). *Facts and figures about stroke*. Retrieved from <https://www.world-stroke.org/component/content/article/16-forpatients/84-facts-and-figures-about-stroke>
- Woytowicz, E. J., Rietschel, J. C., Goodman, R. N., Conroy, S. S., Sorkin, J. D., Whittall, J., & Waller, S. M. (2017). Determining levels of upper extremity movement impairment by applying a cluster analysis to the Fugl-Meyer assessment of the upper extremity in chronic stroke. *Archives of Physical Medicine and Rehabilitation*, 98(3), 456-462. <https://doi.org/10.1016/j.apmr.2016.06.023>
- Wray, F., Clarke, D., & Forster, A. (2018). Post-stroke self-management interventions: A systematic review of effectiveness and investigation of the inclusion of stroke survivors with aphasia. *Disability and Rehabilitation*, 40(11), 1237-1251. <https://doi.org/10.1080/09638288.2017.1294206>
- Wu, L., Li, J.-Y., & Fu, C.-Y. (2011). The adoption of mobile healthcare by hospital's professionals: An integrative perspective. *Decision Support Systems*, 51(3), 587-596. <https://doi.org/10.1016/j.dss.2011.03.003>
- Wu, Y.-H., Damnée, S., Kerhervé, H., Ware, C., & Rigaud, A.-S. (2015). Bridging the digital divide in older adults: A study from an initiative to inform older adults about new technologies. *Clinical Interventions in Aging*, 10, 193. <https://doi.org/10.2147/CIA.S72399>
- Xcertia mHealth App Guidelines. (2019). Retrieved from <https://www.himss.org/sites/hde/files/media/file/2020/04/17/xcertia-guidelines-2019-final.pdf>
- Xiao, L., Gao, Y., & Zhang, L. (2019). Consensus development of components of continuity of care for stroke patients: A Delphi methodology. *Journal of Public Health*, 27(3), 273-279. <https://doi.org/10.1007/s10389-018-0964-y>
- Xie, Z., & Kalun Or, C. (2020). Acceptance of mHealth by elderly adults: A path analysis. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 64, pp. 755-759): SAGE Publications Sage CA: Los Angeles, CA. <https://doi.org/10.1177/1071181320641174>

- Yan, L. L., Li, C., Chen, J., Miranda, J. J., Luo, R., Bettger, J., . . . Zhao, D. (2016). Prevention, management, and rehabilitation of stroke in low-and middle-income countries. *eNeurologicalSci*, 2, 21-30. <https://doi.org/10.1016/j.ensci.2016.02.011>
- Yeng, A. C. M., Han, P. Y., How, K. W., & Yin, O. S. (2022). Hand Gesture Controlled Game for Hand Rehabilitation *Atlantis Press*. Symposium conducted at the meeting of the International Conference on Computer, Information Technology and Intelligent Computing (CITIC 2022)
- Yourganov, G., Fridriksson, J., Rorden, C., Gleichgerrcht, E., & Bonilha, L. (2016). Multivariate connectome-based symptom mapping in post-stroke patients: Networks supporting language and speech. *Journal of Neuroscience*, 36(25), 6668-6679. <https://doi.org/10.1523/JNEUROSCI>
- Yu, K., Wu, S., Liu, R., & Chi, I. (2021). Harnessing mobile technology to support type 2 diabetes self-management among Chinese and Hispanic immigrants: A mixed-methods acceptability study. *Journal of Ethnic & Cultural Diversity in Social Work*. Advance online publication. <https://doi.org/10.1080/15313204.2021.1949775>
- Zapata, B. C., Fernandez-Aleman, J. L., Idri, A., & Toval, A. (2015). Empirical studies on usability of mHealth apps: A systematic literature review. *Journal of Medical Systems*, 39(1), 1-19. <https://doi.org/10.1007/s10916-014-0182-2>
- Zarour, M., & Alharbi, M. (2017). User experience aspects and dimensions: Systematic literature review. *International Journal of Knowledge Engineering*, 3(2), 52-59. <https://doi.org/10.18178/ijke.2017.3.2.087>
- Zhang, H., Liang, L. L., & Wang, Y. L. (2018). Acceptance of smartphone application for home patients with stroke. *Chinese Journal of Rehabilitation Theory and Practice* 24, 824-827. <https://doi.org/10.3969/j.issn.1006-9771.2018.07.013>
- Zhang, H., Wang, T., Zhang, Z., Lin, B., Mei, Y., Zhang, Y., & Chen, G. (2020). The current status of stroke-related smartphone applications available to adopt in China: A systematic review study. *Medicine*, 99(27). <https://doi.org/10.1097/MD.00000000000020656>
- Zhang, M., Luo, M., Nie, R., & Zhang, Y. (2017). Technical attributes, health attribute, consumer attributes and their roles in adoption intention of healthcare wearable technology. *International Journal of Medical Informatics*, 108, 97-109. <https://doi.org/10.1016/j.ijmedinf.2017.09.016>
- Zhang, X., Han, X., Dang, Y., Meng, F., Guo, X., & Lin, J. (2017). User acceptance of mobile health services from users' perspectives: The role of self-efficacy and response-efficacy in technology acceptance. *Informatics for Health and Social Care*, 42(2), 194-206. <https://doi.org/10.1080/17538157.2016.1200053>

Zhou, J., Rau, P.-L. P., & Salvendy, G. (2014). Age-related difference in the use of mobile phones. *Universal Access in the Information Society*, 13(4), 401-413. <https://doi.org/10.1007/s10209-013-0324-1>

Appendix A: Flyer designed to invite individuals to take part in this inquiry



Use of mobile-based self-management applications among older adults post-stroke: Barriers and Drivers

Recruitment for research

Are you a person with a stroke? Or are you a health care professional who works with stroke survivors? Or are you a health-related mobile-based applications designer? We are interested in speaking with you about what factors may influence the acceptance and usage of mobile health applications by stroke survivors. What are your experiences with mobile health technologies? What are your perspectives on mobile-based self-management applications?



YOU ARE INVITED

We are keen to hear from adults who are ≥ 55 years old post-stroke, as well as those working with people who have experienced a stroke.

We hope the findings from this research give us insights into the development of effective guidelines to assist app designers to design mobile-based self-management applications that are personalised to what matters most to people living with stroke.

Your participation in this study is entirely voluntary but your help is greatly appreciated.

If you agree to participate, please contact us to learn more about this research.

Supervisors:

Dr. Robert Wellington	Email: robert.wellington@aut.ac.nz	Phone: 09 921 9999 ext 5432
Assoc. Prof. Nicola Kayes	Email: nicola.kayes@aut.ac.nz	Phone: 09 921 9999 ext 7309
Assoc. Prof. Dave Parry	Email: dave.parry@aut.ac.nz	Phone: 09 921 9999 ext 8918

Researcher:

Soheila Mohammadyari	Email: soheila.mohammadyari@aut.ac.nz	Phone: 09 921 9999 ext 5831
----------------------	---	-----------------------------

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AU TEC ref no. 17/364

Appendix B: Information sheet designed for stroke survivors



Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

14/11/2017

Participant Information Sheet: Stroke survivors

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

Dear participant,
Kia Ora

INVITATION

YOU ARE INVITED to take part in research aiming to explore and understand the perspectives of older adults who are ≥ 55 years old post-stroke using mobile-based self-management applications to manage their illness and have a healthy life. Participants are eligible who are more than six months post-diagnosis, and experiencing ongoing difficulties managing their health and wellbeing. This study is being carried out by the researcher, a PhD student at AUT University. This information sheet will explain the research study. We appreciate your time reading this material. Your participation in this study is entirely voluntary but your help is greatly appreciated. If you agree to participate, please indicate your consent by signing the Consent Form supplied.

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

WHAT IS THE PURPOSE OF THIS RESEARCH?

We are hoping to talk to 15 people with stroke. We will conduct this through interviews. We are hoping to interview the same participant more than once. Therefore, there might be a possibility to conduct more than one interview with participants.

We are interested in speaking with you about your perspectives on mobile-based self-management applications. What hinders or drives the acceptance of such technology by people with stroke, what do you think about self-management applications that can improve post-stroke care?

HOW WAS I IDENTIFIED AND WHY AM I BEING INVITED TO PARTICIPATE IN THIS RESEARCH?

The Stroke Foundation of New Zealand, TalkLink Trust and local stroke communities in Auckland, New Zealand, were contacted and the invitation pack included a flyer, information sheet and a consent form was sent for distribution in their networks. My details were passed on to potential participants.

We are conducting this research to increase our understanding of how mobile-based self-management applications are perceived and experienced by older adults post stroke. As a stroke survivor, you are in an ideal position to give us valuable first-hand information from your own perspective.

HOW DO I AGREE TO PARTICIPATE IN THIS RESEARCH?

You will be asked to fill out a Consent Form prior to commencing an interview. Please note that your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed and allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

WHAT WILL HAPPEN IN THIS RESEARCH?

Interviews will take approximately 60 minutes to complete and will be held at a time and location convenient to you. Interviews will be audio recorded and transcribed.

WHAT ARE THE DISCOMFORTS AND RISKS?

The researcher does not intend to cause any discomfort for participants. The information collected will be aggregated and anonymized so that it will not be linked to any particular individual(s). Your individual data will not be shared. You can choose not to answer any questions you do not feel comfortable answering and can choose to cease your involvement in the interview at any time.

WHAT ARE THE BENEFITS?

The findings of this study will help health care professionals, mHealth app developers, stroke survivors, and mHealth researchers better understand the factors hindering and supporting self-management by use of mobile-based applications among people following stroke. The outcome of this study will be used to develop a set of guidelines to help stroke-related mobile applications developers, and designers to develop applications to be accepted by stroke survivors to support self-management.

HOW WILL MY PRIVACY BE PROTECTED?

The primary researcher will assure the confidentiality of the participants in interviews. The researcher can ensure that when writing up the report, participants' names will not be used. All the data collected will be securely stored and is only accessible for the primary researcher and her supervisors.

WHAT ARE THE COSTS OF PARTICIPATING IN THIS RESEARCH?

The time commitment will be 40-60 minutes. Should you prefer not to participate, or if you wish to cease participation at any time, you are free to do so.

WHAT OPPORTUNITY DO I HAVE TO CONSIDER THIS INVITATION?

One week



WILL I RECEIVE FEEDBACK ON THE RESULTS OF THIS RESEARCH?

If you would like to receive a summary of our findings you can indicate this on the Consent Form and provide your contact details. These will be sent to you at the end of the study.

WHAT DO I DO IF I HAVE CONCERNS ABOUT THIS RESEARCH?

Any concerns regarding the nature of this project should be notified in the first instance to the project supervisors; Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTECH, Kate O'Connor, kate.oconnor@aut.ac.nz 09 921 9999 ext. 6038

WHOM DO I CONTACT FOR FURTHER INFORMATION ABOUT THIS RESEARCH?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

RESEARCHER CONTACT DETAILS:

Soheila Mohammadyari, PhD student, School of Engineering, Computer and Mathematical Sciences (SECMS), DCT faculty, WT025 (office), the Auckland University of Technology (AUT), 09 921 9999 ext. 5831. soheila.mohammadyari@aut.ac.nz.

PROJECT SUPERVISORS CONTACT DETAILS:

Dr. Robert Wellington: robert.wellington@aut.ac.nz 09 921 9999 ext. 5432

Assoc. Prof. Nicola Kayes: nkayes@aut.ac.nz 09 921 9999 ext. 7309

Assoc. Prof. Dave Parry: dave.parry@aut.ac.nz 09 021 9999 ext. 8918

I thank you in advance for your support of this research project.

Sincerely,

Soheila Mohammadyari

Appendix C: Information sheet designed for app designers and HCPs

The logo for Auckland University of Technology (AUT) is displayed in white, bold, sans-serif capital letters on a black rectangular background.

Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

14/11/2017

Participant Information Sheet:
App designers and HCPs

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

Dear participant,
Kia Ora

YOU ARE INVITED to take part in a research aiming to explore and understand your perspectives as health care professionals working with older adults post stroke or as app designers of mobile-based self-management applications to identify what factors affect on accepting such mobile applications among stroke survivors to manage their illness and have a healthy life. Participants are eligible who have 5+ years of professional experience. This study is being carried out by the researcher, a PhD student at AUT University. This information sheet will explain the research study. We appreciate your time reading this material. Your participation in this study is entirely voluntary but your help is greatly appreciated. If you agree to participate, please indicate your consent by signing the Consent Form supplied.

WHAT IS THE PURPOSE OF THIS RESEARCH?

We are hoping to talk to 15 health care professionals and app designers who are currently working with people with stroke. We will primarily conduct this through focus groups but may also do some individual interviews. There might be a possibility to conduct more than one interview with participants. We are interested in speaking with you about your perspectives on mobile-based self-management applications for stroke survivors. What hinders or drives the acceptance of such technology by people with stroke? What do you think about self-management applications that can improve post-stroke care?

HOW WAS I IDENTIFIED AND WHY AM I BEING INVITED TO PARTICIPATE IN THIS RESEARCH?

Participants were recruited using a range of different sources such as privately-owned mobile applications designing/developing companies, the University of Auckland and AUT. For health care professionals, the Stroke Foundation of New Zealand, TalkLink Trust and local stroke communities in Auckland, New Zealand, were contacted and the invitation pack included a flyer, information sheet and a consent form was sent for distribution in their networks. My details were passed on to potential participants.

HOW DO I AGREE TO PARTICIPATE IN THIS RESEARCH?

You will be asked to fill out a Consent Form prior to commencing an interview or focus group. Please note that your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, the removal of your data may not be possible.

WHAT WILL HAPPEN IN THIS RESEARCH?

Individual interviews and Focus groups will take approximately 40-60 minutes and 90 minutes respectively to complete and will be held at a time and location convenient to participants. Focus groups and interviews will be audio-recorded and transcribed.

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AU/TEC ref no. 17/364

WHAT ARE THE DISCOMFORTS AND RISKS?

The researcher does not intend to cause any discomfort for participants. The information collected will be aggregated and anonymised so that it will not be linked to any particular individual(s). Your individual data will not be shared. You can choose not to answer any questions you do not feel comfortable answering and can choose to cease your involvement in the interview at any time.

WHAT ARE THE BENEFITS?

The findings of this study will help health care professionals, mHealth app developers, stroke survivors, and mHealth researchers better understand the factors hindering and supporting self-management by use of mobile-based applications among people following stroke. The outcome of this study will be used to develop a set of guidelines to help stroke-related mobile apps developers, and designers to develop apps to be accepted by stroke survivors to support self-management.

HOW WILL MY PRIVACY BE PROTECTED?

The primary researcher will assure the confidentiality of the participants in interviews but the researcher cannot assure confidentiality in focus groups because the researcher cannot control other participants. The researcher can ensure that when writing up the report, participants' names will not be used. All the data collected will be securely stored and is only accessible for the primary researcher and her supervisors.

WHAT ARE THE COSTS OF PARTICIPATING IN THIS RESEARCH?

The time commitment will be 40-90 minutes. Should you prefer not to participate, or if you wish to cease participation at any time, you are free to do so.

WHAT OPPORTUNITY DO I HAVE TO CONSIDER THIS INVITATION?

One week

WILL I RECEIVE FEEDBACK ON THE RESULTS OF THIS RESEARCH?

If you would like to receive a summary of our findings you can indicate this on the consent form and provide your contact details. These will be sent to you at the end of the study.

WHAT DO I DO IF I HAVE CONCERNS ABOUT THIS RESEARCH?

Any concerns regarding the nature of this project should be notified in the first instance to the project supervisors; Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTECH, Kate O'Connor, kate.oconnor@aut.ac.nz 09 921 9999 ext. 6038

WHOM DO I CONTACT FOR FURTHER INFORMATION ABOUT THIS RESEARCH?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

RESEARCHER CONTACT DETAILS:

Soheila Mohammadyari, PhD student, School of Engineering, Computer and Mathematical Sciences (SECMS), DCT faculty, WT025 (office), the Auckland University of Technology (AUT), 09 921 9999 ext. 5831. soheila.mohammadyari@aut.ac.nz.

PROJECT SUPERVISORS CONTACT DETAILS:

Dr. Robert Wellington:	robert.wellington@aut.ac.nz	09 921 9999 ext. 5432
Assoc. Prof. Nicola Kayes:	nkayes@aut.ac.nz	09 921 9999 ext. 7309
Assoc. Prof. Dave Parry:	dave.parry@aut.ac.nz	09 021 9999 ext. 8918

I thank you in advance for your support of this research project.

Sincerely,

Soheila Mohammadyari

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AU TEC ref no. 17/364

Appendix D: Consent form designed for focus group interviews



Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

Focus group consent form

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

By signing below, I acknowledge that...

- I have read and understood the information provided about this research project in the Information Sheet dated 14/11/2017.
- I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- I understand that notes will be taken during the focus group and that they will be also audio-recorded and transcribed.
- I understand that confidentiality may not be guaranteed because what other members do cannot be controlled.
- I know that no material that could identify me will be used in any reports on this study.

I agree to take part in this research

Name:

Signature:

Date:

I would like to receive a copy of the findings Yes No

I am happy to participate in further focus group and interviews in this research Yes No

Participant contact details

Phone:

Email:

Postal Address:

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Appendix E: Consent form designed for individual interviews



Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

Interview consent form

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

By signing below I acknowledge that...

- I have read and understood the information provided about this research project in the Information Sheet dated 14/11/2017.
- I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- I understand that notes will be taken during the interview and that they will be also audio-recorded and transcribed.
- I know that no material that could identify me will be used in any reports on this study.

I agree to take part in this research

Name:

Signature:

Date:

I would like to receive a copy of the findings

Yes No

I am happy to participate in further interview

Yes No

Participant contact details

Phone:

Email:

Postal Address:

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Appendix F: The focus group protocol



Use of mobile-based self-management applications among older adults post-stroke: Barriers and Drivers

Focus Group Protocol

Before focus groups start, the following procedures will be followed:

Testing materials

- Audio-recording equipment
- Speakerphone
- Information Sheet to read before the interview commences
- Consent Form to get participants to sign before the interview commences
- Interviewer clock
- Snack and drinks
- Checking the venue for the discussion

A skilled moderator will be appointed

Procedure for obtaining informed consent

All interviewees will be given a Consent Form to sign prior to the interview begins. Interviewees will be requested to review, ask any questions, and then sign the Consent Form. Participants will be provided with a copy of the Consent Form. Interviewees will also have an opportunity to read the Information Sheet (again) before the discussion.

Focus groups will begin with providing introductory comments:

Welcoming.

Thanking participants for agreeing to do this discussion.

Introducing myself - My name is Soheila

Explain the purpose of the interviews - to understand your experiences and

perspectives on the acceptance and use of mobile health technologies related to self-care, engagement, and interaction among stroke survivors.
Duration - the focus group may last about 90 minutes.

Explaining ground rules:

- I cannot guarantee confidentiality because I cannot necessarily control what other members do. However, I can guarantee that everything participants tell me will be confidential. I will ensure to protect the privacy of participants; we won't connect the name of participants with anything that they say. Nothing interviewees say will be ascribed to them in any reports that come out of this discussion. All reports will be written in a manner that no interviewee's comments can be attributed to a particular interviewee.
- Please respect others and their confidentiality. What is said in the group stays in the room, 'please do not share other attendees' identities or what anyone says in this group discussion'.
- During our discussion, please notify me if you need anything, if you have any queries or if you would wish not to respond to any specific questions.
- Participants can stop the discussion at any time.
- Reminding - please remember that we want to know what your perspectives are, your experiences, and what you think about mobile health technologies and that there are no right or wrong responses.
- If you feel uncomfortable during the discussion, there is no consequence for leaving. Being here is voluntary.
- I will make sure that one interviewee talks at a time.
- It is okay to take a break if needed or to help yourself to eat or drink (will be provided, any dietary requirements will be asked).
- The discussion will be taking notes about what is discussed.
- Attendees will be asked to seat in a circle to have a high level of interaction.
- An assistant facilitator (moderator) will be here to assist me to undertake the focus group.
- All discussions will be audio recorded.

Discussions:

To help to break the ice and begin the conversation I will start with: Hello my name is Soheila, and since you have read the information sheet:

App designers: I am interested in listening to and exploring your experiences in relation to the design of mHealth applications.

HCPs: I am interested in learning and exploring your experiences of working with people with stroke and how their impairment may impact using mobile-based applications to support self-management.

Indicative questions: for app designers

1. Can you tell me about your experiences working on mobile health-related applications?
[Probe: Have you experienced any challenges?]
2. What concerns are you taking into account when you are designing a mobile health application?
[Probe: are you getting application users to engage in designing an application?]
3. What factors affect designing and developing a mobile health application?
[Probe: any barriers to designing an application?]

Indicative questions: for HCPs

1. Can you tell me about your experiences working with people with stroke?
[Probe: What challenges did you experience?]
2. Can you tell me what you know of the consequences of stroke and how that impacts the person's everyday functioning?
3. How do people with stroke currently manage their condition?
[Probe: Are they getting any support?]
4. Can you tell me about any experience you have with using mobile health applications to support people with stroke?
[Probe: Any barriers to using applications?]

(OR if they have not used mobile health applications to support people with stroke – Can you tell me what your thoughts are on the potential of using mobile apps to support people with stroke? [Probe: What kinds of things do you imagine would help or hinder acceptance of and engagement with mobile health applications following stroke?])

Note: There may be two or three focus groups, thus questions for discussion will be tailored to suit each focus group.

Closing:

- Do any of you have anything further to add to what we have discussed today? Or other areas that we did not discuss but you think are important?

Thank you for your time

Appendix G: Demographic form designed for app designers and HCPs



Use of mobile-based self-management applications among older adults post-stroke: Barriers and Drivers

Demographic information for HCPs and app designers

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

-
1. Participant initials
 2. Age
 3. Gender: Female Male
 4. Ethnicity:
 5. Profession/s:
 6. How long have you been in this position?

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Appendix H: Confidentiality Agreement Form



Confidentiality Agreement

Project title: **Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers**
Project Supervisor: **Robert Wellington**
Researcher: **Soheila Mohammadyari**

- I understand that all the material I will be asked to collect or take notes is confidential.
- I understand that the contents of the notes or recordings can only be discussed with the researcher.
- I will not keep any copies of the transcripts/notes nor allow third parties access to them.

Moderator's signature:

Moderator's name:

Moderator's Contact Details (if appropriate):

.....
.....
.....
.....

Date:

Project Supervisors' Contact Details (if appropriate):

Dr. Robert Wellington: robert.wellington@aut.ac.nz 09 921 9999 ext. 5432

Assoc. Prof. Nicola Kayes: nkayes@aut.ac.nz 09 921 9999 ext. 7309

Assoc. Prof. Dave Parry: dave.parry@aut.ac.nz 09 021 9999 ext. 8918

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Note: The moderator should retain a copy of this form.

Appendix I: The individual interviews protocol

The logo for AUT (Autism Treatment Unit) is displayed in white, bold, sans-serif capital letters on a black rectangular background. This logo is positioned on the right side of a horizontal orange bar that spans the width of the page header.

Use of mobile-based self-management applications among older adults post-stroke: Barriers and Drivers

Individual Interview Protocol

Before the interviews start, the following procedures will be followed:

Testing materials

- Audio-recording equipment
- Speakerphone
- Information Sheet to read before the interview commences
- Consent Form to get participants to sign before the interview commences
- Interviewer clock
- Snack and drinks
- Checking the venue for the discussion

Procedure for obtaining informed consent

Interviewees will be given a Consent Form to sign before the interview commences. Participants will be asked to review, ask any questions, and then sign the Consent Form. Each interviewee will be offered a copy of the Consent Form. Interviewees will be also offered an opportunity to read the Information Sheet (again) before the interview.

Interviews will begin with providing introductory comments:

Welcoming.

Thanking participants for agreeing to take part in this research.

Introducing myself - My name is Soheila

Explain the purpose of the interview - to understand your experiences and perspectives with mobile health technologies related to self-care and engagement.

Duration - the interview may last about 1 hour.

Explaining ground rules:

- Anything participants disclose to me will be confidential. To protect participants' privacy, I won't connect the participants' names with anything that they say. Nothing interviewees say will be ascribed to them in any reports that come out of this interview. All reports will be written in a manner that no interviewee's comments can be ascribed to a particular interviewee.
- During our conversation, please notify me if you need anything, if you have any queries or if you would wish not to respond to any specific questions.
- Participants can stop the interview at any time.
- Reminding - please remember that we want to know what your perspectives and experiences are and what you think about mobile health technologies and that there are no right or wrong responses.
- If you feel uncomfortable during the meeting, there is no consequence for leaving. Being here is voluntary.
- It is okay to take a break if needed or to help yourself to eat or drink (will be provided).
- The interviewer will be taking notes about what is discussed.
- The interviews will be recorded.

Discussions:

Note: The objective is to get the interviewees talking about their perspectives. Indicative questions will be used mainly when the interview stalls.

Indicative questions:

To help to break the ice and begin the conversation I will start with: Hello my name is Soheila, and since you have read the information sheet, I am interested in learning the role of mobile technologies in people's post-stroke recovery. What factors may affect the acceptance of these technologies?

1. You may want to start to tell me about anything that is important to you, as I am looking to explore your perspectives and views, therefore, I am hoping I do not need to ask you too many questions
[Probe: what can you tell me? Tell me about yourself]
2. Could you please tell me about your experiences after a stroke?
[Probe: how was your recovery? Did you get any support?]
3. Can you share your experiences with mobile devices?
[Probe: are you using a mobile phone?]

Note: consistent with the research methodology (Action Research), there may be participants who are repeatedly interviewed, thus interview questions will be tailored to suit the previous discussion/conversation.

Closing

- Is there anything else that you wish to add?

Thank you for your time

Appendix J: Demographic form designed for stroke survivors



Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

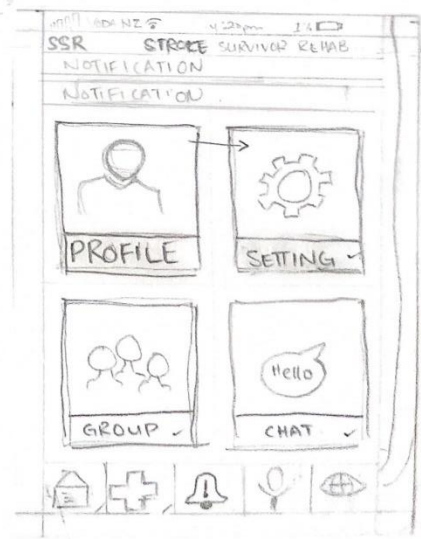
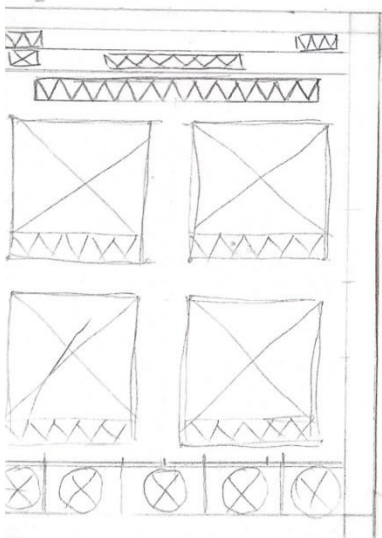
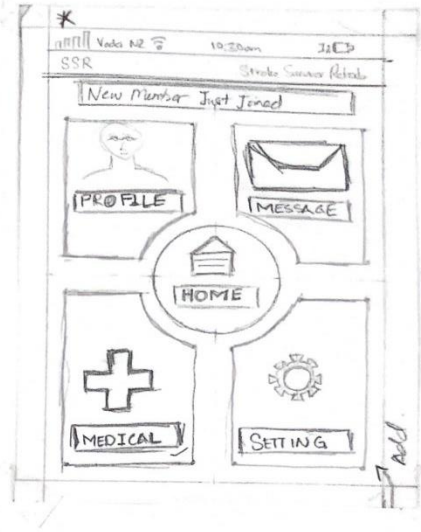
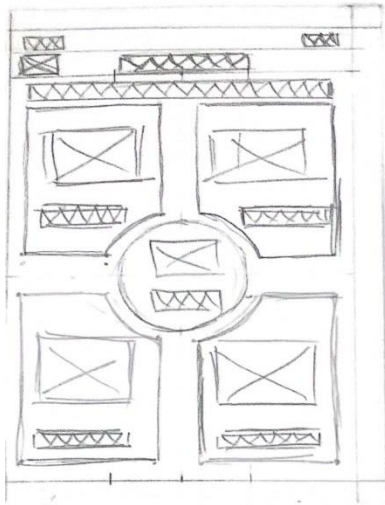
Demographic Information For Stroke Survivors

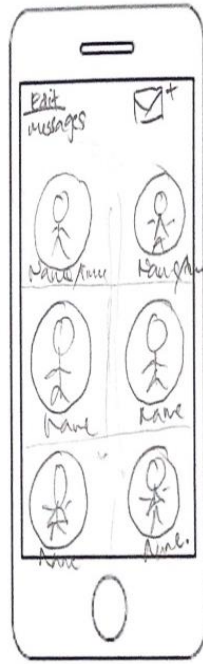
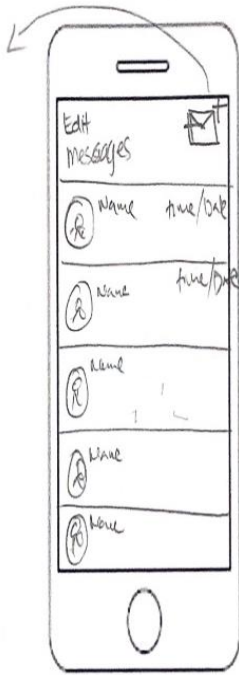
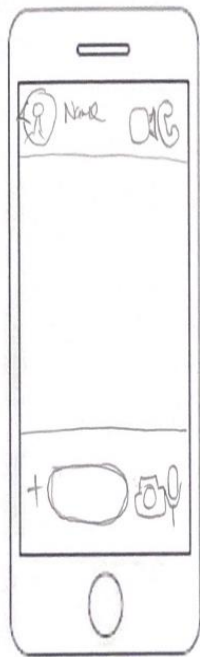
Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, and Assoc. Prof. Dave Parry
Researcher: Soheila Mohammadyari

-
1. Participant initials
2. Age
3. Gender: Female Male
4. Ethnicity:
5. Living Situation: Alone with family with caregiver
6. Date of stroke:

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Appendix K: Some screenshots of the paper-based prototype





Notes:
 when you open up a message
 you are able to see the person's
 profile & name, you are
 able to video call or
 audio call another member
 you are able to send
 text, photo and voice
 send.

edit: allows you to delete
 message
 set ~~message~~ as read
 hide message.

message icon on the top right
 (which allows you to write
 a new message to one
 of your friends)

Notes:
 having it bigger allows
 the members to see it
 more clear and to be
 able to see the other
 member's profile
 so that they know
 who they are messaging.

SM

Appendix L: Development of the prototype

While employing the proposed guidelines in the design, the design of the prototype focused on creating a virtual space for survivors to interact with each other. The idea of designing a social platform for survivors was considered to explicitly address guideline #1. It was believed the virtual space would also allow survivors to connect to their health care providers and get professional advice. In this way, HCPs would be able to monitor their patients' progress. It was hoped the interactive nature of this application may contribute to survivors becoming less likely to isolate, experience less depression, and more likely to be encouraged, and motivated to participate in rehabilitation. In the development of this prototype, survivors' concerns including post-stroke complications such as physical complications were accounted for with the intention of increasing the acceptance of the application. The findings from app designers identified some influential factors, which were integrated into the design of the prototype. As a solution, the 'eye-gazing' feature was identified as one of the main features to help survivors to use such an application.

Simplicity was the main focus of the design process. A platform that is simple, easy to use, see (referring to colour and font size), and navigate connects to guideline #10. The prototype included icons and fonts that are large enough to be noticeable. It was aimed at simplicity with simple steps required to accomplish a task. By applying simplicity concept, I endeavoured to consider simple navigability, decluttering, visual weights, and consistency aspects in the prototype to address poor digital literacy (see guidelines #4 & 10) that some survivors may experience. The following subsections include application pages and the features that were applied in the development of the prototype.

Colours, font size, and suitable size for the icons

Guideline #8 was applied across all pages of the prototype with all colours chosen based on a common agreement achieved by the design team on how suitable they can be for survivors. However, the extent to which chosen colours will be accepted in different cultures remain uncertain and further investigation is required. The main colours were blue, light blue and white for the background, dark blue and grey, and black for text. Blue is known as a calm and strong colour. Font size 16 was chosen to ensure that survivors can see the content.

The sign-up page

Figure 0.1 illustrates the first page which is the sign-up page. The *sign-up* page is simple and decluttered, and all survivors need is their patient ID number. Some survivors may find it hard to input details such as their full name, address, and phone number. These data can be entered by the medical department that is stored under the patient ID number, as such, when a patient wants to join the application all they need is their ID number. Although, some survivors may not feel comfortable being connected to their medical records.

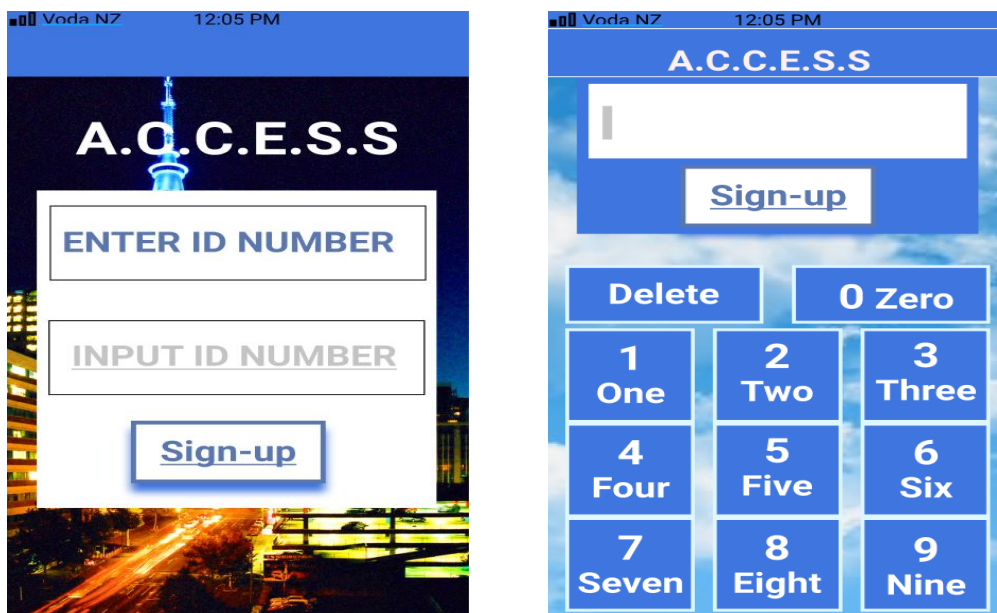


Figure 0.1: Screenshots of the sign-in and sign-up pages

The main page

Considering propositions in guideline #1, the main page includes a notification and reminder notification. The importance of having a notification feature on the main page is to allow users to know who is new to the application, who has posted a status or story, and what events are coming up. The aim is to keep users up to date with news and updates. Another feature included is the reminder notification. The reminder notification reminds survivors of what they did previously when using the application, when to take their medication, or when an upcoming event is happening. The aim of having reminder notifications is to support those who are experiencing cognitive impairment and memory issues. As such, the aim was to support survivors by reminding them of their day-to-day tasks. Figure 0.2 shows the main page contains five sections that are discussed below:

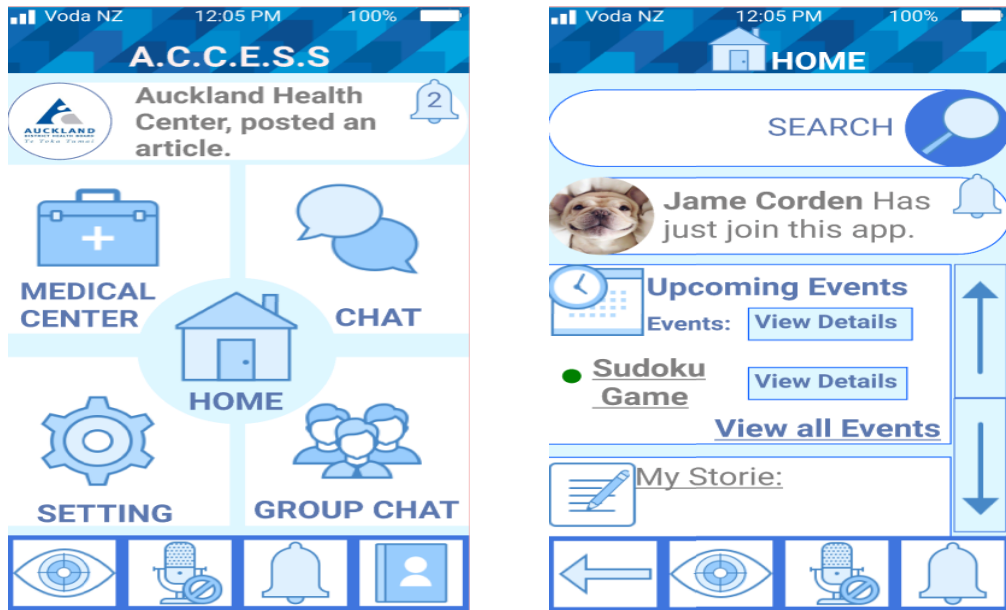


Figure 0.2: Screenshots of the main pages

1- *The medical centre*

The idea behind the project was to design, implement, and develop a working prototype that will deliver the idea of allowing survivors to connect with their HCPs as well. The '*medical centre*', has the following pages:

a) **Medical reminder**

The '*medical reminder*' includes a list of medications that the patient is taking. These features include the date, time, and the medication that needs to be taken as well as whether the medication should be taken with food or not. The main purpose of this medical reminder is to help out those who have trouble remembering things, such as remembering to take their medication (see Figure 0.3).

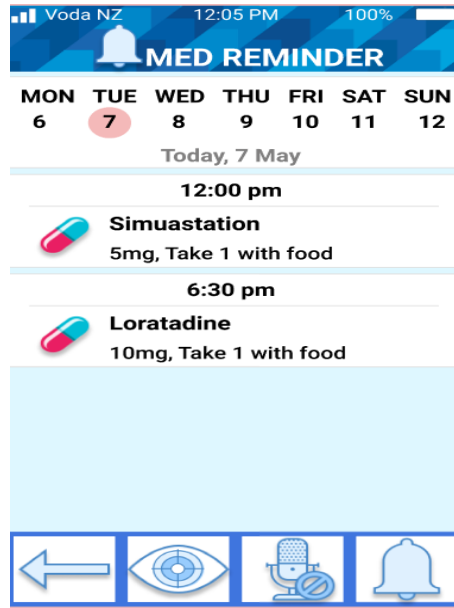


Figure 0.3: A screenshot of the Med reminder page

b) Med info

The '*med info*', is a prescription of what medications the patient is taking. Such as what is the medication and what is the purpose of the medication. The main purpose of this feature is to remind patients what medications they are taking (see Figure 0.4).

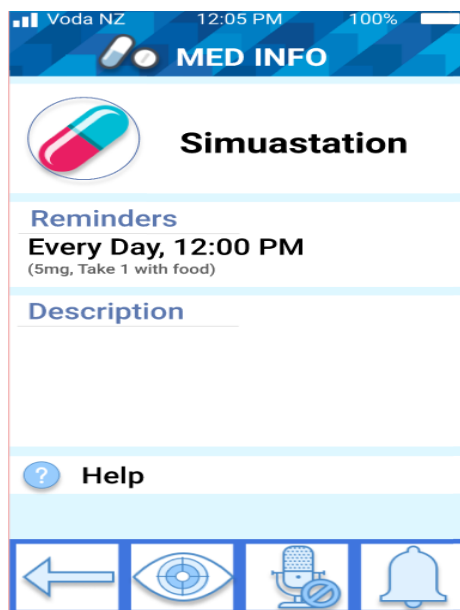


Figure 0.4: A screenshot of the Med info page

c) Book appointment

Booking an appointment is a feature that allows patients to book an appointment with their HCPs. The process of booking an appointment is very simple and is shown in Figure 0.5. The first step is to select their doctor's or HCP's name and the date. Some dates will be highlighted in red, indicating that the doctor/HCP is not available or is fully booked on that day. The dates that are white mean that the doctor is available. Once a date is selected, the user will be able to move on to the select a time. Similar to the date, times highlighted in red mean that the doctor is not available. Once the doctor/HCP, date, and time have been confirmed the doctor/HCP will automatically receive the patient's appointment booking.

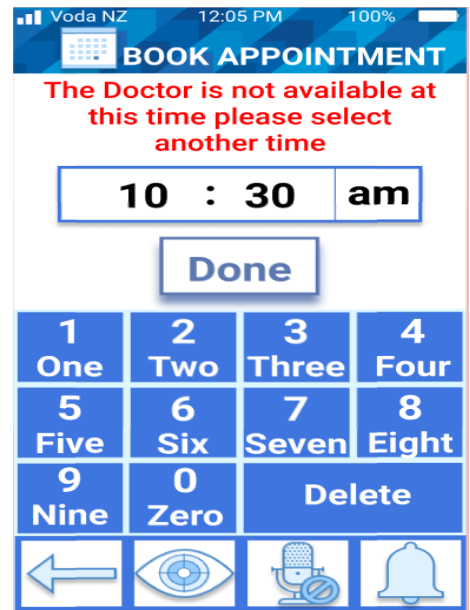
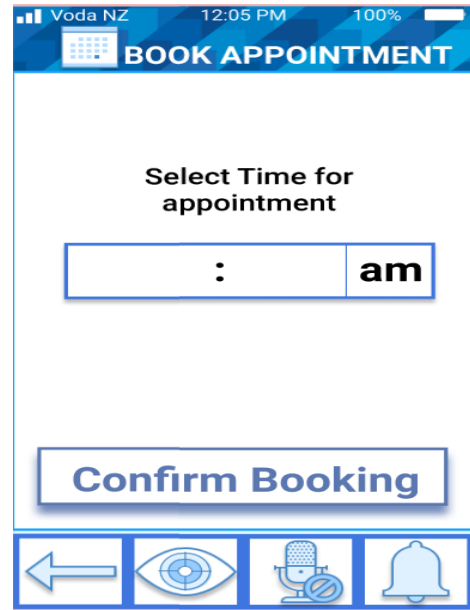
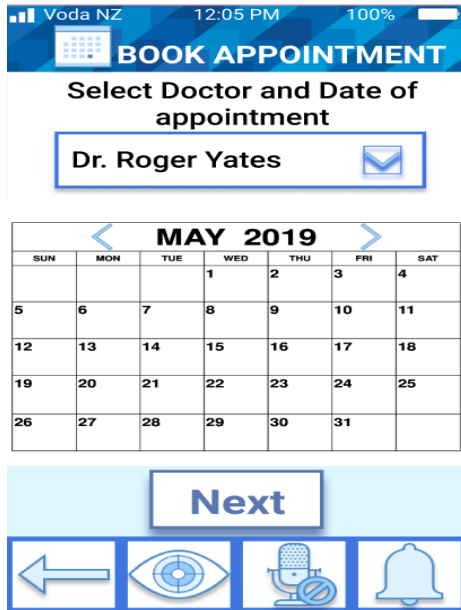


Figure 0.5: Screenshots of pages that users go through to book an appointment with their HCPs

d) Online consulting

Online consulting will be available all the time for survivors if they have any questions or health concerns. This feature enables users to communicate with the health centre to seek information (see Figure 0.6).

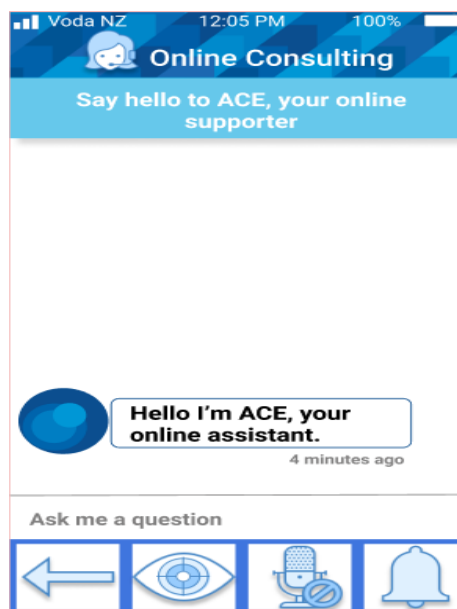


Figure 0.6: A screenshot of the Online consulting page

Connecting survivors to their HCPs will not only enable them to communicate with HCPs directly, but it will also enable HCPs to help survivors by prompting the recovery process by giving them guidelines, articles, and videos that will benefit survivors. As such, the design approach will serve as a convenient tool for quick medical intervention in remote areas where HCPs and medical services are not easily accessible. The intention is that this could bring comfort to survivors; they can socialise with other users as well as be able to communicate with their HCPs.

2- Chat room

The 'chat room' shown in Figure 0.7 is designed as a private chat room. The idea behind the private chat room is to allow users to message or call in private other users. Assuming that sometimes survivors would want to talk to a potential survivor and having a private room will allow them to only message a single user directly.



Figure 0.7: Screenshots of the Chat room pages

Indeed, some survivors may be too shy to communicate with all users at the same time. They may find it hard to even participate in the conversation, therefore, having a chat room would allow those users to communicate directly with other users. The chat room has the following features as shown in Figure 0.7:

- ***Camera - Able to take a photo and send it to another user***
- ***Album - Able to search for a photo in the phone album and send it to another user***
- ***Video call - Able to video chat with another user***
- ***Voice call - Able to voice call another user***
- ***Location - Able to share location with another user.***
- ***Contact - Able to share contact with another user***
- ***Setting - You can customise the chat room such as background colour.***
- ***Search - Able to search for another user***

The main idea behind all these features is to allow survivors to socialise with other users. Most social applications allow users to chat, send pictures, and send videos. As such, the chat room gives the users something that they would be familiar with, because some may already use Facebook messenger or WhatsApp. All these applications are existing social platforms. As such, when survivors are adapting to this prototype, they would also have something familiar to use, which may increase survivors' willingness to accept this application.

3- Group chat room

The idea behind the '*group chat*' is to allow all users to communicate with each other in groups. Some users would not know who to communicate with when they first connect so the group chat would allow all survivors to welcome the new member, making the user feel welcome. When users do not have anyone to communicate with, they may end up uninstalling the application from their mobile devices. The group chat

room not only will attract users to keep using the application, but it will also allow survivors to communicate with one another (see Figure 0.8).

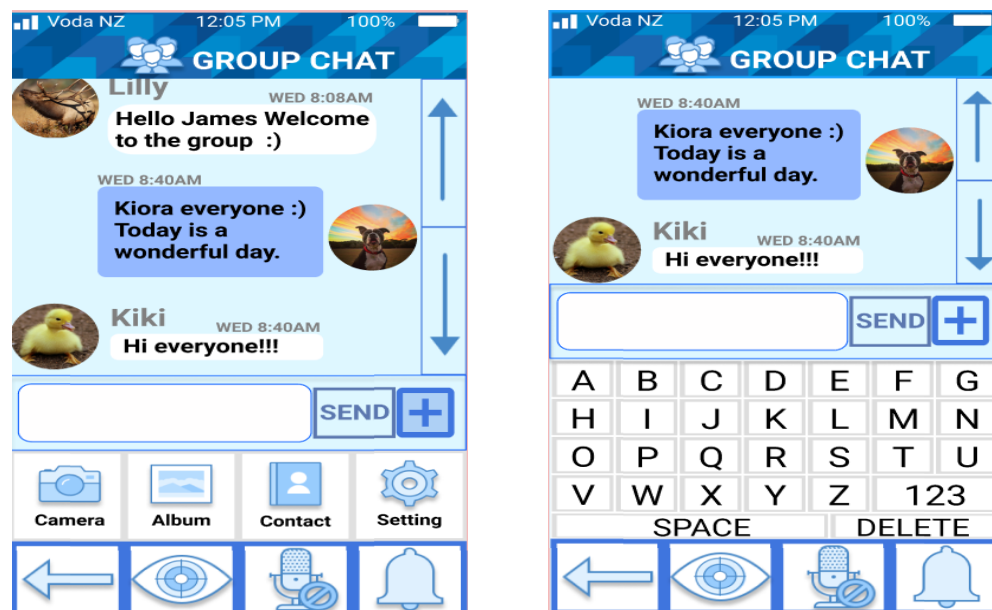


Figure 0.8: Screenshots of the Group chat page

When a new member joins the application, a notification would not only be sent to the homepage, but also to the group chat. Some survivors may not be paying attention to their notification instead they can also get a notification on the group chat, informing all members that a new member has joined.

In the group chat, there are two different colours used to identify which text box is yours and which text box is the other member's. The following features are also added to increase the level of interaction among survivors.

- **Camera** - Able to take a photo and send it to other users
- **Album** - Able to search for a photo in the phone album and send it to other users
- **Contact** - Able to share contact with other users
- **Setting** - Users can customise the chat room such as background colour

4- *Setting page*

Figure 0.9 shows the setting page where users will be able to reset features.

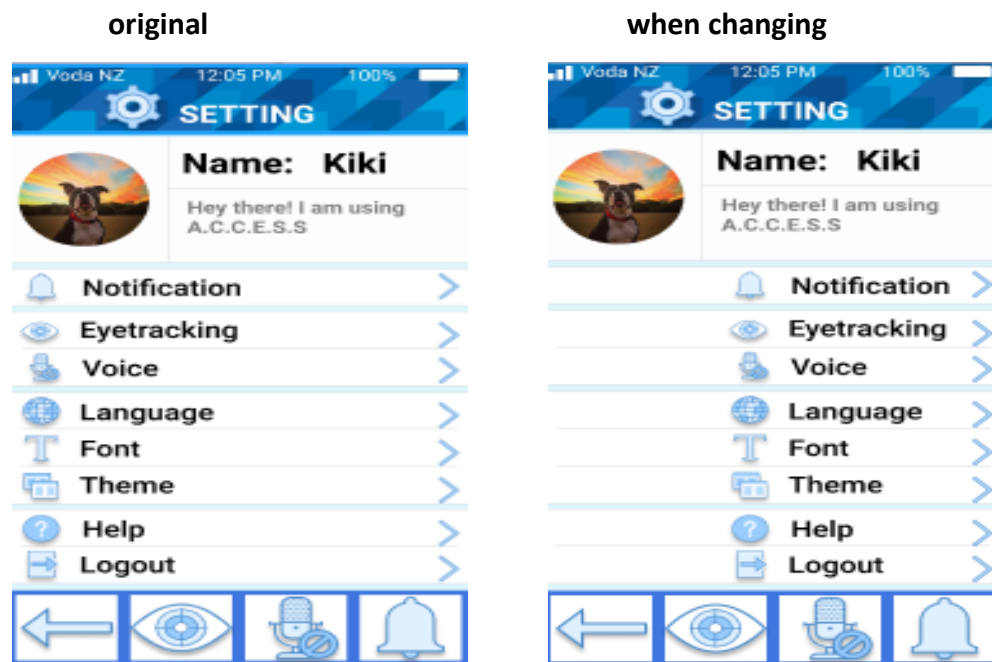


Figure 0.9: We designed this way to increase accessibility and address guideline #2

To apply guideline #9, the setting page is designed in a way to facilitate the use of the application by survivors who are experiencing challenges, for example changing font size to increase readability. The setting page contains the following pages as illustrated in Figure 0.9.

a) *Setting Notification*

Survivors can set a notification. The notification feature will ensure people are notified when a new user joins, and prompt users when with medical reminders, about events coming up, personal and medical status being posted. Some survivors may feel a lot of pressure, so they can turn off the notification and this will allow them to not receive any notification. However, the only notification that is compulsory for users to receive is their medication reminders.

b) *Setting eye-tracking*

Survivors are also able to reset eye tracking because all these features will be set from the very beginning when they first signed up (see Figure 0.10).

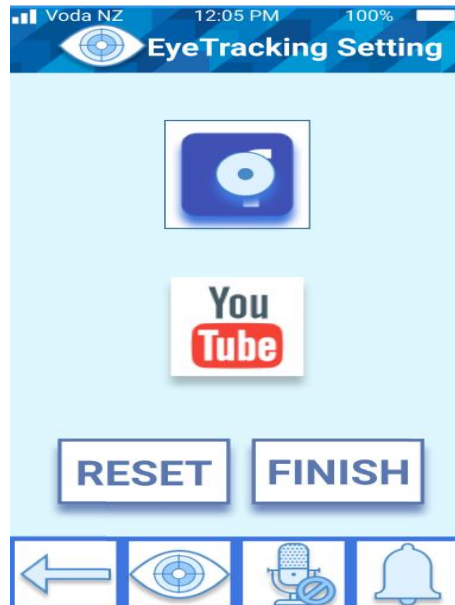


Figure 0.10: A screenshot of the eye-tracking setting page

c) *Setting voice*

This is where the user can activate or deactivate voice. The voice responds to the user. For example, if a survivor wants to video call Jerry, the user can say “please call Jerry” and the voice will respond by calling Jerry (see Figure 0.11).

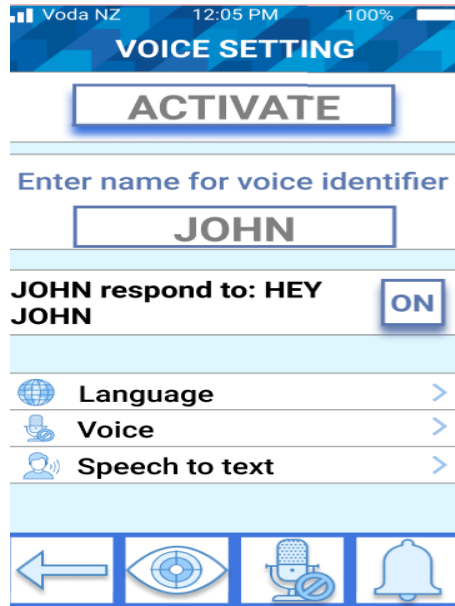


Figure 0.11: A screenshot of the setting voice page

d) *Setting Language*

This feature allows survivors to apply their preferred languages, therefore, guideline #7 is applied.

e) *Setting Font*

Survivors can set the font size if they think that the font size is still too small. With the font setting, survivors will also be able to move text from the left side to the right.

f) *Setting Theme*

Survivors can customise the background.

g) *Setting help*

The help setting will contain everything about the prototype, what features are there, how each feature is used, and what their purpose is. Survivors will be able to

provide their feedback which can be collected as data for the purpose of future development and improvement of the application.

h) Logout

Survivors will be able to log out if they wish.

5- Home

The home icon will get survivors to a page where they can search, check for upcoming events, and post their stories (see Figure 0.12).

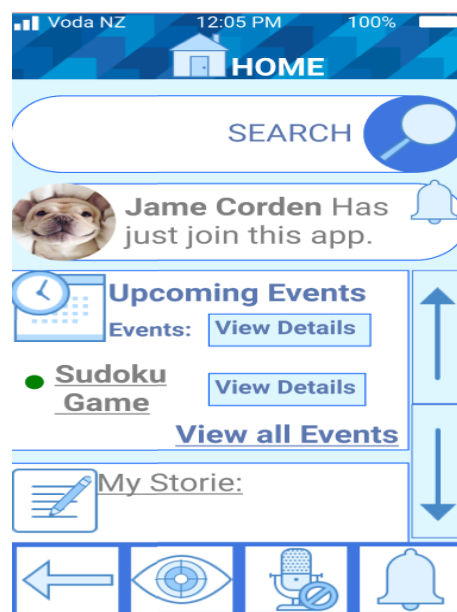


Figure 0.12: A screenshot of the Home page

a) Search

The search feature allows survivors to search for other members. With the search feature, survivors can search for other users as well as their HCPs.

b) Notification

The notification feature on the home page is to inform survivors of new members joining, and new upcoming events, as well as remind users about their medication.

c) *Upcoming events*

This feature informs survivors of events that will be happening in the future. Therefore, survivors may be interested in participating/attending events where they can socialise so that they do not feel isolated or left out from having fun (see Figure 0.13).

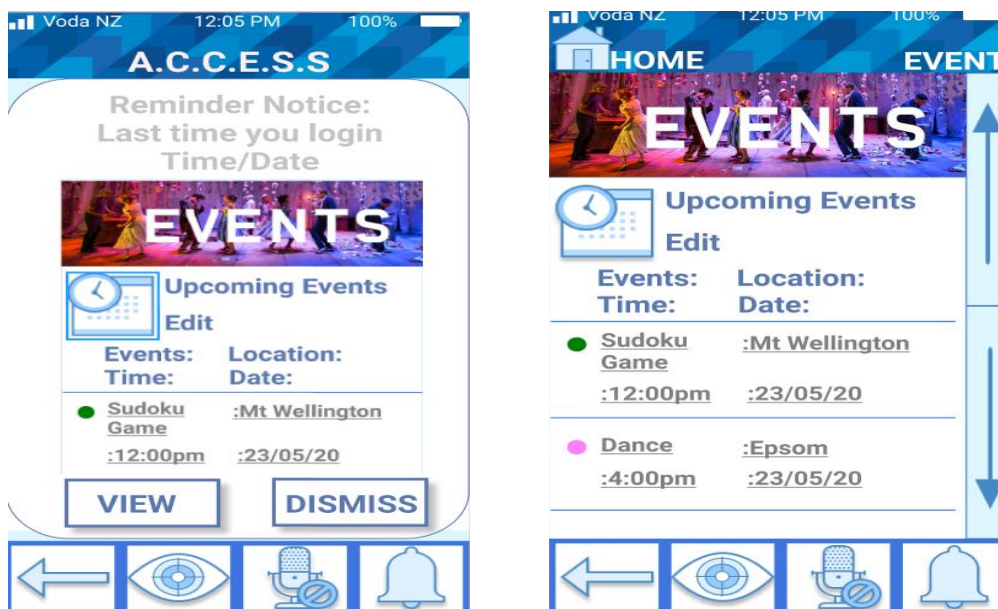


Figure 0.13: Screenshots of the Event pages

The Events page is aimed at local events that are organised by the local community, other users, or HCPs. The upcoming events are for survivors to socialise with each other, to make them feel comfortable being around people who have shared experiences. Upcoming events will include the events' name, time, date, and location.

d) *My story feature*

As shown in Figure 0.14, my story feature allows survivors to share their stories with other survivors, whether it is a photo, video, and article that could benefit other users. On their status, they can share with other users or add comments. It is to allow survivors to express what they have been through all the process of recovery, therapy,

and how they have overcome the fear of having a stroke. It is all to benefit one another, to support and encourage each other.

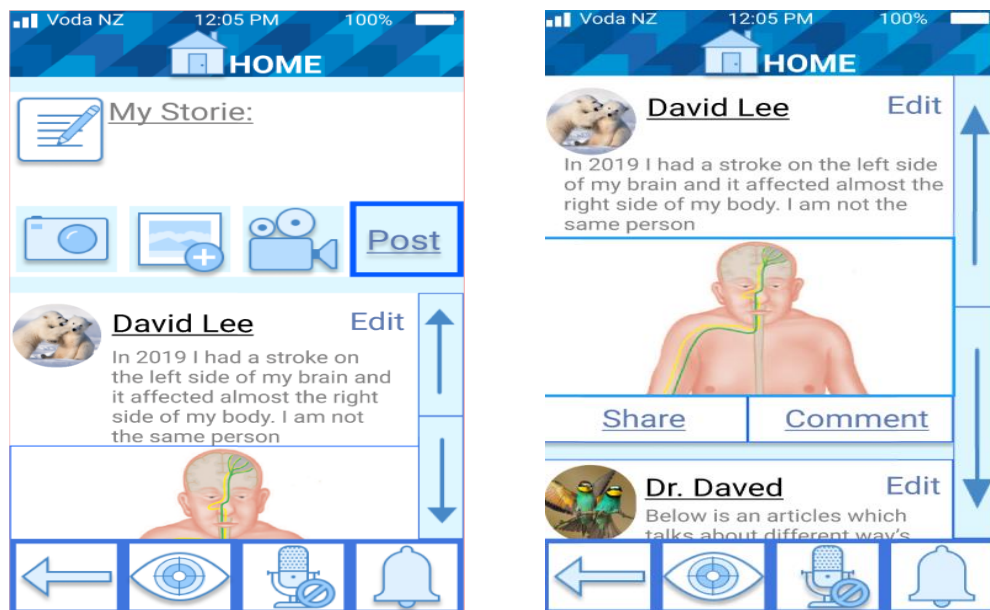


Figure 0.14: Screenshots of the my story's pages

The main purpose of naming it 'my story' instead of status is that survivors have gone through a lot with stroke and 'my story' means I am telling my story, sharing my experiences. Being able to share your story with others can also help other users who have recently experienced a stroke and that are new to it. It is anticipated this could help them feel less isolated knowing that they are not the only ones managing post-stroke. The intention is to bring the stroke community together and to be able to stand together, support one another, and make sure that each and every one is not going through this alone.

6- Main icons on the bottom of each page



Figure 0.15: A screenshot of the main icons

At the bottom of each page, four main icons allow survivors to use either eye-tracking or voice recognition features to increase UX. survivors can also use the 'arrow' icon to get back to the previous page (see Figure 0.15).

a) *Eye-tracking*

One of the main features of this prototype is eye-tracking (see guideline #11). Although this feature was not functional in practice, I needed to create a page to illustrate to survivors what this feature can do. The main purpose of this feature is to enable people with upper limb or communication impairments to use the application. The eye-tracking function will scan the user's face, it moves on to the next page allowing users to choose how they would want to express themselves in selecting something such as using a smile to select the chat icon (see Figure 0.16).

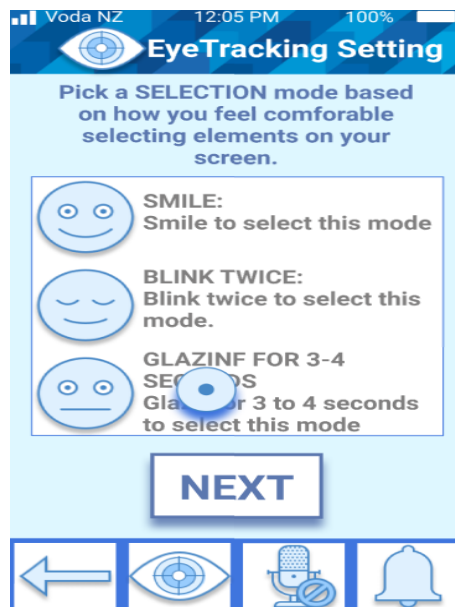


Figure 0.16: Screenshots of the eye-tracking setting pages

b) *Voice recognition*

Voice recognition will be used to benefit survivors who have upper limb impairment or dexterity issues that make using the mobile phone challenging. The voice

recognition will also allow survivors to ask for a task to be completed when first signing up with the application. As a result, guideline #3 will be applied.

c) Reminder

The reminder feature is a feature that supports cognitive impairment. The idea behind this feature is to remind survivors what they need to do, such as taking medication or upcoming events.

7- Keyboard design

The numeric keyboard shown in Figure 0.17 was designed to be simple. It only has numbers from 0-9 and a delete button. The alphabetic keyboard is also designed to be simple and is in alphabetic order. It has letters from A-Z and has both a space and delete button. Both keyboard fonts are large enough for survivors to recognise, see, and are easy to use.

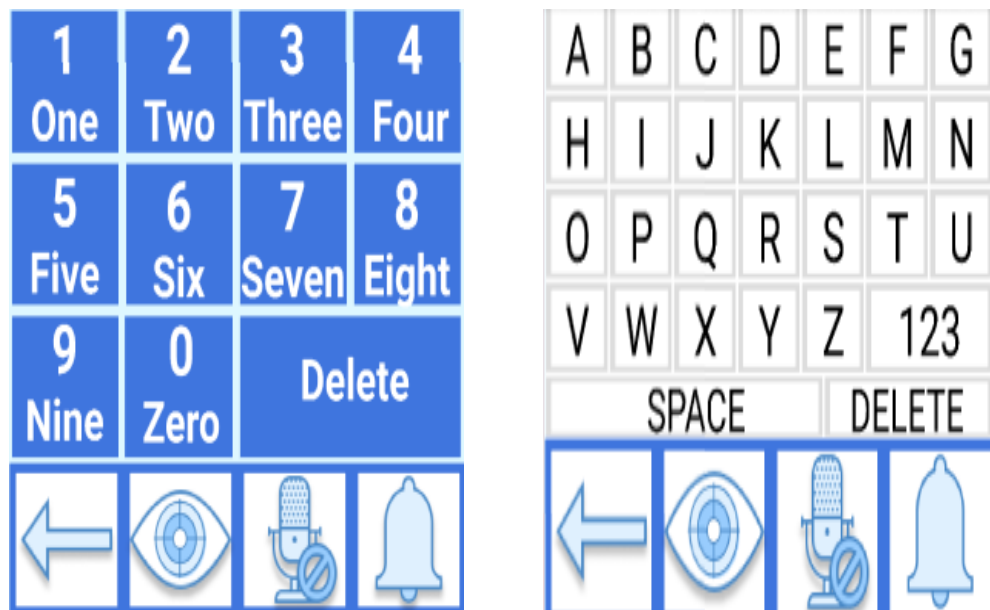


Figure 0.17: Screenshots of both keyboards

The keyboard will also have autocompletion and auto-correction functions. These will finish a word being typed. It is faster and easier for users to use and saves time when typing.

Appendix M: Approval letter for ethics application



AUTEC Secretariat

Auckland University of Technology
D-88, WU406 Level 4 WU Building City Campus
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

AUT

9 November 2017

Robert Wellington
Faculty of Design and Creative Technologies

Dear Robert

Ethics Application: 17/364 Use of the mobile-based self-management applications among older adults with stroke: Barriers and drivers

Thank you for submitting your application for ethical review. I am pleased to advise that the Auckland University of Technology Ethics Committee (AUTEC) approved your ethics application at their meeting on 6 November 2017, subject to the following conditions:

1. Clarification of whether an app is being used in the interviews or focus groups. If it is, then identification of which app is being used, how it is being used, and what is involved in its use;
2. Provision of indicative questions for the interviews and the focus groups, providing the broad outline of what will be asked and what prompts may be used to obtain the desired information;
3. Clarification of what communication difficulties are likely to be encountered and inclusion of advice in the interview protocol of how these will be managed;
4. Provision of an assurance that people who are unable to consent will not participate in the research. AUTEC advises that an Enduring Power of Attorney is unable to give consent for participation in research;
5. Clarification of whether people are able to choose to take part an interview or a focus group, and if so, how this will be managed;
6. Provision of an assurance that no focus groups will take place in private homes;
7. Reconsideration of how much time participants are being asked to contribute to the study. AUTEC observed that 90 minutes may be too long for a stroke survivor;
8. Reconsideration of what level of confidentiality can be offered in a focus group setting and inclusion of advice about this in the Information Sheets and Consent Forms;
9. Removal of the information about counselling in the Information Sheets and reconsideration of whether or not the advice about Accident Compensation cover needs to be included.

Please provide me with a response to the points raised in these conditions, indicating either how you have satisfied these points or proposing an alternative approach. AUTEC also requires copies of any altered documents, such as Information Sheets, surveys etc. You are not required to resubmit the application form again. Any changes to responses in the form required by the committee in their conditions may be included in a supporting memorandum.

Please note that the Committee is always willing to discuss with applicants the points that have been made. There may be information that has not been made available to the Committee, or aspects of the research may not have been fully understood.

Once your response is received and confirmed as satisfying the Committee's points, you will be notified of the full approval of your ethics application. Full approval is not effective until all the conditions have been met. Data collection may not commence until full approval has been confirmed. If these conditions are not met within six months, your application may be closed and a new application will be required if you wish to continue with this research.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

I look forward to hearing from you,

Yours sincerely



Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: soheila.mohammadyari@aut.ac.nz; Nicola Kayes; Dave Parry

Appendix N: Final AUTEK approval letter



AUTEK Secretariat

Auckland University of Technology
D-88, WU406 Level 4 WU Building City Campus
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

1 December 2017

Robert Wellington
Faculty of Design and Creative Technologies

Dear Robert

Re Ethics Application: **17/364 Use of the mobile-based self-management applications among older adults with stroke: Barriers and drivers**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEK).

Your ethics application has been approved for three years until 1 December 2020.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through <http://www.aut.ac.nz/researchethics>.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through <http://www.aut.ac.nz/researchethics>.
3. Any amendments to the project must be approved by AUTEK prior to being implemented. Amendments can be requested using the EA2 form: <http://www.aut.ac.nz/researchethics>.
4. Any serious or unexpected adverse events must be reported to AUTEK Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEK Secretariat as a matter of priority.

Non-Standard Conditions of Approval

1. Moderation of the overly influential reference to 'your participation is vital' in the costs section of the Information Sheet;
2. If interviews are occurring in private homes, the supervisor must review a safety protocol.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEK before commencing your study.

Please quote the application number and title on all future correspondence related to this project.

AUTEK grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,



Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: soheila.mohammadyari@aut.ac.nz; Nicola Kayes; Dave Parry

Appendix O: Safety protocol designed for the researcher's safety



Use of mobile-based self-management applications among older adults post stroke: Barriers and Drivers

Researcher safety protocol

Project supervisors: Dr. Robert Wellington, Assoc. Prof. Nicola Kayes, Assoc. and Prof. Dave Parry
Researcher: Soheila Mohammadyari

To safeguard the researchers during the single face to face interview, the following precautions will be put in place.

Before the interview

- Engage in phone conversation when arranging interview and gather information to make assessments
- Consider the physical area / location
- Consider will other people be in the house during the interview?

Preparation for the interview

- Notify someone of the intended visit or planned itinerary – if this is a significant other, they will be asked to sign a confidentiality form.
- leave contact details (phone number)
- name address and phone number of the participant you are visiting
- the time of the visit
- Carry a charged and active cell phone
- Turn your phone on (it can be on silent to avoid disturbances)
- Dress respectfully and appropriately

During the interview:

- Being respectful to the host
- Keep keys and phone on your person
- Park your car in a way that you can make a quick exit – do not park in a drive where you can be blocked in

After the interview:

- Check in on return of interview and let someone know the interview is finished
- Arrange for someone to call / text if the visit takes longer than anticipated – consider the use of code phrase

Approved by the Auckland University of Technology Ethics Committee on 09/11/2017 AUTEK ref no. 17/364

Appendix P: Definitions of four core post-stroke complications

Core complications	Definitions
Physical complications	Refers to physical inability after a stroke that limits survivors to perform daily activities which include ‘hemiplegia’, ‘hemiparesis’, ‘spasticity’, ‘contractures’, ‘hemianopsia’, ‘dysphagia’ and ‘aphasia’; in other words, lack of mobility, inability to use objects, stiff muscles, issues with vision, difficulty swallowing, issues with physical activities and speech problems (Koenig-Bruhin, Kolonko, At, Annoni, & Hunziker, 2013).
Emotional complications	Refers to uncontrollable emotions that can cause problems in post-stroke social situations such as ‘pseudobulbar’, ‘personality changes’, ‘identity issues’, ‘anxiety’ and ‘depression’. https://www.stroke.org/we-can-help/survivors/stroke-recovery/post-stroke-conditions/cognition/aphasia/ https://www.saebo.com/coping-emotional-changes-stroke/ https://www.stroke.org.uk/effects-of-stroke/changes-to-behaviour https://www.everydayhealth.com/anxiety/anxiety-and-depression.aspx
Psychological complications	Refers to post-stroke psychological effects that change survivors' behaviour such as social isolation, and a lack of independence, self-esteem and confidence (Horne et al., 2014).
Medical complications	Refers to post-stroke complications that are associated with poor functional outcomes such as ‘seizures’, ‘bedsores’, ‘pneumonia’, ‘deep venous thrombosis’, ‘headaches’, and ‘fatigue’. https://epilepsychicago.org/epilepsy/seizure-types/generalized-seizures/ https://medbroadcast.com/condition/getcondition/bedsores https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc20354204 https://www.healthline.com/health/deep-venous-thrombosis https://www.sciencedaily.com/releases/2013/05/130508122841.htm https://www.saebo.com/tired-after-a-stroke-understanding-post-stroke-fatigue/